IUL School of Social Sciences
Department of Social and Organizational Psychology

The science of scientific agendas – insights into the agenda setting process of researchers

João Miguel da Costa Sobreiro Marques dos Santos

Thesis specially presented for the fulfillment of the degree of
Doctor in Psychology

Jury:
PhD Diniz Lopes, Auxiliary Professor, Instituto Universitário de Lisboa (ISCTE-IUL)
PhD Alberto Amaral, Full Professor, Universidade do Porto
PhD Jorge Correia Jesuíno, Retired Professor, Instituto Universitário de Lisboa (ISCTE-IUL)
PhD Teresa Carvalho, Associate Professor, Universidade de Aveiro
PhD Patrícia Arriaga, Auxiliary Professor, Instituto Universitário de Lisboa (ISCTE-IUL)
PhD Hugo Horta, Auxiliary Professor, University of Hong Kong
PhD Lígia Amâncio, Retired Full Professor, Instituto Universitário de Lisboa (ISCTE-IUL)

November, 2019

Acknowledgements

This is perhaps the most difficult section to write, as the amount of people who contributed directly or indirectly to this thesis is such that it would be quite easy to forget someone who would be unjustly left out. To the best of my capacity, I would like to give thanks:

To Hugo, who went above and beyond in providing support throughout this long process which began 6 years ago. This thesis would simply not be possible without this invaluable help.

To Lígia, who took me in, so to speak, when I first arrived in ISCTE, and assisted me throughout the thesis.

To Carla Moleiro, the first person I met when I arrived in ISCTE and helped me greatly in getting settled in throughout the first year of my PhD.

To Marta, for being the best friend I could ever ask for.

To the countless researchers from across the globe who participated in this study and helped me better understand how science moves forward.

To all the friends I talked with regarding this thesis throughout the last years, for the many discussions over a cup of coffee or a beer, most of which late into the night – my heartfelt thanks. It is through you all that many of the ideas contained here emerged, and even though you might not be aware of it, this thesis is also yours.

The present work was funded by a doctoral grant (PD/BD/113999/2015) from the Portuguese Foundation for Science and Technology [Fundação Portuguesa para a Ciência e a Tecnologia].

Abstract

Even though research agenda-setting is at the core of modern research and development activities, little is known regarding the process that leads to the definition of an agenda. The literature indirectly suggests that a series of both exogenous and endogenous factors may shape the preference of researchers concerning the research agendas they intend on pursuing – such as formal education, hierarchical position, working environment, incentives, scientific drive, creativity, risk tolerance, and personality. However, no study has been conducted in order to formally test these associations comprehensively. This project aims to identify the mechanisms underlying research agenda-setting through a multi-stage, multi-disciplinary approach. To this end, new instruments were developed – one focusing on evaluating the factors that influence research agenda setting, and another focusing on workplace related organizational aspects in the academia. Following this, Cluster Analysis was employed in order to determine the existence of overarching doctrines in terms of research agenda setting, and afterwards we explore how cognition can influence the process of research agenda setting. This was followed by an exploratory study on how the organizational setting influences these dynamics and how research agendas are also gendered. A second, more holistic, comprehensive and optimal revision of the initial research-agendas instrument concludes this project, resulting from lessons learned and knowledge acquired as the thesis was being developed. The thesis concludes with an overall discussion of the findings and its contribution to knowledge advancement, implications for practice and policymaking, and the limitations of the study, as well as an agenda for future studies.

Keywords: research agendas; science policy; science and technology; higher education; science studies

PsycINFO Codes:

2260 Research Methods & Experimental Design

2910 Social Structure & Organization

3040 Social Perception & Cognition

3660 Organizational Behavior

Resumo

Apesar do processo de definição de agendas científicas estar no cerne da investigação e desenvolvimento de hoje em dia, pouco se sabe acerca do processo que leva à definição destas agendas. A literatura indirectamente sugere que uma série de factores endógenos e exógenos moldam a preferência dos investigadores no que toca à agenda de investigação que intencionam seguir – tais como educação formal, posição hierárquica, incentivos, ambição científica, criatividade, tolerância ao risco, e personalidade. No entanto, até à data nenhum estudo foi realizado de forma a formalmente testar estas relações de uma forma compreensiva. Este projecto tem como objectivo identificar os mecanismos subjacentes ao processo de definição de agendas científicas através de uma abordagem multi-fásica e multi-disciplinar. Para este fim, foram desenvolvidos novos instrumentos – um focado na avaliação dos factores que influenciam a definição de agendas científicas, e outro focado nos aspectos organizacionais da academia. De seguida, realizou-se uma análise de clusters de forma a identificar a existência de doutrinas gerais em termos de definição de agendas científicas. Seguiu-se um estudo exploratório relativamente ao contexto organizacional e a sua influência nestas dinâmicas, assim como o efeito do género nas agendas científicas. O projecto conclui com uma revisão mais holística do instrumento original, resultante das lições que foram aprendidas, assim como da informação que foi recolhida ao longo da tese. Esta tese termina com uma discussão geral dos seus resultados e implicações para o avanço do conhecimento, para a prática e desenvolvimento de políticas, assim como uma agenda para estudos futuros.

Palavras-chave: agendas científicas; política científica; ciência e tecnologia; ensino superior; estudos em ciência

PsycINFO Codes:

2260 Métodos de Investigação e Design Experimental

2910 Estrutura Social e Organização

3040 Percepção Social e Cognição

3660 Comportamento Organizacional

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Chapter 1
Background and Introduction

"The scientist is not a person who gives the right answers,
he's the one who asks the right questions."

Claude Levi-Strauss

An argument for the study of research agendas

At the beginning of civilization, human knowledge was little more than a chaotic disarray of loose ideas and vague claims, until the most primordial forms of knowledge creation began emerging in 3000 BC (Lindberg, 2010), albeit largely under the form of trial-and-error. These earlier attempts at comprehending reality gave birth to philosophy, mathematics, astronomy, and many other fields of knowledge. Understanding the natural world, human nature, societal behaviors and actions was always part of being human, as well as trying to identify the meaning of life. The prevalence of efforts to better understand reality has had high and low points throughout the course of human history, but through the obscurity of the Dark Ages and into the Renaissance and the Age of Enlightenment, their impact on human civilization has been undeniable. However, science as we know it is a relatively recent development. In hindsight, one can look back and erroneously assume that the creation of knowledge in earlier times followed the same rules as those employed in modern day, but this is merely illusory, as the paradigms which govern science are incommensurable (Kuhn, 2012). Although early forms of the scientific method can be found as early as during the Middle Ages (for example, as evidenced by the works of Ibn al-Haytham and Roger Bacon), it was not until the Enlightenment and the scientific revolution that modern science emerged (Cohen, 1976), triggered by monumental works such as Nicolaus Copernicus's *De revolutionibus orbium coelestium* (1543) and Isaac Newton's *Philosophiæ Naturalis Principia Mathematica* (1687). The term "scientist" did not emerge until the 19th century (Somerville, 1858), roughly at the same time when the first global scientific communities began to take form (Pietsch, 2010). Science had, by then, become a concerted effort.

To many, science itself is an ivory tower, and its inner workings as mysterious as those who practice it. Kuhn (2012) considered science as a process of systematic puzzle-solving where problems are addressed and organized under an existing paradigm, the collective fundamentals agreed upon by the members of a given community. This process occurs until an anomaly arises, one which can no longer fit into the existing order of things, paving the way to a crisis. This heralds the end of normal science and the beginning of extraordinary science. From it, a new paradigm will eventually emerge; parts of the old paradigm will have to be discarded, or changed, and research will continue anew but under new fundamentals – a process which resonates with the philosophical notion of dialectics, the clash between thesis and antithesis which will give birth to a synthesis, incorporating the stronger parts of both (Kant, 2013; Mueller, 1958). Intuitively, most researchers know this – to "re-search" is, after all, to "search again".

The pursuit of the unknown has always been at the heart of mankind's collective drives, and it is this eagerness to acquire knowledge which is made manifest under the form of the scientific endeavor (Heilbron, 2003). Underlying this is the philosophy of positivism, which states that knowledge can only be garnered from the observable (Acton, 1951). Upon its emergence, positivism asserted that the metaphysical must give way to the scientific method (Comte, 1855) – this had deep implications in particular for the social sciences, to which scientific rationalism was also extended, giving birth to new fields of study such as Sociology (Durkheim, Catlin, Mueller, & Solovay, 1938). Thus, the scientific method, in its most basic form, is a process of knowledge acquisition through the testing of falsifiable hypothesis (Newton, 1687). This much, at the very least, is universally accepted; however, in this thesis we will not concern ourselves so much with science as we will with its practitioner, the researcher. Asking any researcher to define the scientific method will, most likely, yield very similar answers; but if one were to ask two different researchers what they are specifically working on, the most likely outcome is receiving completely disparate replies. Science, as it stands, is not monolithic in nature, and the research which drives it forward is likewise comprised of differing traditions, drives, cultures, and *modus operandi* which make the path as different as the destination itself.

And as dynamic as these paths are, so are the individual drives and choices of those who research. Some individuals can excel by pursuing a singular topic throughout their entire careers, while others will shift dramatically at some point; many of the authors cited further ahead in this thesis began, for example, as theoretical physicists and ended up viewing themselves as historians of science further down the road. Furthermore, some researchers become well-known outside of their particular field, even to the general public, while others are virtually unheard of beyond the boundaries of their community. It was once considered that these individuals held a "sacred spark", an inner driving force which fueled their efforts towards discovery (Cole & Cole, 1973; Rodgers & Rodgers, 1999). However, it is now more generally accepted that their success and proclivity to create new knowledge is mostly due to dynamics of cumulative advantage. This is a process through which those who publish tend to publish more, as publications evidence apparent scientific capacity and potential warranting them to acquire more resources from funding agencies and other institutions, which on its turn will lead them to keep publishing more and more often (and often in collaboration with others that want to work with them), and thus creating a virtuous cycle. Those who initially publish less tend to stay behind the curve (Allison, Long, & Krauze, 1982; Allison & Stewart, 1974); this is referred to as the Matthew effect (Merton, 1968), and it is the reason why such asymmetry exists in science, at least concerning publication and citation rates. However, how did some researchers acquire such advantages in the first place? As mentioned before, no two researchers are alike, and neither is their work.

This led to some attempts to study research from a social perspective, of which one of the first was conducted by Latour & Woolgar (1979). In this study, Latour immersed himself in a laboratory taking the role of a naïve observer who actively took part in its daily activities, with the goal of better understanding the inner workings of the laboratory life, which were – until then – somewhat of a black box. As stated by Bruno Latour and Steve Woolgar:

Whereas we now have fairly detailed knowledge of the myths and circumcision rituals of exotic tribes, we remain relatively ignorant of the details of equivalent activity among tribes of scientists, whose work is commonly heralded as having startling or, at least, extremely significant effects on our civilisation. (…) Although our knowledge of the

external effects and reception of science has increased, our understanding of the complex activities which constitute the internal workings of scientific activity remain undeveloped. (Latour & Woolgar, 1979, p. 17)

This idea was particularly evidenced as the central focus of Becher & Trowler (2001)'s seminal work – "Academic Tribes and Territories". In this essay, the authors employ the metaphor of tribes to describe the differences between the various disciplines of science. At a top-level, the various fields of science can be loosely categorized into four distinct archetypes, based on them being either "hard" or "soft" science, and "pure" or "applied": hard-pure, in which we can find for example physics; soft-pure, as is the case of humanities; hard-applied, such as medicine; and soft-applied, in which we can find, for example, psychology. The classification itself is not as important for the topic at hand as is the underlying implication, which is duly noted by the authors – each of these tribes have their own cultures, discourses, artefacts, creating their own *ethos* and sense of identity to the respective tribesmen. However, the authors also note that the boundaries between some of these territories are tenuous, and occasional "raiding parties" – employing their own metaphor – venture forth into adjoining lands. This creates some common grounds in which shared methodologies, concepts, and ideas can be found. However, we will argue that these common grounds go deeper than what can be found at the surface.

Indeed, one can make an argument that, in anthropological terms, certain concepts from one field manifest themselves elsewhere under a different guise. Similarly to how most human cultures hold a creation myth which tends to be specific in content but similar or even identical in principle (Sproul, 1979), there are ideas which are part of the *mythos* of a given field but yet not specific to it. Let us consider for a moment the idea of *uncertainty*. If we delve into the topic of quantum physics, it will not be long until we run across Heisenberg's Principle of Uncertainty (Heisenberg, 1983). In layman's terms, it states that it is not possible to simultaneously know with absolute precision the position and momentum of a given particle, reflecting that reality itself is *uncertain* by nature. In quantum physics, this is stated explicitly – but if one goes just a little beyond the surface, we can find the exact same myth, for example, in data science – as an implication of the Curse of Dimensionality (Keogh & Mueen, 2010). The Curse is often interpreted in one

of two manners – the first one, and more directly relatable, is the fact that humans, existing in a three-dimensional plane, cannot directly observe hyperdimensional spaces (Köppen, 2000). This means, that for example, it is not possible to visualize data with more than three dimensions and is a limitation that most researchers will likely encounter at some point – even if they are not aware that there is a name to this phenomenon. The second and more technical interpretation of the Curse of Dimensionality is the fact that, as a given data matrix increases in dimensionality, the resulting matrix tends to become sparse as a significant amount of space will be void of datapoints while also causing exponential increases in computational requirements as well as greater difficulty in extrapolation (i.e., "overfitting") (Bungartz & Griebel, 2004). One way to overcome this is by projecting hyperdimensional data into two or three-dimensional spaces, where it can be visualized, and generally yields a non-sparse matrix (Agarwal, El-Ghazawi, El-Askary, & Le-Moigne, 2007). A major concern when applying such methods is maximizing information gain by reducing entropy. As it turns out, the definition of entropy, according to information theory, is the *uncertainty* of a given variable (Ghahramani, 2006). Thus, two entirely different fields tackle the exact same issue – in this case, *uncertainty* – from different angles and using different tools.

This notion of parallel convergence through divergence resonates with the concept of science as a republic, as presented by Michael Polanyi (2000). Polanyi considers that the scientific endeavor, as a republic, consists of a myriad of independent initiatives loosely working together towards an unknown future, or, as Polanyi puts it, "the joint discovery of a hidden system of things" (Polanyi, 2000, p. 2). In this sense, the previous given example regarding uncertainty fits into this idea of science as a republic. Such a process can be argued as desirable in handling complex issues – as is the case of uncertainty – which are prevalent in many areas of science and can be considered ill-structured problems – those without clear paths to a solution (Simon, 1973). Indeed, these types of problems represent a great deal of the challenges presented to modern day scientists, and a reason why multi-disciplinary approaches are considered necessary (e.g., Martimianakis & Muzzin, 2015; Schut, van Paassen, Leeuwis, & Klerkx, 2014). This is an important notion to keep in mind, as the ideas of convergence and divergence will be a recurring theme throughout this thesis.

In the same manner, it is also possible to argue that no two institutions are alike despite the existence of common ground. While world class universities are known to focus more on quality over quantity (Radojicic & Jeremic, 2012), and provide greater funding and freedom to their researchers (Altbach, 2003), this is not the case in a great deal of institutions. As researchers, we know that in present day we must publish lest we perish. The emergence of managerialism and performativity has led to many institutions adopting a corporate-like push for efficiency in terms of publications (Deem, Hillyard, Reed, & Reed, 2007), curbing the freedom of the individual researcher (Schrecker, 2012) who is then left with little choice but to publish in increasing amounts (Levin & Aliyeva, 2015) – at some point, survival, rather than scientific discovery, will become his goal (Rzhetsky, Foster, Foster, & Evans, 2015). Although these policies and the transformations that resulted from them have been shown to result in better productivity in terms of quantity (Brew, Boud, Crawford, & Lucas, 2018), autonomy is lost as a result, the laboratory becomes a production pipeline (Edgar & Geare, 2013), and discovery is curtailed (Young, 2015). This neo-liberal paradigm has largely permeated Higher Education systems all over the world (Jemielniak & Greenwood, 2015), even though the type of incentives each institution implements and the strategies they follow, as well as the challenges they face, vary on a case-by-case basis (e.g., Athanassopoulos & Shale, 1997; He, 2016; Radojicic & Jeremic, 2012; Tham & Kam, 2008). Thus, disparate institutional realities, similarly to the field of science, cannot be the sole explanation for the differences between researchers.

Despite the fact that each field of science has its own *ethos,* and the same can be said for each institutional reality, we argue that there are certain aspects to the creation of knowledge which are intrinsic to the individual and thus, again, disciplinary and institutional differences alone cannot account for the immense variability that underlines scientific advancement. This is Michael Polanyi (2012)'s notion of "personal knowledge" – that the act of knowing is personal, irrespective of the field of the knower, and depends more on the individual's degree of connection and sensitivity to reality than on objective scientific facts. Polanyi called this "tacit knowledge" – knowledge which cannot be easily translated into words and is largely intrinsic to the individual. The existence of this deeper level of knowledge means that we must consider that disciplinary and institutional

differences, although important, are not the only factors accounting for differences between scientists.

Thus, we know that each academic tribe, be it a field of science or a laboratory, has its own *ethos* (Becher & Trowler, 2001; Latour & Woolgar, 2013); we know also that are some common goals concerning which unknowns are meant to be made known (Kuhn, 2012), even if the path taken there is walked independently (Polanyi, 2000); and finally, we also know that the creation of knowledge is meant to be personal (Polanyi, 2012). Academic research is a process known to contain several layers of complexity. It relates to the identity of academics, it influences the sense of belonging that academics have to specific communities, and it is influenced by overlapping institutional realities. Academic research has been analyzed from perspectives emphasizing inequality, internationalization, mobility, its association to gender, careers, and work-life balance (e.g., Kwiek & Antonowicz, 2015); but what seems to have been overlooked is the identification of factors that influence the research agenda setting of individual researchers. A possible reason explaining this is that if one considers academic research from the perspective of a production model, quite often the research agenda setting comes before the input, or it results from the less visible outcomes of a previous research project. In other words, it is a more intangible part of the process, but a very important one. It is through the researcher's agenda that science is either advanced or consolidated, and the factors and processes that converge into this singular choice were, until now, inside a black box – one which we endeavored to open with this thesis, and through that shed some light into how science progresses at the individual level.

On the nature of agendas, scientific or otherwise

In globalized, fast-paced, complex, and uncertain societies, understanding the agenda setting of highly qualified people - such as academics - becomes increasingly important due to their contribution to knowledge advancement (Pump, 2011). The concept of "agendas" originates from communication studies, where most of the body of literature rests. The original concept concerns agenda-setting and interaction between the

government, the public, and the media (Guo, Vu, & McCombs, 2012). Agendas are complex, mixed and interacting. They can be singular, collective, outspoken or hidden (Day, Grabicke, Schaetzle, & Staubach, 1981). Agendas vary between individuals as goals differ, aligned or not with those of the organization where individuals work (Schwartzman, 1981). Yet, the setting of research agendas – known to drive academics' work - is a thematic largely unexplored in the literature (Harris, 2001). The relevant question, is ***what drives academics to set specific research agendas that largely shape the knowledge they produce and their careers?*** It is known, from the literature that academics and researchers are strongly bounded by disciplinary frameworks, identities, and rationales (Becher & Trowler, 2001).

It is also known that research agendas are dependent on educational paths (Karvalics, 2013) but also on individual, group, and professional choices (Dennis et al., 1990). Studies that drawn from bounded rationality models have shown that agenda choices are constrained by four boundaries: individuals are not omniscient of every dimension of a given problem; decision-makers do not possess perfect information regarding their choices; individuals are faced with uncertainty regarding their decisions; and, individuals may not be fully aware of their own preferences (Simon, 1990). This idea, that choices have to be made under uncertainty, has been said to be the basis of all agenda-setting studies, ranging from organizational to individual-level agendas (Pump, 2011), and is of particular importance in certain fields of science due to the increasing complexity of emerging problems.

Careers are no longer considered linear paths, including those of academics (Cantwell, 2011). As the academic career becomes increasingly uncertain and complex, the study of research agenda setting cannot be understood from a one-dimensional perspective. Rather, it must combine cultural (associated to national, institutional and scientific field identities), social (sense of belonging to scientific communities and the influence of working place values, norms and incentive frameworks), and individual elements (personality traits and cognition). It also needs to consider the career dynamics, and time and career stage as a critical element (Latour & Woolgar, 2013). As academics develop activities in creative environments, the working activities and environment need to be at the center of the analysis (Hemlin, Allwood, & Martin, 2008; Latour & Woolgar,

2013). This entails analyzing academic's motivations (Bourdieu, 1999; Cole & Cole, 1973), research collaborations and networks (Horta & Santos, 2014), career incentives (Mangematin, 2000), career paths (Horta & Yonezawa, 2013), mentors' influence (Pinheiro, Melkers, & Youtie, 2014), and a better understanding of the working place as a social dimension (Csikszentmihalyi, 1999). Finally, this needs to be related to personality and other individual-level aspects, since empirical research has shown that agenda choices are also construed by individual personality traits (Gottfredson, Jones, & Holland, 1993).

The concept of agenda-setting has received limited attention in science studies (Harris, 2001). Despite the fact that the idea of "research agenda" is ubiquitous in science and research related artefacts, such as papers, proceedings, and others – the term appears to be used rather intuitively without much formal thought given to it. Indeed, the only formal definition of a "research agenda" we could find was in a quite recent article, where it is considered to be both a problem-solving framework in which to operate, and the set of actions taken to pursue these goals (Ertmer & Glazewski, 2014). Thus, a research agenda can be seen as both strategic and tactical, by having a high-level plan which is pursued by a subset of low-level actions.

The choice of a research agenda, although classically considered a highly personal choice (Polanyi, 2000), is nowadays constrained by exogenous factors such as limited funding, thus leading to prioritizing strategies at a high level which effectively pre-determine which avenues of research are pursuable at any given time (Bantilan & Keatinge, 2007). Panels of experts convene in some areas, especially in healthcare, in order to establish the most viable strategy to tackle a specific problem (Loeb et al., 2001; Smith, Mitton, Peacock, Cornelissen, & MacLeod, 2009). In these fields, individual choice is likely to be constrained mostly by hierarchy.

Even though most of the literature on agenda-setting has focused on fields not related to research nor research settings, there are some links which, over time, have emerged and will allow us to bridge the existing gap between agenda-setting and science policy studies. What follows is a review of some of the fragmented literature which was pieced together to serve as the building blocks for our model on research agenda setting.

On the determinants of research choices and agendas

First and foremost is the educational background (Karvalics, 2013). The simplest of all predictors, it is also the one with the most profound effect – evidently, the educational background of a researcher will from the onset determine in which field of science (sub-fields not withstanding) he will operate in throughout his career. For example, an individual who completes a degree in astrophysics is unlikely to end up performing research in medicine. This is closely linked to the concept of time as both a limited resource and also as an investment (Bourdieu, 1999) – the more time an individual invests in any given field, the less likely he is to "branch out" to other fields. However, recent studies have noted that the research pursued by scientists shift over the academic life cycle, usually consisting of a single research focus during the PhD stage, before diverging into typically unrelated trails at the post-doc level, before converging again later on (Horlings & Gurney, 2013). Despite this, acquiring a position of authority in a field of science takes quite some time and thus convergence is eventually attained - and this brings us to another critical motivator for researchers – scientific ambition. Most scientists are driven by some measure of scientific ambition, that is, the desire to be recognized by his peers as authorities in their given fields, thus increasing their social capital (Bourdieu, 1999). This scientific ambition leads us to a crucial factor in agenda-setting, which is a researcher's hierarchical position (Bourdieu, 1999; Latour & Woolgar, 2013). Depending on the researcher's social position in his field of science, he may be constrained in his choices of agenda, that is, his choices might not be his own but rather his supervisors'. Thus, it is reasonable to assume that it is in any researcher's best interest to acquire some measure of prestige, at the very least in order to obtain the status required to overcome hierarchical constraints in his agenda-setting.

Factors of a more abstract nature can also be identified. For example, one is the risk and the uncertainty of given scientific fields. In accordance to the bounded rationality theory, most choices are not fully rational given the limited amount of information (Simon, 1990), and this is particularly true for fields of science which are relatively new (there is no telling if they are research dead ends until a considerable amount of time has been invested in them) and/or uncertain (with high funding competitiveness, for example)

(Bourdieu, 1999). Thus, some degree of risk-taking is expected in order to engage in some fields of science, particularly those with a lesser degree of maturity.

Individual aspects need also be considered, such as the case of personality. Most studies relating personality traits and professional matters focus on the concept of vocational personality, which relates to professional preferences, and has been shown to influence a series of career choices (Holland, 1997). More importantly, vocational personality has been shown to relate very strongly to more generalist theories of personality, as is the case of the Big Five theory (Gottfredson et al., 1993). The Big Five model is a personality theory with five distinct factors – openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism (Goldberg, 1990). These five axes allow for vast applications of the Big Five model, which have made it arguably one of the most widespread and robust personality frameworks used nowadays. Studies have shown the five-factor structure to be remarkably robust and constant across cultures (Thompson, 2008) and ages (McCrae & Costa, 2003). Further, the Big Five personality traits have been shown to influence professional outcomes – for example, individuals with low scores on the extraversion axis are very likely to shun work of a social nature, and will in fact perform very poorly if forced upon such tasks (Barrick & Mount, 1991). Incidentally, despite the lack of studies focusing specifically on the personality profiles of researchers, those few which exist seem to indicate the possibility of differing personality profiles in researchers: for example, a 1970's study pictured a researcher as an introvert, inward-looking individual (Helson & Crutchfield, 1970), while a 1980's study pictured a very different researcher, one who is ambitious and aggressive in the pursuit of his goals (Rushton, Murray, & Paunonen, 1983). There are two possible and non-mutually exclusive reasons for this: the personality profile of researchers shifted in the course of a decade (and if this was the case, it has likely shifted even further until present time); and also differences between fields of science, which were not fully accounted for, can equally yield different personality profiles. However, both studies consider the importance of creativity for those in research functions.

The cultural aspect of the workplace (in this case, very likely a laboratory) must also be considered. The sociological dimension of laboratory life was first explored by Latour (2013) – even though many models exist for representing the culture of

organizations, of which a laboratory is but one of many types. Although a laboratory's output is substantially different than that of a business, since research is based largely on creativity and the pursuing of novel ideas, a laboratory must be a creativity-fostering environment (Csikszentmihalyi, 1999; Hemlin et al., 2008). Thus, it is plausible to expect that some rigid, traditional, or output focused cultures such as the case of the hierarchical (too rigid and with little room for innovation) or the market driven (too focused on producing output for the sole sake of output) will actually curb some scientific agendas which can only thrive in creative environments (Hemlin et al., 2008). Indeed, freedom has been identified as a key element of academic self-determination (Marginson, 2008), and lack of it can only be detrimental to the creative process underlying scientific discovery.

Finally, other aspects need also be considered. First, the role of the mentor. As we previously saw hierarchy strongly affects a researcher's agenda, and thus it is expected that having a mentor (from the PhD or otherwise) also shapes somewhat an agenda. Indeed, it has been shown that mentors have some impact on a researcher's output (Pinheiro et al., 2014). Likewise, pursuing some types of collaborations has been shown to also affect output (Horta & Santos, 2014), thus it is plausible that it might also have an effect on agendas.

One final but critical aspect to consider is the existence of hidden agendas (Day et al., 1981; Ulrich, 2001). These are motivations which are unknown to all but the researcher himself. The implication of this is that the existence of underlying, unspoken motivations must always be considered.

Building the foundations for the study of research agendas

It became necessary, during the early stages of this project, to create a basis from which a novel and independent theory could be developed. The absence of a singular model on research agenda-setting, coupled with a great deal of fragmentation in terms of literature, presented a unique challenge. Because of this, it was decided that an existing

framework – one that could, conceivably, be applied to the study of research agendas – would have to be used, to serve as an incubator of sorts until this research became mature enough to stand on its own. Also, this framework would need to accommodate the entirety of the constellation of factors hypothetically affecting the process of agenda setting. The solution to this challenge became apparent following another PhD student's presentation, where Bandura's Social Cognition Theory was serendipitously discussed.

Although perhaps best known for his work on self-determination, we will concern ourselves rather with his concept of triadic reciprocity (Bandura, 1986). In this theory, it is stated that behavior is a function of both personal and environmental factors, and the latter are concomitantly a function of the former, while simultaneously affecting each other. In other words, behavior is shaped by reality – both inner and outer - just as behavior shapes reality. Figure 1 better illustrates this model:

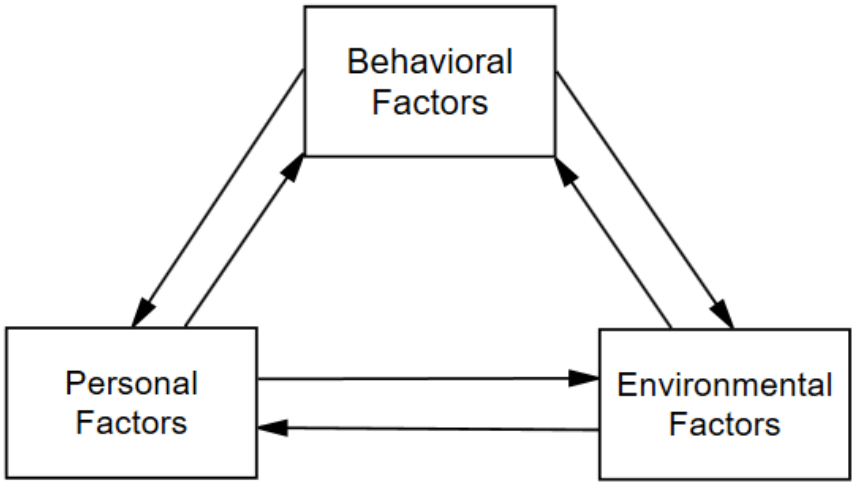

Figure 1: Triadic reciprocity.

There was an undeniable appeal regarding the idea of applying this framework to the study of research agendas. On the environmental end of the spectrum, we could consider the workplace environment, disciplinary doctrine, policy, funding availability, and many others (e.g., Bandura, 1997, 1999). Regarding personal aspects, this is where personality and cognition could be positioned. Although Bandura himself considered this level to be more concerned with psychological aspects (Bandura, 1978), in this exercise

we will consider it to be more of a psycho-social nature, and also include here intrinsic aspects related to one's self-identity and *ethos*, such as reputation and status. And, finally, at the behavioral end, the agenda setting itself. One could easily argue that the agenda pursued by the researcher is affected by the environment, and shapes the environment in turn; for example, a researcher can pursue a specific topic (behavior) in order to secure funding (environment), acquiring more prestige following successful publishing (personal), allowing him to access to further resources in his or her next ventures (environment).

Of course, it was reckoned that this framework was reasonable but not perfect fit. For example, as mentioned in the previous paragraph, the social aspects of a science, notably reputation and prestige, would have to be positioned in the same sector as cognitive factors. Research agenda-setting was tentatively positioned on the behavior factor – but what of productivity and visibility, i.e., two of the primary measurable outcomes of research activity? An argument could be made that these were a product of the research agenda, and thus it would make little sense to include them in the same sector as the research agenda-setting. Would this require de-aggregating the behavioral component into two different levels, for example high-level behavior (agenda setting) and low-level behavior (research outcomes)? And finally, would it even make sense to position research agenda setting under behavioral factors? Surely, if it is an intrinsically personal choice, as stated by Michael Polanyi (2000), it would make more sense to consider it a personal aspect rather than a behavior. Or could research agendas, rather, position themselves in separate components over more than one end of the triadic reciprocity spectrum?

All of these questions led to only one certainty – this framework would be a useful starting point, but the theory on research agenda-setting would have to outgrow it at some point. Unbeknownst to us at the time, the theory would indeed evolve into something else entirely.

Methodological and structural considerations

In this introduction, we will only briefly focus upon the methodological aspects of this work to give context to the reader. Further chapters will discuss these aspects in much greater depth.

At the onset of the project, it was decided that the goals we laid out could only be achieved through the procurement of massive amounts of data, preferably of a global and multi-disciplinary nature. Data science methodologies would have to be employed, adapted, or even developed for this to become possible. Although this is something which is relatively common in hard sciences, the presentation of such proposals in the social sciences are still rather uncommon. It became quickly apparent that securing funding would be a tricky proposition, as reviewers scoffed at the notion of employing "robots" or "algorithms" as part of the data gathering process. Thus, it was necessary to conduct a pilot exercise as a proof-of-concept. This was an important step, as pilot studies allow the researcher to know in advance what kind of trouble he or she will run into during the main study, and prepare for it in advance (Van Teijlingen & Hundley, 2001). This pilot turned out to be more successful than initially foreseen and became the basis for the bulk of the work here presented. Throughout the project, a larger-scale data gathering process also took place, one which lasted for two years and was only completed in time for the production of a single article still within the scope of this doctoral thesis. The implication of this is that further research on the nature of research agendas will have to continue beyond the scope of the current thesis and will stretch on for the immediately foreseeable future.

The pilot data gathering exercise began in May 2015, by employing automated algorithms which identified and retrieved all papers published between 2004 and 2014 in the field of Higher Education, using as search parameters "tertiary education" or "higher education" in the journal title. The choice of field was due not only to our familiarity with it, giving us greater sensitivity to the data, but also out of necessity to constrain initial findings to a single disciplinary area, before venturing forth into cross-disciplinary exercises. Once this initial prospection was concluded, we determined that, in total, the

published articles were associated with 5,985 individual corresponding authors. Each of these were contacted via e-mail and invited to participate in the current study. Those who accepted the invitation were required to provide informed consent before proceeding to the survey itself. In total, 1,348 researchers agreed to participate.

Due to the logistical implications of implementing a study at this scale, and the required amount of data, it was determined that the survey would contain all necessary questions – even if it caused it to become somewhat lengthy - so that further data-gathering exercises would not be required. As such, the effective N will vary throughout the later chapters, due to loss of participants who dropped out without concluding the survey entirely, rendering some variables unavailable for certain analysis. This pilot data is used for Chapters 2 through 7. For Chapter 8, the much larger dataset which was gathered throughout the project was employed instead. This dataset followed similar data gathering methodologies as the pilot exercise, but with the distinct advantage of being multi-disciplinary in nature rather than focusing on Higher Education. For the sake of parsimony, and as this will not be relevant until later chapters, the specifics and methodological details of this exercise will be discussed only in the relevant chapter.

This thesis is organized as such: Chapters 2 and 3 deal with instrumentation, and the development of frameworks and instruments which can evaluate research agendas and organizational aspects of the academia, respectively. These instruments will be used throughout the remaining chapters. Chapter 4 aims to determine the existence of overarching doctrines or archetypes of researchers based on their research agendas. In Chapter 5, we explore the cognitive aspects behind the research agenda setting, specifically through the use of thinking styles. Chapter 6 deals with the organizational aspects of the academic workplace, and how they shape the research agendas of the individuals who work there, while also briefly touching on their personality aspects. Chapter 7 focuses on gender issues, by applying research agendas to the study of the gender gap in academia. Chapter 8 revisits the instrument developed on Chapter 2, and a new validation exercise for the agendas-measuring instrument is conducted which aims to implement the lessons learned throughout the course of this project, and also demonstrate the universality of the instrument across all fields of science. Finally, Chapter

9 provides a global summary of the findings, implications, and an agenda for the continuation of the study of research agendas.

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Chapter 2
An instrument to measure researchers' research-agenda setting—the Multi-Dimensional Research Agendas Inventory

Chapter based on: Horta, H., & Santos, J. M. (2016). An instrument to measure individuals' research agenda setting: the multi-dimensional research agendas inventory. Scientometrics, 108(3), 1243-1265.

Abstract

In this study, an instrument named the Multi-Dimensional Research Agendas Inventory was developed to measure the key factors associated with the process of research-agenda setting. Research agendas reflect the preferences, strategies, influences, and goals that guide researchers' decisions when investigating specific topics. The results of validation exercises indicated that the instrument has eight distinct dimensions: Scientific Ambition, Convergence, Divergence, Discovery, Conformity, Tolerance for Low Funding, Mentor Influence, and Collaboration. The model underlying the instrument exhibited a very good fit ($X2/df = 1.987$; $CFI = 0.965$; $PCFI = 0.795$; $RMSEA = 0.033$; $P[rmsea \leq 0.05] < 0.001$), and the instrument itself was found to have excellent measuring properties (in terms of validity, reliability, and sensitivity). Potential interpretations of the instrument and its implications for research and practice are also discussed in this article.

Introduction

Given the contribution of research to knowledge creation and accumulation, it is important in our increasingly global, fast-paced, multifaceted risk societies to understand the process by which individual researchers set research agendas (Pump 2011). Research agenda setting by governments, field experts, communities and organisations has received substantial attention in the literature (e.g. Andrews and Johnson 2016). The type of research agenda setting practised by organisations such as research-funding agencies, which is generally associated with government priorities for national development, is relatively straightforward and usually less complex than the process followed by researchers, whose careers increasingly follow non-linear paths (Cantwell 2011). The process by which researchers set research agendas – which drive research – is largely unexplored in the literature (Harris 2001). Although the idea of a research agenda is ubiquitous in contexts and artefacts related to scientific research (e.g. articles and conference proceedings), the term is generally understood intuitively. The concept of a research agenda as instituted by individual researchers has been formally defined in only one recent publication, in which it is envisaged as both a problem-solving framework and a set of actions taken to pursue goals (Ertmer and Glazewski 2014). Based on this definition, a research agenda can be interpreted as a high-level plan implemented via a subset of low-level actions. Although this definition is helpful, a fundamental question remains unanswered: what factors drive researchers' decisions about research agendas, which so powerfully shape the knowledge they produce and ultimately their careers?

This article offers new insights into how researchers set research agendas. An instrument – the Multi-Dimensional Research Agendas Inventory (MDRAI) – was developed to measure the endogenous dimensions of research agenda setting. A questionnaire survey was constructed based on the literature and qualitative data obtained from researchers in the field of higher-education. The data were subjected to exploratory factor analysis (EFA) and structural-equation modelling (SEM), specifically confirmatory factor analysis (CFA). In the next section, a brief overview of the literature providing the rationale for the questionnaire is presented. In the third section, the method is explained. This is followed by a comprehensive analysis of the methodology and

results. The article concludes with an overview of the contributions made by the authors and recommendations for future research.

Literature review

Research careers no longer follow linear paths (Cantwell 2011). As researchers' career trajectories become more and more uncertain and complex, the process by which they set research agendas is increasingly determined by their motivation (Bourdieu 1999), incentives (Cole and Cole 1973), collaborations (Mamun and Rahman 2015), career paths (Horta and Yonezawa 2013), influence of their mentors (Pinheiro, Melkers, and Youtie 2014) and other factors likely to influence research choices.

When considering the relevance of research agendas to a researcher's career, it is vital to acknowledge that the more a researcher has invested in a given field (through learning, researching and publishing), the less likely he or she is to move into other fields (Bourdieu 1999). Specialising in a single field is a well-known predictor of research productivity, as moving into another field is likely to incur hidden transaction costs that may outweigh the benefits of the change (Leahey 2007). Nevertheless, recent studies have shown that approaches to research change over the course of academic careers: researchers usually focus on a single subject while studying for a PhD, diverge from this subject to address unrelated issues during their post-doctoral years and then converge to a single research focus later in their careers (Horlings and Gurney 2013). Expertise in multiple fields is particularly desirable given the increasing complexity of problems tackled by researchers today, many of which require multi-disciplinary approaches (Martimianakis and Muzzin 2015; Schut, van Paassen, Leeuwis, and Klerkx 2014). The changing trajectory of the typical research career suggests that convergence and divergence are two possible – competing, yet concomitant – dimensions of the process of research agenda setting.

As acquiring a position of authority in a field of knowledge takes a long time, convergence is usually attained at a late stage in a researcher's career (in line with the

cumulative advantage in scientific fields; see Allison, Long, and Krauze 1982). Most researchers are driven by a certain amount of scientific ambition, and by the desire to be recognised by their peers as authoritative in their respective fields (Merton 1968). Although such recognition increases researchers' status and prestige (Bourdieu 1999; Latour and Woolgar 2013), it may also affect their research-agenda choices. Researchers' social positioning within a field of knowledge may constrain their research agenda setting, as their research may not be completely autonomous – in some cases, it may be significantly influenced by others (such as PhD mentors; see Levitt 2010). Therefore, both scientific ambition and mentor influence must be considered when analysing how individuals set research agendas. In this context, it is also worth noting that the extent of the autonomy that researchers have to set individual research agendas varies across disciplines and their communities. Research agendas tend to be set through interactions with peer communities that are socially and cognitively informed by specific beliefs, traditions, sets of rules, norms and taken-for-granted behaviour (Whitley 2000). To a large extent, the influence of these communities on the research agenda setting of individual researchers is exerted through a consensus over what are the significant research challenges to be addressed (Becher and Trowler 2001); achieving such a consensus is more common in the pure sciences and related fields of knowledge than in the social sciences and the humanities (Becher 1994).[1]

Other relatively endogenous features may also influence researchers' decisions about research agendas. Collaboration has been shown to affect access to resources and ideas (Ebadi and Schiffauerova 2015), publication output and citation outcomes (Horta and Santos 2016), and behavioural and career considerations (Hoffman et al. 2014). It is thus important to determine whether and how collaboration with other researchers affects the process of research agenda setting. Collaboration is considered desirable when tackling multi-disciplinary subjects (Katz and Martin 1997). Additionally, studies of network effects in scientific-collaboration networks have shown that individuals who more frequently collaborate attain a greater visibility and thus are more likely to be invited

[1] Decision-making processes related to research focus also tend to be collective rather than individual in some fields of knowledge such as biomedicine (Verbree et al. 2015), and are substantially centralised in some fields of knowledge such as physics, particularly in the context of large experimental laboratories (Boisot, 2011).

to participate in future collaborations (Uddin, Hossain, and Rasmussen 2013). However, as not all individuals are 'team players' (Barrick and Mount 1991), the collaboration dimension of research agenda setting must be assessed in terms of both willingness and opportunity to collaborate.

Other, more abstract factors reported in the literature are relevant to the development of an instrument measuring researchers' research agenda setting. For example, research agendas in emerging or relatively new fields of knowledge incur greater risk and uncertainty than agendas in well-established fields, due to the greater probability of both dead ends, with no compensation for time and other resources consumed, or substantial rewards for persistence. Both the probability of failure and the probability of success affect research decisions and behaviour (Cummings and Kiesler 2005). Individuals' responses to risk vary widely, from risk seeking to risk aversion (Hillson and Murray-Webster 2007). Some researchers are less willing than others to pursue or persist with research in high-risk fields. For example, researchers in biomedicine have been shown to pursue conservative research strategies, which become more conservative over time and are considered to be a safer choice for careers, even if these strategies do not significantly advance the field (Rzhetsky, Foster, Foster, and Evans 2015). Perceptions of risk have also been shown to vary based on the nature of the risk (Slovic, Fischhoff, and Lichtenstein 1982), the resources available (mostly financial; see Ebadi and Schiffauerova 2015) and the amount of information provided, all of which influence a researcher's decision to implement a more or less risky research agenda (assuming a bounded-rationality approach; see Simon 1990). Therefore, it is important to consider research area (e.g. emerging or mature) and limited funding as separate yet equally integral determinants of researchers' risk propensity and thus their choice of research agendas. Such a measure, at an individual level, would complement measures of conformity associated with researchers' belief systems, that is, the tendency for research practices and outputs to reinforce existing knowledge rather than develop innovative findings (Klavans, Boyack, Sorensen, and Chen 2013).

In the following sections, the methodology and operationalisation of the study's constructs are discussed.

Methods

Structural Equations Modelling

This study was largely conducted using Structural Equations Modelling (SEM), specifically, confirmatory factor analysis (CFA), using the statistical software package AMOS 22. In this section, a brief overview of the procedure is provided to assist readers unfamiliar with the procedure to better understand the following sections.

SEM is a modelling technique used to test hypothetical causal relations between variables. It extends traditional generalised linear modelling and exploratory factor analysis (EFA) techniques by combining the strengths of both methods. (For an in-depth analysis of the applications of SEM techniques, see Arbuckle 2007; Bollen 2014; Jöreskog and Sörbom 1989; Kline 2011; Marôco 2010).[2] SEM has two main advantages over traditional methods: 1) the capacity to specify latent variables, which are variables that cannot be directly observed but can be estimated using other variables, similar to disturbance terms (Bentler and Weeks 1980), and 2) its incorporation of multiple traditional linear modelling techniques, such as analysis of variance, analysis of covariance and linear regression, into a single analytical method (Marôco 2010). In addition, SEM provides a vast number of fit indicators that can be used to evaluate and further refine a model. SEM also mitigates the over-inflation of disturbance terms by allowing researchers to consider systemic relations between variables that are difficult to detect or specify using traditional linear modelling techniques (Bollen 2014; Marôco 2007; Marôco 2010).

CFA is a specific case of SEM, in which the model can be written as follows (Bollen 2014; Marôco 2010):

[2] David Kenny (whose work on linear modeling is seminal) has maintained very comprehensive and up-to-date guidelines for SEM on his personal webpage, http://davidakenny.net/cm/causalm.htm, which may be useful to readers interested in learning how to operate SEM software.

$$X = \Lambda_x \xi + \varepsilon$$

where X is the vector for the manifest variables; Λ_x is the matrix for the factorial weights of ξ in x; ξ is the vector for the latent variables; and ε is the disturbance term.

CFA is typically (but not necessarily) used as a follow-up to a more traditional modelling method, EFA. The critical difference between the two types of factor analysis is that whereas EFA allows variables to be loaded freely into any of the extracted factors (hence 'exploratory'; the procedure is used to extract an otherwise unknown structure) (Marôco 2003), CFA requires the factorial structure to be specified *a priori*, creating constraints on the variables' factorial loading (Brown 2015). The specification of the model is typically based on insights obtained previously using EFA (and may also be used to test a structure identified via EFA) or findings reported in previous studies. Either way, CFA can be used to confirm the specified factorial structure.

Maximum Likelihood (ML) estimation was used in this study because it is robust to deviations from multivariate normality, which makes it safe for use in most analytical contexts (Marôco 2010). Details of the implementation of ML estimation using SEM software and the calculations underlying this method can be found in numerous related books and articles (see, for example, Arbuckle 2007; Jöreskog and Sörbom 1989).

Model estimation is generally followed by fit evaluation. A vast number of fit indicators are available, typically categorised by the functions they serve or the dimensions of fit they evaluate. There is no widely accepted set of 'best' indicators; researchers simply tend to choose those with which they are most familiar, selecting one indicator from each category to ensure a more comprehensive fit evaluation (Bentler 1990). For the purposes of this study, the most commonly used indicators are reported: the $X^2/\ d.f.$ indicator (Arbuckle 2007; Barrett 2007; Bentler 2007; Marôco 2010); the comparative-fit index (CFI) (Bentler 1990); the parsimony CFI (PCFI) (Marôco 2010); the root mean square error of approximation (RMSEA) (Steiger, Shapiro, and Browne 1985); the Akaike information criterion (AIC); and the Browne-Cudeck criterion (BCC) (Anderson, Burnham, and White 1998; Marôco 2010).

If the model fit is poor, the model can be re-specified to improve its fit with little effort. The first and most conservative strategy for improving model fit involves eliminating non-significant trajectories or trajectories with low loadings (Marôco 2010), followed by re-specification typically based on modification indexes (MI). MIs are used to estimate the relative change in the X^2 statistic when parametric or trajectory adjustments are made to the model. It is primarily an optimisation procedure, but cannot be performed automatically, as adjustments that benefit the model statistically may be theoretically implausible. Therefore, the researcher must carefully consider which adjustments to the model make sense (Arbuckle 2007). In AMOS 22, MIs are implemented using the Lagrange multipliers method, as described by Bollen (2014). MI adjustments are conducted iteratively. In the first pass, only adjustments with the highest MI value are performed, followed by a re-estimation of the model and a re-evaluation of the fit and MIs. This process is repeated until optimal fit is attained. Typically, the first pass involves adjustments with an MI value higher than 11, which corresponds to a type I error probability of 0.001; the second pass involves adjustments with an MI value higher than 4, representing a type I error probability of 0.05 (Marôco 2010).

Pilot study

Prior to the main study, a small pilot study was conducted. In a first step, a large pool of questions was drafted based on the literature. At this stage, the questions were discussed informally with researchers and academics to obtain their feedback, which was used to refine the structure and content of the questions (see Kassam et al. 2012). Next, preliminary validation exercises were conducted with the goal of reducing the initial number of questions and obtaining preliminary insights at a structural level. In this section, the procedures and results of this process are briefly described.

Question drafting

The initial set of questions was based on themes that emerged from the literature review. Further discussion of these themes with colleagues led to an initial draft of the

questionnaire. This initial version contained 84 Likert-style questions (answers ranging from 1 to 7, with 'don't know' options) with a mixture of true-scored and reverse-scored items, divided into seven blocks according to the following themes: scientific ambition; convergence; divergence; risk propensity (field); risk propensity (funding); mentor influence; and collaboration.

The Scientific Ambition block contained questions measuring the participant's desire to excel in the field and gain recognition for his or her scientific endeavours (e.g. 'I aim to be recognised by my peers'). The Convergence block contained questions regarding specialisation in a single field of science (e.g. 'I have mastered a single scientific area'). Conversely, the Divergence block comprised questions on diversification (e.g. 'I would be interested in pursuing research in other fields'). The Risk Propensity (Field) block dealt with the participant's attitude toward fields of science whose outcomes are considered risky or uncertain (e.g. 'I find "cutting-edge" scientific areas more appealing than well-established ones'). The questions in the Risk Propensity (Funding) block also addressed risk perception, but dealt with fields with limited funding (e.g. 'Limited funding does not constrain my choice of field'). The Mentor Influence block contained questions regarding the degree to which the participant's PhD mentor continues to influence his or her decision making (e.g. 'My PhD mentor's opinion carries much weight in my research choices'). The questions in the Collaboration block dealt with the participant's willingness and opportunity to engage in collaborative work (e.g. 'I often seek peers with whom I can collaborate on scientific articles').

Preliminary test

A key issue that emerged during the pilot study was that an 84-question survey was too long to be of practical use. Reducing the number of items used in the final survey was necessary. As long questionnaires can have poor response rates, one of the primary tasks at this stage was to reduce the number of questions per theme (for similar work see, for example, Rammstedt and John 2007). A preliminary test was conducted in May 2015 to obtain initial feedback on the questionnaire, gain insights into the factorial structure and reduce the number of questions. The original 84 questions were given to a limited sample of 43 researchers in a range of fields, who were affiliated with various institutions

worldwide. The respondents were asked to provide qualitative feedback on the questionnaire in addition to their survey responses. The 84 questions were presented in random order for each participant.

The data obtained in this preliminary deployment were analysed by EFA using Varimax rotation and subsequently CFA. As the small sample size did not allow factor analysis to be conducted on all 84 questions simultaneously, analysis was performed separately on each of the seven blocks, with each block containing 12 questions. We had two goals at the EFA stage: 1) to perform a first pass of question elimination, and 2) to obtain insights into the underlying lower order factorial structure (see Bentler and Weeks 1980). Anti-image matrices were produced and questions that had a measure of sampling adequacy (MSA) value smaller than 0.50, indicating poor fit (Marôco 2003), were eliminated. After removing some questions and performing EFA again with Varimax rotation (Ebrahimy and Osareh 2014), the optimal numbers of factors and corresponding questions were determined based on three criteria: a) the Kaiser criteria; b) scree-plot analysis; and c) factor and total extracted variance. The extracted factors were labelled according to the content and themes of their highest-loaded constituent questions.[3] Subsequently, a model was specified and estimated using the extracted structure and subjected to preliminary CFA. At this stage, questions with factor loadings under 0.50 were removed. Additionally, items with MIs that suggested implausible correlations were eliminated (Marôco 2010). Finally, once all of the problematic questions had been excluded, the items with the lowest factor loadings were removed until only six items remained, all containing the same number of lower-order factors. The goal was to maintain a balanced number of items per factor, facilitating the calculation of composite scores (DiStefano, Zhu, and Mindrila 2009). The choice of six items was thus determined by the factor with the smallest number of non-problematic items (the scientific ambition factor). Forty-two questions were removed, leading to a final pool of 42 questions. Finally, Cronbach's alpha was computed to measure the questionnaire's reliability. The findings of these preliminary tests are summarised in Table 1.

[3] More in-depth information on these lower-order factors is provided in later sections of this article.

Table 1: Preliminary EFA results

Factor	Average Loading	Cronbach's Alpha	Number of Items
Scientific Ambition	**0.788**	**0.906**	**6**
Prestige	0.866	0.897	3
Scientific Recognition	0.868	0.893	3
Collaboration	**0.718**	**0.873**	**6**
Willingness to Collaborate	0.866	0.900	3
Invited to Collaborate	0.756	0.799	3
Convergence	**0.776**	**0.905**	**6**
Mastery	0.903	0.928	3
Stability	0.803	0.796	3
Divergence	**0.765**	**0.911**	**6**
Branching out	0.875	0.866	2
Multi-disciplinarity	0.955	0.953	2
Flexibility	0.915	0.910	2
Mentor Influence	**0.786**	**0.906**	**6**
Risk Propensity (Funding)	**0.630**	**0.822**	**6**
Risk Seeking	0.863	0.899	3
Risk Aversion	0.751	0.810	3
Risk Propensity (Field)	**0.785**	**0.906**	**6**
Risk Seeking	0.900	0.951	3
Risk Aversion	0.876	0.906	3

Note: Factors in bold indicate primary constructs. Values in bold indicate single-factor parameters.

Several issues emerged from the preliminary analysis. First, certain reverse-scored items were loaded into entirely separate factors. This occurred in both Risk Propensity scales, in the Mentor Influence scale and in the Collaboration scale. This effect has been documented in the literature, and occurs when the reverse wording used in a question is perceived as the exact opposite of the true wording (Spector, Van Katwyk, Brannick, and Chen 1997). In the Risk Propensity scales, for example, risk-seeking behaviour (true-scored questions) and risk-averse behaviour (reverse-scored questions) were probably perceived by the participants as incompatible. As treating the two sets of questions as a single factor worsened the fit, we opted against merging them into a single factor at this stage. During CFA, the reverse-coded factors that emerged in the mentor influence and collaboration scales were found to be non-significant and detrimental to model fit, and were thus removed entirely from the analysis. Finally, EFA indicated an additional factor in the Risk Propensity (Funding) scale, which we labelled Competition. This factor

comprised questions on the participants' perceptions of competition for funding. However, CFA revealed that this factor was non-significant and detrimental to fit, so it was also removed from the analysis.

Main study

Following the pilot study, a tentative final questionnaire was distributed to a much larger sample to conduct a full validation exercise, including EFA, CFA, validity, reliability and sensibility evaluation. In this section, both the procedures and the results of this exercise are described in detail.

Procedures

Before distributing the tentative questionnaire, a search was conducted on the Scopus database in May 2015 to identify the corresponding authors of all articles published between 2004 and 2014 with 'tertiary education' or 'higher education' in the journal title. There were two methodological reasons to restrict the respondents to higher education researchers. First, as the responses were highly likely to differ considerably between fields of knowledge, we restricted the participants to a single field to prevent inter-field variability.[4] Second, the authors have published extensively on higher education research (authors 2015a, 2015b, 2014), and their knowledge and expertise in this field makes it an ideal choice for an exploratory study. The Scopus search yielded 5,985 authors. The sampling process was conducted in a non-probabilistic manner through availability sampling, as all of the matching authors were invited to participate.

The MDRAI was implemented via an online surveying platform. Invitations to participate in the study were sent by e-mail in a series of waves between June and November 2015; each e-mail provided a description of the survey's purpose and a link to

[4] However, higher education research is to some extent multi-disciplinary, with contributions from most of the social science fields (e.g. economics, political science, sociology and psychology). In future research, using a new set of data, the authors will carry out further validation exercises with different cohorts (in this case, academics from other fields) to maximise the robustness of the instrument.

the platform. An opt-out link was also provided for recipients who did not wish to be contacted again. The recipients who followed the link to the platform were directed to a page containing an informed consent letter; they were required to provide their informed consent before proceeding to the survey itself.

A minimum of 500 subjects was considered necessary to adequately conduct the analysis (as recommended by MacCallum et al. 1999). Of the 1,348 researchers who agreed to participate, 416 did not complete the MDRAI questions, and were thus excluded from further consideration, leading to a sample size of 932, meeting the proposed threshold. Females comprised 495 (53.1%) of the participants, and the remaining 437 (46.9%) were male. The participants ranged from 24 to 84 years old (M = 51.01, SD = 11.23). The majority of the participants were affiliated with institutions in the United States (231; 24.8%), followed by those with affiliations in Australia (143; 15.3%) and the United Kingdom (127; 13.6%). Scholars in these countries have produced the majority of publications on higher education research worldwide (Kosmützky and Krücken 2014). The remaining 431 (46.3%) participants were affiliated with institutions in 65 other countries.

For the purpose of cross-validation, the sample was randomly split into two sub-samples, in line with similar studies (e.g. Johnson and Stevens 2001). The original sample was further randomly divided into a training sample, which contained approximately 40% of the individuals (N = 342) and was used for the exploratory factor analysis, and a holdout sample, which contained the remaining 60% of the participants (N = 590) and was used for the confirmatory factor analysis.

Imputation

Missing values were handled using a series of data-imputation techniques. A Markov Chain Monte Carlo (MCMC) multiple imputation procedure was conducted to obtain five complete EFA datasets. The datasets were subjected to further analysis, and the pooled estimates and parameters for all five were used for decision-making and reporting purposes. For the structural-equation models, imputation was conducted via the Full Information Maximum Likelihood (FIML) estimation, which is considered superior to other imputation techniques (Enders and Bandalos 2001). However, it was not possible

to use FIML estimation to calculate the MIs due to computational limitations; one of the MCMC datasets was used instead.

EFA

Prior to CFA, an EFA was conducted on the training sample, using a method similar to that used in the preliminary tests, to obtain a tentative structure for specification by CFA. The procedure followed here was the same as that previously described.[5] As most of the potential problems with fit had been dealt with in the preliminary test, no problematic items were identified at this stage (based on the MSA criteria). However, the primary loadings of some items shifted toward other factors, and some factors collapsed altogether. The most notable differences were as follows. The loading of one item shifted from the Prestige factor toward the Scientific Recognition factor. As the two remaining items measuring the prestige factor were related to publishing scientific articles, we renamed this factor Drive to Publish. One item from the Invited to Collaborate factor shifted toward the Willingness to Collaborate factor. The lower-order constructs on the Convergence factor collapsed into a single factor, with predictably lower factorial loadings and reliability. Two-factor extraction was used to replicate the structure identified in the preliminary tests, and yielded a greater percentage of explained variance at the cost of lower factorial loadings for some of the items, along with unacceptably low levels of reliability. As a result, we opted to carry out CFA with a single-factor structure for these items. Our findings are summarised in the following table.

[5] Although the sample size at this stage allowed EFA to be conducted on all of the items simultaneously, we opted to perform EFA with separate question blocks, as in the preliminary test, to ensure consistency.

Table 2: Summary of EFA results

Factor	*Average Loading*	*Cronbach's Alpha*	*Number of Items*
Scientific Ambition	**0.766**	**0.860**	**6**
Scientific Recognition	0.813	0.864	4
Drive to Publish	0.886	0.817	2
Collaboration	**0.818**	**0.900**	**6**
Willingness to Collaborate	0.791	0.880	4
Invited to Collaborate	0.883	0.875	2
Convergence	**0.647**	**0.717**	**6**
Divergence	**0.698**	**0.784**	**6**
Branching out	0.844	0.724	2
Multi-disciplinarity	0.907	0.871	2
Flexibility	0.931	0.879	2
Mentor Influence	**0.821**	**0.900**	**6**
Risk Propensity (Funding)	**0.762**	**0.855**	**6**
Risk Seeking	0.815	0.810	3
Risk Aversion	0.839	0.851	3
Risk Propensity (Field)	**0.659**	**0.854**	**6**
Risk Seeking	0.834	0.808	3
Risk Aversion	0.792	0.851	3

Note: Factors in bold indicate primary constructs. Values in bold indicate single-factor parameters.

Model Specification

Using the holdout sample, the first implemented model-specification strategy was to replicate the factorial structure previously identified by EFA. An initial estimation of the model with this structure was conducted to identify specification problems. However, an inadmissible solution was obtained due to an estimation problem affecting two factors: the variance in the disturbance terms in the Risk Propensity (Field) factor and the Risk Propensity (Funding) factor was negative. This situation, known as a Heywood case, is typically caused by either model misspecification or a small sample size (Kolenikov and Bollen 2012). As our sample size was adequate for the analysis conducted, the structure extracted during the EFA was probably not fully confirmed at the CFA stage. This possibility has been acknowledged in the literature (Marôco 2010). To mitigate the estimation problem, EFA was conducted again using all 12 items belonging to both of the Risk Propensity factors. A three-factor solution rather than the expected four-factor solution was extracted, because three items ('If a research area has little available funding,

then I will not consider it'; 'I am afraid of engaging in research areas with no funding'; and 'I only research topics for which research funding is available') loaded into two separate factors. Therefore, these items were eliminated from further analysis. In addition, the three remaining Risk Propensity factors were separated to give three independent factors without a second-order structure. They were renamed to more accurately convey their new content, as follows. Risk Seeking as a low-level construct of Risk Propensity (Field) was renamed Discovery (e.g. 'I find "cutting-edge" scientific areas more appealing than well-established ones'). Risk Aversion as a low-level construct of Risk Propensity (Field) was renamed Conservative (e.g. 'I prefer "safe" or "stable" fields of study'). Finally, Risk Seeking as a low-level construct of Risk Propensity (Funding) was renamed Tolerance for Low Funding (e.g. 'Highly limited funding does not constrain my choice of field'). This re-specification of the model corrected the observed problems.

As a follow-up strategy, we scanned the factorial items and the low-level constructs to identify poor loadings, and conducted an initial analysis of validity and reliability. We identified a potential problem with the low-level construct of Flexibility, which had a low loading into the second-order construct of Divergence ($\lambda = 0.43$). As a result, the validity of the Divergence factor was low, with an average variance extracted (AVE) of 0.492, which was below the threshold of 0.5 suggested by Hair, Black, Babin, Anderson, and Tatham (2007).[6] Further analysis of the content of the corresponding items revealed that they both contained the expression 'jack of all trades' ('In terms of research-field preferences, I like to think of myself as a "jack of all trades"' and 'I am a "jack of all trades" when it comes to research preferences'). These items probably loaded into the same factor due to their shared use of this expression, not because they represented the concept of Divergence. This would explain why they loaded strongly into a low-level construct that in turn loaded poorly into its second-order construct. As a result, these two items were eliminated from further analysis to ensure the validity of the Divergence construct, which improved significantly after this change. All of the items had factorial loadings above the 0.50 threshold, with two exceptions: one item in the Conservative factor, which had a loading of 0.46 ('I find emerging fields of science less preferable than

[6] This indicator is described in detail in a later section of the article.

well-established ones') and one item in the Mastery factor, a low-order construct of the Scientific Ambition factor, with a loading of 0.40 ('I have mastered a single scientific area'). These items were excluded, because loadings under 0.5 indicate poor construct validity (Marôco 2010).

The third and final strategy was to specify the covariance between selected disturbance terms based on the MI criteria, as previously described in the section on methodology. A single pass was conducted at a threshold of 11, which corresponds to a type I error probability of 0.001, and only the disturbance terms for items in the same factor were considered. Based on information theory fit indexes, the re-specified model had a much better fit (AIC = 1179.351; BCC = 1198.360) than the original model (AIC = 2254.491; BCC = 2288.065). After implementing these three strategies, the final model was analysed. The findings are reported below.

CFA

The final model was estimated using FIML. The overall model and all of the individual trajectories were found to be significant ($p < 0.001$). Evaluation of the various fit indicators with commonly used thresholds (Barrett 2007; Hair et al. 2007; Hooper, Coughlan, and Mullen 2008; Marôco 2010) revealed that the model had a very good fit ($X^2/df = 1.710$; CFI = 0.961; PCFI = 0.791; RMSEA = 0.035; $P[RMSEA \leq 0.05] < 0.001$). Table 3 provides the factorial loadings for all of the items, and the full model is represented in Figure 2.

Table 3: Factorial loadings for the MDRAI

Code	Item	Loading
A1	I aim to one day be one of the most respected experts in my field.	0.871
A2	Being a highly regarded expert is one of my career goals.	0.846
A3	I aim to be recognized by my peers.	0.771
A4	Standing out from the rest of my peers is one of my goals.	0.715
A5	I feel the need to constantly publish new and interesting papers.	0.819
A6	I am constantly striving to publish new papers.	0.844
C1	My expertise is focused on a single scientific area.	0.668
C2	I believe that specialization in one area is preferable to diversification.	0.676
C3	Shifting towards another field of science is not a part of my plans.	0.536
C4	Studying subjects outside of my main field of work is pointless.	0.620
C5	I have invested far too much in my current field to consider branching out into another.	0.603
DI1	I find "cutting-edge" scientific areas more appealing than well-established ones.	0.763
DI2	I would rather conduct revolutionary research with little chance of success than replicate research with a high chance of success.	0.564
DI3	I prefer "cutting-edge" research to "safe" research, even when the odds of success are much lower.	0.822
CN1	I prefer "safe" or "stable" fields of study.	0.880
CN2	I prefer fields of study that are considered "safe" or "stable."	0.799
TL1	Limited funding does not constrain my choice of field.	0.815
TL2	Highly limited funding does not constrain my choice of field.	0.793
TL3	The availability of research funding for a certain topic does not influence me doing research on that topic.	0.673
CO1	I enjoy collaborating with other authors in my scientific articles.	0.881
CO2	My scientific articles are enhanced by collaboration with other authors.	0.824
CO3	I see myself as a team player when it comes to research collaboration.	0.781
CO4	I often seek peers with whom I can collaborate on scientific articles.	0.764
CO5	My peers often seek my collaboration in their scientific articles.	0.873
CO6	I am often invited to do collaborative work with my peers.	0.890
M1	My PhD mentor's opinion carries much weight in my research choices.	0.881
M2	A part of my work is largely due to my PhD mentor.	0.671
M3	My research choices are highly influenced by my PhD mentor's opinion.	0.869
M4	My PhD mentor is responsible for a large part of my work.	0.774
M5	My PhD mentor still often works alongside me.	0.728
M6	My PhD mentor largely determines my venues of research.	0.805
D1	I look forward to diversifying into other areas.	0.766
D2	I would be interested in pursuing research in other fields.	0.734
D3	I enjoy multi-disciplinary research more than single-discipline research.	0.851
D4	For me, multi-disciplinary research is more interesting than single-discipline research.	0.905

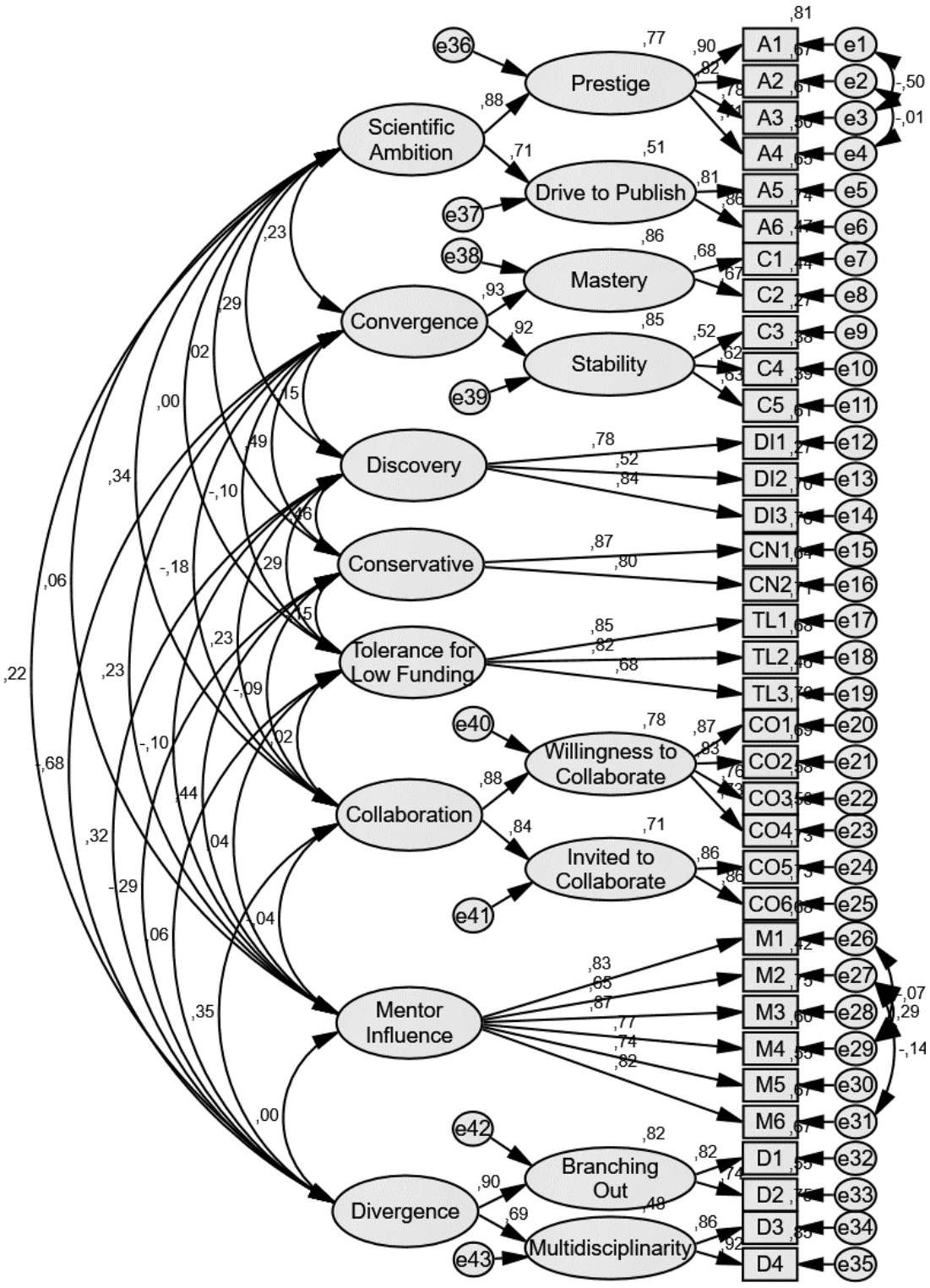

Figure 2: Measurement model for the MDRAI with standardized regression weights (loadings). Note: ellipses indicate latent variables, and squares indicate manifest variables. Disturbance terms are indicated by the latent variables labeled "e."

Validity, Reliability and Sensitivity

Validity is commonly assessed in three dimensions: factorial validity, convergent validity and discriminant validity (Hair et al. 2007; Marôco 2010). *Factorial validity* is confirmed when all of the individual items have standardised loadings above 0.50 (Marôco 2010). As previously described, items with loadings below this threshold were removed, so the model had full factorial validity. *Convergent validity* is confirmed when the manifest items for a latent factor load heavily into that factor. The average variance extracted (AVE) of a given factor has been proposed as a useful index of convergent validity (Fornell and Larcker 1981). AVE is calculated as follows:

$$\widehat{AVE_J} = \frac{\sum_{i=1}^{k} \lambda_{ij}^2}{\sum_{i=1}^{k} \lambda_{ij}^2 + \sum_{i=1}^{k} \varepsilon_{ij}}$$

where λ_{ij}^2 are the squared standardised factorial loadings for each item and ε_{ij} is the disturbance terms for those items.

Convergent validity is confirmed when AVE is higher than a 0.5 threshold (Hair et al. 2007). In our model, all of the factors were above this threshold, confirming the convergent validity of the MDRAI. Finally, *discriminant validity* describes the extent to which the items for a given factor are correlated with those for other factors. Discriminant validity can be confirmed by determining whether the AVE for factors *i* and *j* is equal to or greater than the squared correlation between the two factors (Fornell and Larcker 1981). Additionally, the AVE must be equal to or greater than both the maximum shared variance (MSV) and the average shared variance (ASV). Again, all of the factors in our model exceeded these thresholds, confirming that the model exhibited adequate discriminant validity.

We also evaluated *reliability*, defined as measurement consistency and replicability (Marôco 2010), by calculating the commonly used composite reliability (CR) indicator (Fornell and Larcker 1981). For a factor *j* with *k* items, CR is obtained as follows:

$$\widehat{CR_J} = \frac{(\sum_{i=1}^{k} \lambda_{ij})^2}{(\sum_{i=1}^{k} \lambda_{ij})^2 + \sum_{i=1}^{k} \varepsilon_{ij}}$$

where λ_{ij} are the standardised factorial loadings for each item and ε_{ij} is the disturbance terms for those items.

A CR value above 0.7 is considered to confirm the reliability of a measure (Hair et al. 2007). As all of our factors received CR values above this threshold, we concluded that the MDRAI is a reliable instrument overall. Table 4 summarises the results of our validity and reliability assessment.

Table 4: Validity and reliability for the MDRAI

Factor	*Composite Reliability*	*Average Variance Extracted*	*Maximum Shared Variance*	*Average Shared Variance*
Scientific Ambition	0.751	0.603	0.099	0.040
Convergence	0.923	0.857	0.511	0.129
Discovery	0.764	0.525	0.164	0.076
Conformity	0.828	0.706	0.212	0.094
Tolerance to Low Funding	0.806	0.582	0.072	0.023
Collaboration	0.857	0.750	0.132	0.044
Mentor Influence	0.905	0.616	0.153	0.031
Divergence	0.780	0.643	0.511	0.131

Finally, sensitivity is defined as the ability of an instrument to differentiate between individuals. Sensitivity is confirmed if the items have a normal distribution (Marôco 2010). The skewness and kurtosis of each of the items were analysed to identify any deviation from normality. The items were considered to exhibit an acceptably normal distribution if their skewness and kurtosis were each lower than an absolute value of 3 (Kline 2011). Using these criteria, no issues with normality were detected, indicating that the MDRAI is a sensitive instrument. Table 5 presents a summary of the descriptive statistics (mean and standard deviation) for each of the higher-order latent factors identified in the present study. For simplicity of presentation, the totals for the latent variables were computed using the mean for their respective manifest variables.

Table 5: Descriptive statistics for the MDRAI

	Gender				*Age*								*Degree*					
	Female		*Male*		*>=40*		*41-50*		*51-60*		*>60*		*Bachelor*		*MSc. MBA*		*PhD*	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Ambiti.	4.92	1.04	5.00	1.06	5.20	0.98	4.94	1.09	4.89	1.05	4.85	1.04	5.02	0.90	4.68	1.07	5.05	1.05
Conver.	3.51	0.87	3.45	0.98	3.52	0.85	3.45	0.97	3.50	0.92	3.46	0.95	3.42	0.92	3.17	0.76	3.50	0.94
Diverg.	4.99	0.93	4.98	1.06	5.05	0.93	5.05	1.02	5.01	0.98	4.81	1.02	5.05	1.06	5.10	0.91	4.97	0.97
Discov.	4.37	1.07	4.63	1.11	4.46	1.07	4.47	1.16	4.51	1.12	4.54	1.01	4.59	1.08	4.63	1.11	4.46	1.12
Conser.	3.04	1.03	2.94	1.04	3.24	0.96	3.01	1.09	2.94	1.03	2.82	1.00	2.98	1.07	2.75	0.98	3.00	1.07
TTLF	4.43	1.28	4.72	1.26	4.49	1.20	4.49	1.36	4.58	1.30	4.73	1.20	4.64	1.19	4.60	1.20	4.62	1.32
Mentor	2.65	1.27	2.63	1.29	3.19	1.27	2.59	1.27	2.48	1.24	2.35	1.19	2.74	1.29	2.53	1.47	2.62	1.26
Collab.	5.43	0.88	5.20	1.02	5.21	0.89	5.39	1.00	5.37	0.91	5.27	1.00	5.22	0.96	5.26	0.82	5.39	0.96

Discussion

In this section, some issues regarding the interpretation and scoring of the MDRAI are discussed.

Scientific Ambition was found to be a key variable in researchers' research agenda setting, consistent with the literature. Gaining recognition for one's research from academic peers and thereby moving up the scientific community hierarchy are important incentives for engaging in research (Bourdieu 1999; Latour and Woolgar 2013; Merton 1968), and thus have a considerable influence on research agendas. Researchers with high scores for this factor can be said to be research-community driven, in that they aim to become prominent in their respective fields (with the corresponding career benefits). This factor is subdivided into Prestige, the desire to acquire recognition *per se*, and Drive to Publish, the desire to produce scientific articles (which may be related to the accumulative-advantage hypothesis; see Allison et al. 1982 and/or the current 'publish or perish' paradigm; see Jung 2014).

The second factor, Convergence, relates to the intention to specialise in a single field of knowledge, which is a traditional professional strategy (Leahey 2007) with a significant influence on research agenda setting. A researcher scoring high for this factor is likely to create a research agenda characterised by much time and effort devoted to a single field of knowledge. This factor has two dimensions: Mastery, representing the goal

of becoming an expert in a specific topic; and Stability, which represents the time investment made in a topic. The results for both dimensions were aligned with previous findings (Bourdieu 1999). The third factor, Divergence, reflects the desire to branch out into other fields of knowledge, a useful approach to the complex problems of modern science (Horlings and Gurney 2013). Researchers with high scores for this factor are likely to create research agendas with particular emphasis on establishing themselves in (or pursuing research interests in) many fields of knowledge (or researching inherently multi-disciplinary topics that encompass or relate to many fields of knowledge). Divergence is subdivided into Branching Out, the desire to expand one's research work to address other (potentially many) research topics, and Multi-disciplinarity, which indicates a preference for multi-disciplinary research ventures.

The next factor, Discovery, indicates a propensity for risky fields of knowledge. Researchers with high scores for this factor usually create research agendas in emerging and largely unexplored fields with greater risk—and greater potential reward—than more established fields of knowledge. Conservative represents the opposite: a preference for setting research agendas in established and thus safer fields in which outcomes are more predictable. The Tolerance for Low Funding factor represents the extent to which the availability of funding affects a researcher's choice of research topic. Researchers with high scores for this factor do not place particular emphasis on funding when setting research agendas, whereas researchers with low scores create research agendas based largely on the availability of funding.

The next factor, Collaboration, represents a researcher's engagement (as reflected in his or her research agenda) in collaborative research endeavours, a critical strategy in science (Katz and Martin 1997; Uddin et al. 2013). A researcher with a high score for this factor is both willing and able to collaborate to produce research, as reflected in the lower-order factors Willingness to Collaborate (which measures a researcher's intrinsic inclination to set up research agendas in collaboration with others) and Invited to Collaborate (which indicates the frequency with which the researcher is actively invited to partake in research ventures initiated by others, as reflected in his or her research-agenda setting).

Finally, Mentor Influence indicates the extent to which a researcher's research agenda setting is influenced by his or her PhD mentor. Individuals with high scores for Mentor Influence are likely to perform research alongside their PhD mentors (perhaps even long after completing their doctoral work), and their research agendas and corresponding work are significantly shaped by this relationship (Pinheiro et al. 2014). Researchers with low scores for this factor are likely to set research agendas without considering the opinions of their PhD mentors, perhaps because the mentor-researcher relationship has weakened over the years.

There is a vast range of computational methods (DiStefano et al. 2009) to calculate composite scores, but it is important to avoid computing scores by simple summation alone. As the factorial dimensions contain different numbers of items (despite our efforts to balance item numbers in the preliminary tests), simple summation would yield composite scores with a different range of values for each dimension, requiring the scores to be standardised further to enable unbiased comparison. The simplest way of calculating composite scores is to compute equally weighted averages for the items in each dimension. In our case, this results in standardised continuous scores ranging between 1 and 7, which were considered adequate. In cases in which imputation is impossible or undesirable, averages have the added benefit of mitigating score deflation resulting from missing values. Alternatively, weighted averages can be used to provide additional robustness. The factor loadings presented in Table 3 can be used as weights. Finally, in future research based on the MDRAI, the use of lower-order factors should be considered optional, depending on the purposes of the research undertaken.

Conclusion

This article describes the first instrument capable of evaluating the endogenous aspects of researchers' research agenda setting. The Multi-Dimensional Research Agendas Inventory enables the examination of a broad range of factors critical to researchers' decision making, and has robust measuring properties in terms of validity, reliability and sensitivity. In addition, the model underlying the instrument has a very

good fit. The development of this instrument has important implications for both researchers and policy makers. It will add value to studies of scientometric research, higher-education research and scientific policy research by providing a tool for investigating researchers' individual agendas. This has the potential to open up new directions for research. The instrument will also be of interest to policy makers, especially funding managers and university managers, as it offers a new method of prediction and evaluation. For convenience, the full instrument in its final form is provided in Appendix A. It is recommended that the items be randomised prior to use.

Nevertheless, it is important to highlight some limitations of the instrument developed in our study. First and foremost, the instrument is perception-based, and thus incurs all of the risk inherent in subjective measures. Therefore, it is necessary to consider and prepare for the possibility of individual bias in the responses before implementing the survey (in part by obtaining a sample large enough to mitigate such bias). Second, the validation exercise was carried out in a single field (higher education), and should thus be tested in other fields of knowledge. It is expected that the current instrument is more applicable to individual researchers in the social sciences and humanities than in the pure sciences. This is due to the greater autonomy that individual researchers in these fields of knowledge have in setting the research focuses that guide their research practice. (This is particularly evident in studies of research topics contributed by researchers from different disciplinary backgrounds within the social sciences; see Morley 2003.) The authors plan to carry out additional validation exercises in the near future; the aim is to eventually identify the dimensions that make the instrument more applicable to a wider range of fields of knowledge. As this is the first instrument of its kind, some important dimensions of research agenda setting may not have been considered. We hope that as the MDRAI is used and discussed by members of the scientific community, further dimensions will be identified and included in future revised versions of the instrument. An example that arose from the review process is that a dimension relating to items inquiring about the role and influence of collective research agenda consensus by research communities on individual research agenda setting is required to broaden the applicability of the instrument to all fields of knowledge. It was also recognised that the instrument should be revised to include additional questions measuring the factors that have only two items in the current

version. Although the use of two items per factor is not entirely unheard of (see, for example, Rammstedt and John 2007), it may lead to problems if the respondent skips one or both of the questions.

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Chapter 3
Development and Validation of the Multi-Dimensional University Research Workplace Inventory (MDURWI)

Chapter based on: Santos, J. M. (2018). Development and Validation of the Multi-dimensional University Research Workplace Inventory (MDURWI). Higher Education Policy, 31(3), 381-404.

Abstract

This study describes the development and validation of an instrument aimed towards measuring organizational features of an academic research workplace. The question pool was developed based on data from a pilot study (N = 43). The survey was deployed to academic researchers in the field of higher education research worldwide (N = 850). An exploratory factor analysis conducted on 36 questions, followed by confirmatory factor analysis, which lead to a final pool of 27 questions in 5 subscales, one of which divided into 3 lower-order factors. The final model exhibited very good fit ($X2/df = 2.561$; $CFI = 0.972$; $PCFI = 0.784$; $RMSEA = 0.043$; $P[rmsea \leq 0.05] < 0.001$; $AIC = 891.018$; $BCC = 987.839$) and psychometric properties, in the form of factorial, convergent, and discriminant validity, as well as reliability and sensitivity. Implications of this instrument for research and policymaking are discussed, as well as future research directions.

Introduction

The work of academic researchers is increasingly filled with contradictions that result from tensions between tradition and neo-liberal policies (Shattock, 2014). Academic researchers require a significant amount of freedom (Marginson, 2008) to develop creative work (Hemlin et al, 2008), but are constantly subjected to the current "publish-or-perish" paradigm (Jung, 2014), according to which they must constantly publish lest they fall behind their peers (Dobele and Rundle-Theile, 2015). Academic researchers also have to cope with other institutional duties such as committee participation, mid-level leadership roles, attracting funding, and balancing the teaching-research nexus (Henkel, 2000; Horta et al, 2012; Pepper and Giles, 2015; Young, 2015). The stress of balancing this multi-dimensional work life and appeasing the many different stakeholders while maintaining a productive track record creates a unique environment arguably far different than working, for example, in a private firm (even if universities are increasingly adopting managerial practices traditional of the business private sectors (Kauppinen and Kaidesoja, 2014); these are mostly considered a threat to academic research, culture and work (Jemielniak and Greenwood, 2015)). The understanding of the research workplace that affects academic research is central to understand research work, and although there have been studies focusing on it (e.g., Horta and Lacy, 2011; Leisyte et al, 2008), there is a lack of properly validated questionnaires used to conduct systemic research on how the work of researchers in academia is influenced by the organizational setup (as argued by the literature; see Blackburn and Lawrence, 1995; Tigelaar et al, 2004).

This article contributes to this knowledge gap by proposing a new instrument – the Multi-Dimensional University Research Workplace Inventory – (MDURWI) - to evaluate representative work dimensions, tailored to the specificity of research life in research workplace. Research workplace in this article is defined by the broad academic setting of universities, and understood by the general set of values, norms, and taken-for-granted beliefs and attitudes of the university as the closest organizational environment influencing scholarly activities. This means that the research workplace is not necessarily framed to the development of a research activity in a specific spatial place, such as doing

research in a laboratory or in a research center. Rather, it refers to doing research in a university academic setting where research is a key component of academic work, and is informed, constrained and modelled by other dimensions that affect it and are typical of universities as places of inquiry (see Clark, 1995). This broader understanding of research workplace enables to consider critical factors influencing the research activities of academic researchers such as their involvement in teaching (teaching-research nexus), but also the workload, governance styles, identity and other elements that define the university as unique and distinct organization (see Leisyte, 2016 ; Slade et al, 2016 ; Cattaneo et al ., 2016; Kessler et al., 2014; Shin and Jung, 2014; Webber, 2012)

The analysis is conducted through exploratory and confirmatory factor analysis on a pool of questions based on the literature and on feedback obtained from academic researchers in discussion panels, scientific meetings, and through informal conversations. In this next section, the literature providing the rationale for the different factors will be considered. Then, the methodological aspects of this article are presented, and the article concludes with the analysis and its discussion.

Literature Review

No validated instrument currently exists to assess the academic researcher work dimension. A worldwide project called "Changing Academic Profession" (CAP) employs a survey implemented in several countries about the academic profession as a whole, but no report, book chapter or article was found concerning its validation process. Moreover, the focus on the research environment represents only a limited component of the survey (see Teichler et al, 2013), and these elements were taken into consideration when designing the current instrument. Taking this into account, the development of this article's instrument is sourced from key factors identified in the literature from various fields, as well as overarching factors drawn from organizational psychology. The choice of these key factors is not meant to be exhaustive (as it would be arguably impossible to create an instrument measuring all known organizational variables), but rather to obtain a balance between conceptual coverage and instrument size. These factors were chosen

based on being well-established – one could name them "classics" - with a robust theoretical background (which is covered further ahead), and being commonly employed in studies on both academic (e.g., Peluchette, 1993; Stahl and Koser, 1978) and non-academic (e.g., Schyns and von Collani, 2002; Babakus et al., 1996; Hersey et al., 1969) contexts.

The first factor to be considered and the most prominent one in the literature on organizations is satisfaction with the institution and one job's duties since this satisfaction has been linked to organizational productivity (Böckerman and Ilmakunnas, 2012). Job satisfaction is also highlighted in studies focusing on the academic profession (Machado-Taylor et al, 2014; Shin and Jung, 2014) but the relation between job satisfaction and research productivity has warranted mixed findings (Abouchedid and Abdelnour, 2015; Kerlin and Dunlap, 1993; Kessler et al, 2014; McNeece, 1981; Terpstra et al, 1982). These contradictory results have been attributed to the lack of properly validated instruments tailored to the realities of academia (Blackburn and Lawrence, 1995), underlining the need to include satisfaction as a critical dimension in studies focusing on academic research workplaces. A second factor concerning satisfaction is satisfaction with the leadership. The reason why this level of satisfaction should be considered separately is due to the abundance of literature linking leadership to various other workplace characteristics (Gil et al., 2005; Podsakoff et al, 1996; Podsakoff et al, 1990; Roberts et al, 1968). Although an individual's relationship with one's leader is certain to affect to some degree one's institutional satisfaction (Lok and Crawford, 2004), the satisfaction with the leadership effect is considerable enough to stand on its own. This is increasingly important and evident in academic contexts (see Alonderiene and Majauskaite, 2016) including those more directly related to academic research activities, their management and associated strategies (Horta and Martins, 2014).

Another critical dimension is organizational commitment, which is still rather understudied in the context of university research workplaces (as argued by the recent publication by Jing and Zhang, 2014). Organizational commitment as a key organizational dimension has been largely explored in the organizational psychology literature (Meyer and Allen, 1991; Mowday et al, 1979; O'Reilly and Chatman, 1986). It is a concept related to the linkage between individual and organization and how it is

perceived at an individual level (Mowday et al, 1982). It can be further sub-divided into attitudinal commitment, which is the congruence between the organization and the individual (in some ways, the feeling of belonging), and behavioral commitment, which is related to intentions of staying or leaving the organization (Mowday et al., 1982). These aspects have been developed in other questionnaires (Mowday et al., 1979), which provide inspiration for this component of the present study.

It is also important to consider the social dimension of the university research workplaces, since engaging in collaborative work is considered highly desirable in present day research (Ebadi and Schiffauerova, 2015) and has been linked with both productivity (Horta and Santos, 2015) and career prospects (Hoffman, 2009). As the academic researcher's colleagues are the most direct opportunity for collaborations, the quality of this relationship can be seen as a gauge for intra-institutional collaborations (Horta and Lacy, 2011). It is also linked to organizational commitment (Madsen et al, 2005) and the development of the psychological contract between individual and institution (Cuthbert, 1996). The sense of belonging and identity in higher education can be particularly strong with one's individual institution, independent of tensions between one's identification with the culture and ethos of a university and the mindset of disciplinary and professional communities to which the researcher can belong to (e.g., Findlow, 2012).

Another critical dimension is the matter of freedom. Academic researchers require a significant amount of freedom (Marginson, 2008) associated to time dedicated to research-oriented activities (which can encompass postgraduate education; see Kwan, 2013), but this is often limited due to hierarchical constraints (Bourdieu, 1999; Latour and Woolgar, 2013) or other competing tasks, such as teaching duties and management and bureaucratic tasks (Pepper and Giles, 2015; Young, 2015). Indeed, it has been reported that individuals feel that institutions actively attempt to limit this freedom by shifting the researcher's priorities towards administrative tasks as a way of weighting the scales of power in favor of the institution (Henkel, 2000), which has a negative impact on the bond between individual and institution (Cuthbert, 1996). In this article, freedom is understood from two differences perspectives. The first one is the classic notion of academic freedom, a form of intellectual independence, allowing the researcher to pursue

research of his own volition (e.g., Ren and Li, 2013; Polanyi, 2000). This autonomy at an individual level should be not confused with the concept of "Institutional Autonomy" (Ren and Li, 2013) which is often enshrined in law. The second notion of freedom relates to the absence of external pressures on the work of the academic researcher. These forces can be of three natures: bureaucratic, meaning pressure into committee participation, management duties, or simple administrative requirements (e.g., Pepper and Giles, 2015; Young, 2015); hierarchical, meaning that the academic researcher's work is imposed or dependent on his hierarchical superior (e.g., Bourdieu, 1999; Latour and Woolgar, 2013); or pressure, derived from academic "marketization", which can push the academic researcher into a direction which is not his or hers own, thus curbing his or her freedom (Ek et al., 2013).

The final dimension to be considered is access to resources. This has been reported to be linked to many of the previously discussed factors and some others such as productivity (Jacob and Lamari, 2012). The lack of funding might cause academic researchers to shift their priorities towards other fields out of necessity instead of interest, lowering morale and satisfaction (Blackburn and Lawrence, 1995; Bourdieu, 1999; Henkel, 2000).

These dimensions have a wealth of instruments developed to measure them in organizational contexts other than academia such as private businesses (see, for example: Higgs and Dulewicz, 2003; Mowday et al., 1979; Amabile et al., 1996; Spector, 1994). However, as these instruments were validated in one specific context, it is not entirely clear whether they directly translate into university research workplaces. Indeed, some items present in those instruments simply do not apply to universities workplaces (e.g., "I do not think that wanting to be a 'company man' or 'company woman' is sensible anymore" [Allen and Meyer, 1990]), while some dimensions are largely absent (for example, freedom is not a common theme in the private business context, and tends to only be present in the context of creativity environment studies and surveys; e.g., Amabile et al, 1996). This poses a significant challenge to scholars wishing to study university research workplaces; if they wish to use existing instruments, they are faced with the choice of either using various lengthy instruments in tandem (after reviewing them to ensure that all items apply to this setting) and ending with an extremely extensive survey,

or devising their own measures. In fact, quantitative studies on organizational variables in university research workplaces usually opt for the latter option (e.g., the "Changing Academic Professions" survey). An instrument developed by Stahi (1977) which measures several organizational variables specifically in laboratory settings, has a measure of conceptual overlap with the MDURWI (e.g., leadership related aspects, freedom, and the social dimension are represented in some manner). However, it has the drawback of missing the commitment dimensions, being a decades-old validation exercise which might not apply entirely to the current generation of academic researchers (and universities that are re-inventing themselves), and the content of the items not being made available from the publication. This noticeable absence of properly validated quantitative instruments has been consistently noted by the literature (see Blackburn and Lawrence, 1995; Tigelaar et al, 2004).

As this study was conducted in the field of higher education, some context must also be given regarding the specificity of this field. First the object-focused paradigm of the field translates into a largely multidisciplinary approach, which means that researchers engaged in this field hail from a multitude of academic backgrounds (Altbach et al., 2006; Teichler, 1996). Second, and following this first consideration, the higher education researcher communities are not restricted to their respective countries due to disparities in the relative sizes of these communities (Tight, 2012; Teichler, 1996); rather, communities are generated around the topics they work on (Kim et al, 2017; Kuzhabekova et al., 2015; Chen and Hu, 2012) or their stances on policy and issues (Ashwin et al., 2016). Thus, even though the field has a degree of overlap between the role of researcher and practitioner (Harland, 2012; Teichler, 1996), the diversity of the field ensures that a multitude of ideas, stances, theories and methods co-exist forming an academic archipelago that is cohesively anchored around issues that pertain to higher education issues (MacFarlane, 2012).

Method

Participants

Prior to the present study, all corresponding authors matching a search for articles in journals with "tertiary education" or "higher education" in the title were identified in SCOPUS. Subsequently, they were invited by e-mail to participate in the present study by filling an online survey. An informed consent form was provided as a landing page to the survey, to which the participants were required to agree before being able to proceed. A total of 1,348 individuals agreed to participate; of these, 498 did not complete the survey entirely and were removed from subsequent analysis, leading to a final sample of 850 participants. 54.2% (N = 461) of the participants were female, with the remaining 45.8% (N = 389) being male; ages ranged between 24 and 84 (M = 51.04, SD = 11.22). The majority of the participants operated from institutions within the United States (N = 216), followed by Australia (N = 128) and the United Kingdom (N = 117); the remaining participants were distributed over 65 other countries. The participants in this study work in universities, although it is assumed that some may also have ties to non-university institutions, including governments (see Harland, 2012). In both the pilot and main study, the questions were presented in a random order for each participant.

Question drafting

An initial pool of 72 Likert-style questions (range 1 to 7 with the option for "Don't Know") was drafted and divided by the five themes identified in the literature: institutional satisfaction, organizational commitment, leadership satisfaction, social satisfaction, freedom, and resources. Previous discussion of the instruments' thematic was also conducted in workshops, such as meetings with various degrees of formality and discussion panels, which concomitantly converged into the aforementioned dimensions. One of the goals while developing this survey was keeping the total number of items relatively low for ease-of-use, similarly to what has been done with other questionnaires (see Rammstedt and John, 2007). In order to achieve this, during May of 2015 these 72 questions were deployed to 43 researchers from a variety of fields of knowledge and institutions worldwide in order to conduct preliminary exploratory and confirmatory

factor analysis with the sole aim of removing poor items, therefore reducing the total number of items. Due to sample size constraints, the following analysis were conducted separately for each block of 12 questions: in a first step an Exploratory Factor Analysis (EFA) was performed, and through analysis of the anti-image matrices items with a Measure of Sampling Adequacy (MSA) under 0.50 were removed (Marôco, 2003). After this first pass, a new EFA was conducted using Varimax rotation, and the optimal number of factors were determined based on the Kaiser criteria, screeplot analysis, and extracted variance. Subsequently, the extracted factorial structure was used to conduct a Confirmatory Factor Analysis (CFA). At this point, items with factorial loadings under 0.50 – indicating potential factorial validity issues (Marôco, 2010) – were eliminated. This procedure led to the final pool of 36 questions (6 per theme) which was used in the present study, and is summarized in Table 6. It is important to note that on the "Resources" dimension, all but one of the items referring to non-financial resources were removed based on the criteria. Due to this, it was opted to use "Funding" in lieu of "Resources" for the remainder of the analysis. Participant feedback was also requested at the end of the pilot; it was noted that the full pilot instrument (72 questions) was too large to be of practical use, which was in line with the initial goal of item reduction. No feedback was provided regarding the content of the items themselves.

Table 6: Initial question pool for the MDRWI

Code	*Item*	*Scoring*
	Institutional Satisfaction	
IS1	I am happy working at my current department/Faculty.	True
IS2	I am happy with the duties which are assigned to me by the department/Faculty.	True
IS3	Overall, I am happy to be a part of my department/Faculty.	True
IS4	I do not feel rewarded for the work I do at my department/Faculty.	Reverse
IS5	I am satisfied with my current department/Faculty.	True
IS6	My current department/Faculty is a place where I am happy to work.	True
	Organizational Commitment	
OC1	I feel like I am a part of my current department/Faculty.	True
OC2	I do not feel like I belong in this department/Faculty.	Reverse
OC3	I consider my department/Faculty's success to be my own success.	True
OC4	I would be happy to spend the rest of my career in this department/Faculty.	True
OC5	I would not expect to spend the rest of my career in this department/Faculty.	Reverse
OC6	Spending the rest of my career in this department/Faculty would be a good thing.	True
	Leadership Satisfaction	
LS1	The leadership of my department/Faculty is considerate towards the people who work in it.	True
LS2	The leadership of my department/Faculty understands my concerns.	True
LS3	The leadership of my department/Faculty sometimes makes people feel uncomfortable.	Reverse
LS4	The leadership of my department/Faculty makes me stressed.	Reverse
LS5	The leadership of my department/Faculty treats its employees kindly.	True
LS6	People sometimes get uncomfortable with the decisions of my department/Faculty's leadership.	Reverse
	Social Satisfaction	
SS1	I have good relations with my peers.	True
SS2	I recognize my peers to be highly competent.	True
SS3	I enjoy working with my peers.	True
SS4	My peers give me great research ideas.	True
SS5	I am on good terms with my peers.	True
SS6	Working with my peers is a pleasure.	True
	Freedom	
F1	I do not have much autonomy in my work.	Reverse
F2	I feel like I have a great deal of autonomy in my work.	True
F3	I have a significant amount of autonomy in what I do.	True
F4	My work is constrained by my department/Faculty's demands.	Reverse
F5	I spend a lot of time handling the bureaucratic aspects of my department/Faculty.	Reverse
F6	My department/Faculty's demands constrain my work.	Reverse
	Resources	
R1	I have access to considerable amount of resources.	True
R2	Obtaining research funding is not a problem for me.	True
R3	I never had problems regarding research funding.	True
R4	I have no shortage of research funding.	True
R5	I do not have problems in obtaining research funding.	True
R6	Research funding is not an issue for me.	True

Results

Exploratory Factor Analysis

Exploratory Factor Analysis (EFA) was performed on the pool of 36 questions using IBM SPSS 22 using Principal Component estimation. Due to expectation to some degree of correlation between the factors, it was opted to use an oblique rotation – Direct Oblimin (Abdi, 2003; Marôco, 2003). Missing data was handled through Markov Chain Monte Carlo (MCMC) multiple imputation, from which five complete datasets were produced. EFA was conducted on all five datasets simultaneously; for analytical purposes, only the pooled estimates were considered and reported. Data adequacy for EFA was evaluated on several levels; first, normality of the data was observed through skewness and kurtosis for the different items. All of them were lower than an absolute value of 3, indicating no serious departure from normality (Kline, 2011). The Kaiser-Meyer-Olkin (KMO) was 0.934 and Bartlett's test of sphericity was significant ($\chi 2$ (630) = 22539.175, $p < 0.001$), indicating that the data is adequate for EFA (Hair et al, 2007; Marôco, 2003). Finally, individual items were evaluated through the Measure of Sampling Adequacy (MSA) obtained through the anti-image matrices; all of them were above the 0.50 threshold, and thus no items were candidates for removal at this stage (Hair et al., 2007).

The optimal number of factors was determined based on the Kaiser criteria (>1 eigenvalue), scree-plot interpretation, and finally extracted variance. Accordingly, all rules pointed towards a 6-factor solution accounting for 68.36% of variance. However, 6 items had factorial loadings under 0.50, being potential candidates for removal. These were the following: "I do not feel rewarded for the work I do at my department/Faculty"; "I am happy working at my current department/Faculty"; "Overall, I am happy to be a part of my department/Faculty"; "I do not feel like I belong in this department/Faculty"; "I consider my department/Faculty's success to be my own success"; and "I am happy with the duties which are assigned to me by the department/Faculty". These items were removed and a new EFA was conducted. On this second pass, a new item emerged with poor factorial loadings: "People sometimes get uncomfortable with the decisions of my

department/Faculty's leadership". This item was also removed and an additional EFA conducted. On this final pass, all items met the 0.50 threshold. Five items ("I am satisfied with my current department/Faculty"; "I feel like I am part of my current department/Faculty"; "My current department/Faculty is a place where I am happy to work"; "The leadership of my department/Faculty makes me stressed"; "The leadership of my department/Faculty sometimes makes people feel uncomfortable") exhibited moderate loadings into other factors (>0.30). It was opted not to remove these items at this stage, but rather re-evaluate their performance during the CFA stage. This final EFA yielded a 6-factor solution explaining 71.82% of variance. Additionally, Cronbach's Alpha was computed for each of the factors in order to evaluate internal consistency. Its values ranged from 0.789 (Factor 6) to 0.920 (Factor 1), indicating an overall reliable scale. Table 7 presents the results for this analysis:

Table 7: Exploratory Factor Analysis with oblique rotation

	Item	*Factor Loading*					
		1	*2*	*3*	*4*	*5*	*6*
LS5	The leadership of my department/Faculty treats its employees kindly.	**.90**	.03	-.02	.05	.01	-.02
LS1	The leadership of my department/Faculty is considerate towards the people who work in it.	**.90**	-.01	-.05	.09	.03	-.03
LS2	The leadership of my department/Faculty understands my concerns.	**.82**	-.01	.04	.02	-.02	.04
OC 1	I feel like I am a part of my current department/Faculty.	**.56**	.02	.15	.10	-.16	.35
IS5	I am satisfied with my current department/Faculty.	**.55**	.07	.13	.07	-.02	.37
LS4	The leadership of my department/Faculty makes me stressed.*	**.54**	-.05	-.01	-.05	.43	.07
IS6	My current department/Faculty is a place where I am happy to work.	**.53**	.04	.14	.12	-.06	.37
LS3	The leadership of my department/Faculty sometimes makes people feel uncomfortable.*	**.50**	-.02	.05	-.16	.44	-.01
R5	I do not have problems in obtaining research funding.	.06	**.89**	-.05	.00	.02	-.07
R2	Obtaining research funding is not a problem for me.	-.01	**.89**	-.03	.05	.00	.01
R3	I never had problems regarding research funding.	.00	**.87**	-.08	.04	.00	-.01
R4	I have no shortage of research funding.	-.06	**.87**	.05	-.03	.06	-.04
R6	Research funding is not an issue for me.	-.01	**.82**	-.05	-.08	-.01	.04
R1	I have access to considerable amount of resources.	.02	**.63**	.15	.11	-.02	.05
SS6	Working with my peers is a pleasure.	-.05	-.03	**.91**	.00	.03	.01
SS3	I enjoy working with my peers.	-.07	-.05	**.91**	.02	.01	.03
SS1	I have good relations with my peers.	.05	-.08	**.81**	.12	-.03	-.05
SS5	I am on good terms with my peers.	.02	-.05	**.79**	.15	-.02	-.05
SS2	I recognize my peers to be highly competent.	-.01	.00	**.78**	.02	.03	.03
SS4	My peers give me great research ideas.	.03	.15	**.71**	-.22	.01	.01
F3	I have a significant amount of autonomy in what I do.	.05	.07	.04	**.89**	-.02	.00
F2	I feel like I have a great deal of autonomy in my work.	.06	.08	.02	**.88**	.04	-.02
F1	I do not have much autonomy in my work.*	-.01	-.05	.01	**.76**	.20	.04
F6	My department/Faculty's demands constrain my work.*	.03	.04	.03	.14	**.79**	.06
F5	I spend a lot of time handling the bureaucratic aspects of my department/Faculty.*	-.08	.05	-.04	.05	**.78**	.03
F4	My work is constrained by my department/Faculty's demands.*	.06	.04	.06	.11	**.77**	.07
OC 5	I would not expect to spend the rest of my career in this department/Faculty.*	-.14	-.03	-.07	-.02	.11	**.91**
OC 4	I would be happy to spend the rest of my career in this department/Faculty.	.13	.01	.06	.04	-.02	**.84**
OC 6	Spending the rest of my career in this department/Faculty would be a good thing.	.15	.02	.04	.00	.00	**.82**

Note: standardized loadings from Direct Oblimin rotation are reported. Bolded values indicate the factor with the highest loading.
* Reverse-coded item. Inverted prior to the analysis.

As the extracted factors did not entirely match the proposed structure, a new interpretation of the factor loadings was conducted. Many of the institutional satisfaction and satisfaction with the leadership, as well as some commitment items, coalesced into Factor 1. Additionally, many of the institution satisfaction items were removed – as previously described – due to poor or ambiguous loadings. As such, Factor 1 can be interpreted to represent a more global satisfaction measure, and was labelled "Institutional Satisfaction and Satisfaction with the Leadership". Factor 2 contains the 6 items for the funding dimension, and the "Funding" label remained the same. Factor 3 represents the "Social Satisfaction" dimension as it encompasses the 6 predicted items. Half of the items from the freedom dimension loaded into Factor 4, representing aspects more directly related to individual autonomy, led this factor to be labelled as "Individual Autonomy". Factor 5's items deal with the willingness to stay in the institution, representing a specific section of the commitment theme. Accordingly, this factor was labelled as "Willingness to Stay". Finally, Factor 6 contains the other half of the freedom theme's items, those which relate to bureaucratic tasks and demands. In line with the reverse-scored content of the items, this factor was labelled as "Unconstraint".

Confirmatory Factor Analysis

Procedure. Following the EFA, a Confirmatory Factor Analysis (CFA) was conducted. This analysis was performed using IBM AMOS 22 (Arbuckle, 2007) and Maximum Likelihood estimation, which is the most commonly used method, and has adequate robustness to deviations from normality (Arbuckle, 2007; Marôco, 2010). At this stage, missing data was handled through Full-Information Maximum Likelihood (FIML) estimation (Enders and Bandalos, 2001). Model fit was evaluated through the $\chi 2$ goodness-of-fit test (Barrett, 2007) and its X2 statistic (Bentler, 2007), the X2/df index (Arbuckle, 2007), the comparative-fit index (CFI) (Bentler, 1990) and its parsimony-adjusted variant, PCFI (Marôco, 2010), the root mean square error of approximation (RMSEA) (Steiger et al, 1985), the Akaike Information Criterion (AIC) (Anderson et al, 1998), and the Browne-Cudeck Criterion (BCC) (Marôco, 2010). At each respecification iteration, Modification Indices (MI) (Arbuckle, 2007; Bollen, 2014) were scanned for fit improvement opportunities. Covariances were specified between error terms for manifest variables belonging to the same latent variable whenever such a change yielded a positive

fit change with a MI value of 11 or higher, which corresponds to a type I error probability of 0.001 (Marôco, 2010).

Specification. The first attempt at model specification was replicating the factorial structure extracted in the previous EFA. The model exhibited adequate fit but with room for improvement (X2/df = 3.020; CFI = 0.958; PCFI = 0.773; RMSEA = 0.049; P[rmsea ≤ 0.05] < 0.001; AIC = 1285.850; BCC = 1294.129). Further ahead in the analysis of this first model, concerns began to emerge in regards to the validity of this structure, in particular regarding the Institutional Satisfaction and Satisfaction with the Leadership factor, for which the square root of the Average Variance Extracted (AVE) was less than its correlation with the "Willingness to Stay" factor, and also less than its Maximum Shared Variance (MSV). Both of these situations suggested problems with discriminant validity (Hair et al., 2007). At this point, it became evident that some confounding effect was affecting the institutional satisfaction, satisfaction with the leadership, and organizational commitment variables, likely due to some unobserved general satisfaction/commitment variable. This was corroborated by a) the strong correlation between the "Willingness to Stay" and the "Institutional Satisfaction and Satisfaction with the Leadership" (r = 0.81), b) the fact that some of the items had some degree of loading into other factors, as determined in the previous EFA, and c) most of the generalist satisfaction items – which were previously removed – were already exhibiting ambiguous loadings at the EFA stage. Because of this, the factorial structure for these items was re-specified based on the observed correlations, including those proposed by the MIs. First, all of the items which had some degree of loading into other factors (and previously noted in the EFA) were removed from the analysis, with the exception of item OC1 - I feel like I am a part of my current department/Faculty. Items OC2 – I do not feel like I belong in this department/Faculty and OC3 – I consider my department/Faculty's success to be my own success, which were previously removed in the EFA stage, were reintroduced and placed along with OC1 in a "Belonging" factor. The "Institutional Satisfaction and Satisfaction with the Leadership", now with only 3 items from the leadership theme, was rebranded "Satisfaction with the Leadership". A second-order construct (Hair et al., 2007; Marôco, 2010) - "Organizational Commitment" - was created, under which "Belonging", "Satisfaction with the Leadership", and "Willingness to Stay" were placed.

Respecification of the model in this manner resulted in considerable improvements to model fit (X2/df = 2.561; CFI = 0.972; PCFI = 0.784; RMSEA = 0.043; P[rmsea ≤ 0.05] < 0.001; AIC = 891.018; BCC = 987.839), which can be considered good or very good depending on the index (Barrett, 2007; Hair et al., 2007; Hooper et al, 2008; Marôco, 2010). Validity issues were also eliminated, as will be described in the next section. Table 8 presents the factorial loadings for the items in this model, and Figure 3 represents the model itself.

Table 8: Factorial loadings for the MDRWI

Code	*Item*	*Factor Loading*
	Organizational Commitment - Leadership Satisfaction	
1.LS1	The leadership of my department/Faculty is considerate towards the people who work in it.	0.92
2.LS2	The leadership of my department/Faculty understands my concerns.	0.81
3.LS5	The leadership of my department/Faculty treats its employees kindly.	0.91
	Organizational Commitment - Belonging	
4.OC1	I feel like I am a part of my current department/Faculty.	0.91
5.OC2	I do not feel like I belong in this department/Faculty.	0.84*
6.OC3	I consider my department/Faculty's success to be my own success.	0.63
	Organizational Commitment - Willingness to Stay	
7.OC4	I would be happy to spend the rest of my career in this department/Faculty.	0.94
8.OC5	I would not expect to spend the rest of my career in this department/Faculty.	0.72*
9.OC6	Spending the rest of my career in this department/Faculty would be a good thing.	0.92
	Resources	
10.R1	I have access to considerable amount of resources.	0.57
11.R2	Obtaining research funding is not a problem for me.	0.90
12.R3	I never had problems regarding research funding.	0.85
13.R4	I have no shortage of research funding.	0.81
14.R5	I do not have problems in obtaining research funding.	0.88
15.R6	Research funding is not an issue for me.	0.77
	Social Satisfaction	
16.SS1	I have good relations with my peers.	0.79
17.SS2	I recognize my peers to be highly competent.	0.74
18.SS3	I enjoy working with my peers.	0.90
19.SS4	My peers give me great research ideas.	0.62
20.SS5	I am on good terms with my peers.	0.77
21.SS6	Working with my peers is a pleasure.	0.91
	Autonomy	
22.F1	I do not have much autonomy in my work.	0.75*
23.F2	I feel like I have a great deal of autonomy in my work.	0.92
24.F3	I have a significant amount of autonomy in what I do.	0.92
	Unconstraint	
25.F4	My work is constrained by my department/Faculty's demands.	0.86*
26.F5	I spend a lot of time handling the bureaucratic aspects of my department/Faculty.	0.62*
27.F6	My department/Faculty's demands constrain my work.	0.87*

* Reverse-coded item. Inverted prior to the analysis.

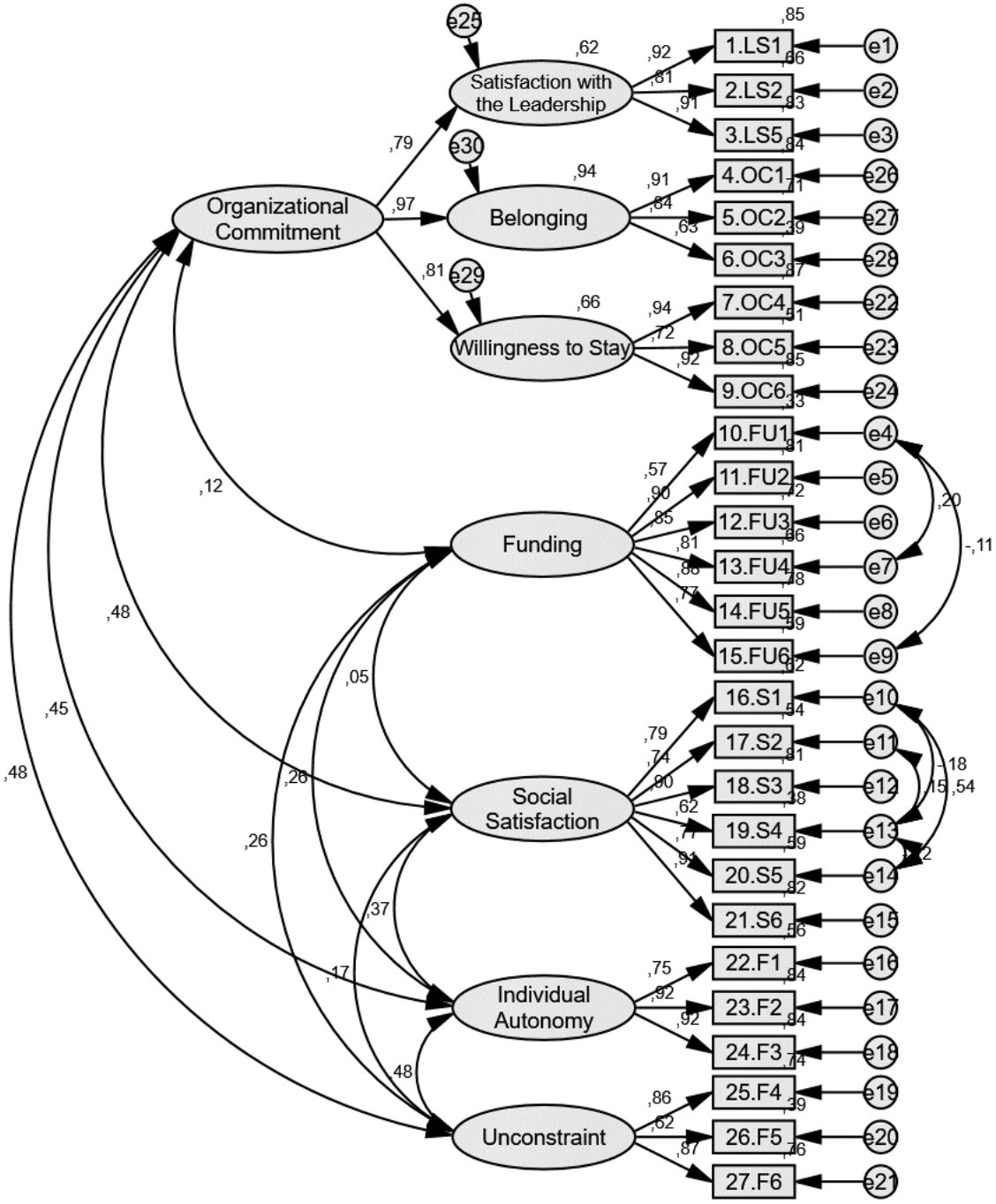

Figure 3: Measurement model for the MDURWI with standardized regression weights (loadings). Note: ellipses indicate latent variables, and squares indicate manifest variables. Disturbance terms are indicated by the latent variables labeled "e."

Validity, Reliability, and Sensitivity. Validity was evaluated in three facets: factorial, convergent, and discriminant validity (Hair et al., 2007; Marôco, 2010). Factorial validity can be established by having all factorial loadings above 0.50 in all items (Marôco, 2010), which has already been demonstrated in the previous section. Convergent validity was evaluated through the Average Variance Extracted (AVE) indicator (Fornell and Larcker, 1981). AVE must exceed the 0.5 threshold in order to establish convergent validity (Hair et al., 2007), which was also observed for all factors in the model. Finally, discriminant validity can be observed if AVE is equal to or greater than the squared correlation between two factors, and additionally, it must be equal to or greater than both the maximum shared variance and the average shared variance (Hair et al., 2007). As the issues regarding discriminant validity were resolved in a previous iteration of the model, as described in the former section, discriminant validity can be claimed for all factors in the final model.

Reliability, which indicated measurement consistency and replicability (Marôco, 2010) was evaluated through the composite reliability indicator (CR) (Fornell and Larcker, 1981). All of the factors met the proposed 0.7 threshold (Hair et al., 2007), indicating that the instrument is reliable. Finally, sensitivity – which indicates whether or not an instrument can differentiate between individuals (Marôco, 2010) – was evaluated by the distribution of each item. The distribution is considered acceptably normal, and thus indicating sensitivity, if the absolute value for skewness and kurtosis is lower than 3 (Kline, 2011). Again, all items were in accordance to these criteria. Table 9 summarizes this section of the validation exercise:

Table 9: Validity and reliability

Factor	*Composite Reliability*	*Average Variance Extracted*	*Maximum Shared Variance*	*Average Shared Variance*
Organizational Commitment	0.904	0.761	0.241	0.176
Autonomy	0.899	0.749	0.227	0.160
Unconstraint	0.833	0.630	0.241	0.142
Social Satisfaction	0.909	0.629	0.239	0.103
Resources	0.917	0.653	0.072	0.040

Discussion

Although the final factorial structure of the MDURWI departed slightly from what was originally expected, the final model is conceptually sound and presents a very good fit and measurement properties. In this section, a brief summary on how to interpret scores on each of the dimensions will be presented. Additionally, the final version of the instrument is provided in Appendix B (with a non-randomized question order).

The first dimension, Organizational Commitment, is a classic variable in organizational studies (e.g., Meyer and Allen, 1991; Mowday et al, 1979; O'Reilly and Chatman, 1986). It represents the bond between the individual and an organization; and individual scoring high in this factor can be said to experience a strong link with his working place, and has little desire of leaving it. It can be further sub-divided into three lower order factors: Satisfaction with the Leadership, which indicates how the individual perceives his leadership (and reflects on how one feels the leadership treats him or her); Belonging, which indicates how much the individual identifies oneself with the department or Faculty; and Willingness to Stay, which relates to one's desire to stay in his department/Faculty. Belonging and Willingness to Stay are analogous to the concepts of attitudinal and behavioral commitment (Mowday et al., 1982) in organizational commitment models. The inclusion of Satisfaction with the Leadership as a lower-order factor of this dimension, while not initially planned, is not unexpected – previous studies have found very strong correlations between the type of leadership and organizational commitment (Avolio et al, 2004; Chiok Foong Loke, 2001; Nguni et al, 2006; Yousef, 2000). In light of this, it is plausible that Satisfaction with the Leadership is acting as a proxy for normative commitment, the third concept in Mowday et al's (1982) model of organizational commitment.

The second dimension, Individual Autonomy, relates to the degree of independence an individual has in his current occupation. An individual with a high score in this factor can be said to have a greater freedom to conduct work in an independent manner. This is something that should be expected in creativity-driven environments

(Hemlin et al., 2008; Marginson, 2008), but is not always guaranteed (Latour and Woolgar, 2013). It is closely related to the concept of Unconstraint, which is the lack of institutional pressure to conduct tasks and services unrelated to research. An individual scoring high in Unconstraint has little pressure from his institution to participate in such tasks. This is an important consideration since these institutional pressures have been on the rise, with a negative impact on the perceived relationship between individual and institution (Cuthbert, 1996; Henkel, 2000; Tierney, 1999).

The following factor, Social Satisfaction, relates to the quality of co-worker interactions. An individual scoring high in this factor is happy to work with his colleagues and recognizes them to be competent, as well as recognizing the importance of such interactions. This is considered positive because such interactions lay the groundwork for collaborations which are very desirable in modern science and lead to a variety of positive work-related outcomes (Horta and Santos, 2015; Katz and Martin, 1997). The quality of social interactions is also correlated with the degree of organizational commitment, in accordance with the literature (Madsen et al., 2005). Finally, the factor Funding, relates to the availability of funding which the individual can use. Funding is a critical component of research and lack of it can have various ramifications (Bourdieu, 1999; Ebadi and Schiffauerova, 2015). An individual scoring high in this factor can be said to have access to much funding.

Conclusion

The MDURWI represents a new way of measuring a variety of work-related dimensions in academic research settings through a simple "all-in-one" questionnaire. The lack of an instrument of this kind has been previously noted in the literature (e.g., Blackburn and Lawrence, 1995) and partly explains the absence of research of these aspects in research workplaces. The development of this instrument offers new opportunities for researchers engaged in science and technology studies or higher education studies, while also creating a new way for universities to measure some of their

own organizational dimensions. With that said, it is important to consider the methodological limitations of the present study.

First, the instrument validation was conducted in a sample restricted to academic researchers performing research in the field of higher education. This was a methodological choice with the goal of mitigating inter-field variability; however, it also means that at present time, it is unknown whether or not the results will be replicated in samples from radically different fields. Further validation exercises are being planned across other fields in order to address this concern. Additionally, the diversity inherent to the field of higher education (as described in the first section of this article) serves as a double-edged sword. On one hand, it may mean that a great deal of diversity and its information is incorporated into the model, making it as wide-ranging in applicability as possible. On the other hand, it can also mean that some sensitivity might have been sacrificed by making the model more generalist, in the sense that applying it to specific communities within the field might yield skewed response distributions. Naturally, this a more practical consideration, which can strengthen or weaken the instrument depending on what the focus of research and intended use is, and thus must be kept in mind for academic researchers intending to use it in their own endeavors. Second, the fact that the items dedicated to job satisfaction alone were removed during the analysis due to confounded factorial loadings is unfortunate, but not unexpected – previous studies have shown that job satisfaction is very strongly correlated with organizational commitment (Dirani and Kuchinke, 2011; Veličković et al., 2014), which explains why items originally from both themes loaded into the same factor, and also why such a factor evidenced validity concerns later on. Thus, general job satisfaction could arguably be measured through a composite score computed from some of the items in the current study, but such an endeavor is likely best left for a future revision of the instrument. On a similar note, in the current version the planned resources measure is limited to financial resources, i.e., funding. Since resources as a concept encompasses a far larger scope (e.g., human resources, facilities) it is important that this dimension is expanded in future work. Furthermore, the satisfaction with leadership scale does not fully explore the concept of leadership. In future versions, it would be relevant to add measures for different leadership styles using one of the many existing models (e.g., Eagly et al., 2003). Third,

although the choice of themes included in this instrument was planned to be as broad as possible, it does not cover every possible organizational variable, and as such it is likely that equally important variables were left out of the current version. It is hoped that, through presentations and usage of this instrument, the feedback obtained through the scientific community will allow further improvements to the instrument in future revisions, such as adding other dimensions in order to improve the instrument's coverage of organizational aspects in the academia.

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Chapter 4
The research agenda setting of higher education researchers

Chapter based on: Santos, J. M., & Horta, H. (2018). The research agenda setting of higher education researchers. Higher Education, 76(4), 649-668.

Abstract

Research agenda setting is a critical dimension in the creation of knowledge since it represents the starting point of a process that embeds individual researchers' (and the communities that they identify themselves with) interest for shedding light on topical unknowns, intrinsic and extrinsic factors underpinning that motivation, and the ambition and scope of what a research endeavor can bring. This article aims to better understand the setting of individual research agendas in the field of Higher Education. It does so by means of a recently developed framework on research agenda setting, that uses cluster analysis and linear modeling. The findings identify two main clusters defining in individual research agenda setting – cohesive and trailblazing – each with a different set of determining characteristics. Further analysis by cross-validation through means of sub-sampling shows that these clusters are consistent for both new and established researchers, and for frequent and "part-time" contributors to the field of Higher Education. Implications for the field of higher education research are discussed, including the relevance that each research agendas cluster has for the advancement of knowledge in the field.

Introduction

Academic research is a dynamic process containing several layers of complexity (Latour and Woolgar, 2013). As a concept, academic research is not easily definable, which accounts for the many dimensions associated with it (Brew et al., 2016). These dimensions encompass issues related to the sense of belonging and identity, including which research communities individual academic researchers serve, contribute to, and receive value and normative input from (Fyfe, 2015). These communities provide guidance for the research engagement of individual researchers, but increasingly overlap (while sometimes competing) within frameworks that foster co-existing, competing, or cooperative logics framed by multidimensional dichotomies such as international versus national research communities, interdisciplinary, multidisciplinary, and disciplinary priorities, and quality or quantity, among others (Lauto and Sengoku, 2015). In addition to these, a multitude of institutional overlaps and interdependencies arise, which range from research communities, to national research and higher education systems, universities, faculties, departments, and research centers, each of which may impact the academic research developed by individual academics (Henkel, 2015). Environmental pressures such as competitive research funding, the drive to 'publish or perish', and the increasing tensions between teaching and research foci are associated with the introduction of managerialist practices at universities all over the world; all of these have a substantial impact on career progression and academic work itself, which further complexifies the understanding of what academic research is, and what being an academic researcher means (Shattock, 2014).

In this framework, Akerlind (2008) has found that the understandings held by individual academics, of what they are as researchers and what their research is, relates to their own research motivations, but also to the processes and outcomes of the research journey, and who it impacts: these factors provide an important conceptual starting point. This understanding of how academics construct the meaning of their academic research is helpful because it centers research choices on the individual academics while at the same time acknowledging the importance of contextual sets of constraints and incentives that help shape individual decisions during the research process (Moss and Kubacki,

2007). A substantial body of research has described and analyzed academic research processes in the context of their institutional configuration (Stubb et al., 2014), delineating how these research processes relate to other learning processes such as teaching (Hajdarpasic et al., 2015). The largest body of knowledge thus far constructed concerning academic research relates to research productivity and its determinants. Factors affecting productivity include such demographic characteristics as age and gender, individual ability, and self-efficacy, professional factors such as rank, funding, and network centrality, work-related issues including workload, preference for teaching and research, current and past resources, past activities and learning experiences (such as earning a PhD abroad), and social aspects such as marital status and number of children (e.g., Kim and Kim, 2017; Leisyte, 2016; Kwiek, 2016; Baccini et al., 2014; Quimbo and Sulabo, 2014). In the overall characterization of academic research, what has been somewhat overlooked thus far is the set of factors influencing individual academics as they set their research agendas. The reason for this neglect might relate to the fact that setting agendas often precedes the inputs (resources) needed to start research projects, and may therefore be taken for granted by studies that begin with the input phase. Agendas emerging from ongoing research projects may simply be understood as outcomes of an initial research project that feeds the motivation and resources to engage in a new research project, in a known cycle of knowledge production and accumulation (Conceição and Heitor, 1999).

This is not to say that academics are unaware of their own research agendas and the place these hold in their research and professional aspirations. At least one study on university-industry collaborations found individual research agendas to be influential in determining the engagement of academics in those types of collaboration (Lee, 2000), but such individual research agendas remain nevertheless largely ignored at a formal level. In Lee's (2000) work, research agendas are presented as somewhat of a common sense or presupposed idea that academics implicitly understand, without really defining what they are or are meant to be. Formal definitions for research agendas are almost non-existent:[7],

[7] The definition provided by Ertmer and Glazewski (2014) is a notable exception, albeit only an initial effort; this definition will be shown in the next section of the article.

academics may know what they mean when they talk about their research agenda (after all, they are engaged in research) but coming up with a definition for it has been more challenging. Research agendas can be associated with individual interests or preferences that carry the potential to shape while being shaped by a set of broad dimensions (e.g., environmental, social, and individual characteristics) and narrow dimensions (associated with the challenges of the research undertaking itself and its possible outcomes), which in combination influence the engagement on researching themes or topics of interest at a given time and place (a similar understanding of research agendas is proposed by Leisyte et al., 2008). This process refers to an interaction between the characteristics of the academic and the specificities of the research interest. Just as complex dynamics, identities, and influences affect one's self-definition as a researcher – following Arkelind's (2008) argumentation – the construction of research agendas is expected to aggregate dimensions of a dialectic between the academic's self-identification as a researcher, including attitudes toward research and associated incentives, and specific attributes relating to the specificities (and related challenges) of the research agenda itself. For example, the fact that an academic prefers to work collaboratively can be a dimension brought into the setting of the research agenda as part of the identity of the academic as a researcher, but it may also influence the choices made and actions taken in developing the research agenda. In other words, a research agenda on a particular topic may not be conceived by the individual academic if collaboration is not part of the initial conception. These connections may not be easy to disentangle, even by the academics themselves, in a highly pressurized, constantly changing academic research environment (Brew and Lucas, 2009).

This article aims broadly to identify the characteristics of research-agenda setting by higher education researchers. The article does not investigate the process of research agenda setting, in that it does not follow the intricacies of the decision-making process followed by individual academics. It also does not identify the topics, issues, or questions chosen (or the methods used to investigate them), but rather identifies factors that shape the decisions defining research agendas (i.e., the choice of themes and topics with different characteristics). Specifically, the question to be asked is whether certain "archetypes" or "doctrines" can be used to group or differentiate academics in their

research agenda setting process? The field of higher education is suitable for this exploratory study because it receives contributions from a multitude of researchers from different social sciences backgrounds including education, sociology, political science, economics, and anthropology among others, making it multidisciplinary while at the same time carrying a broad thematic focus (Tight, 2013). The analysis is accomplished by means of cluster analysis, a procedure that aims to identify groups of individuals based on a set of variables – in this case, based on the critical dimensions of the Multi-Dimensional Research Agendas Inventory developed by Horta and Santos (2016). This clustering is followed by a regression analysis aiming to characterize the importance of various dimensions of the research agenda, followed in turn by a cross-validation of the cluster structure, using two split-sample analyses. Since it is known that the understandings, involvement, and activities of academic researchers are bound to change throughout an academic career (Brew et al., 2016), research agenda setting by both new and established higher education researchers will be analyzed. The same analysis is also performed for academics with different degrees of engagement with the higher education research community (see Harland, 2012). The article is structured as follows. A brief literature on research agendas and the main characteristics of the field of higher education are presented in the next sections. The methodological section is next, followed by the results section. The conclusion sums up and discusses these findings, drawing implications for the advancement of knowledge in the field.

Research Agendas

While conducting the literature review, a significant number of articles using the term "research agenda" were found, but only Ertmer and Glazewsky (2014) attempted a formal definition of the concept. According to them, research agendas can be conceptualized as a combination of strategic problem-solving frameworks and the operationalization of actions to pursue research goals (Ertmer and Glazewski, 2014). In this manner, research agendas can be seen as both strategic and tactical. In the literature, research agendas are usually articulated in relation to broad topics representing challenges

identified by a research community (or by policymakers) as critical for the advancement of knowledge, for the solution to a societal issue, or both. Although collective agreement concerning common challenges is a stronger influence on individual research agendas in the natural sciences, engineering, and the health sciences, priority setting based on research and policy communities is also present in the social sciences, including in the field of higher education (Middlehurst, 2014). As the formulation of individual research agendas in the social sciences is by nature less collective and more focused on application, the individual experiences, backgrounds, and sets of incentives and constraints presented in the immediate institutional environments is expected to have a greater bearing on the choice of research agenda that individual researchers decide to pursue (Spalter-Roth, 2007).

Individual choices concerning research agendas shape the advancement of knowledge in each discipline and field of knowledge, but in today's complex and uncertain world, where academics face careers with increasingly non-linear paths and re-shifting boundaries (Shattock, 2014), these choices are also defined by career considerations and sets of organizational incentives and constraints (Kwiek and Antonowicz, 2015). This suggests that research agendas may not be designed solely for the sake of knowledge advancement itself, but rather are prepared to cope with sets of environmental constraints and incentives that influence the potential of any research agenda including its material and symbolic rewards (this is aligned with the seminal work of Allison and Stewart, 1974, criticizing generalizations of the "sacred-spark" hypothesis). In any case, individual research agendas shape knowledge and the evolution of fields and disciplines, and even granted the influence of collective agendas and the organizational environment, the choice for one research agenda over the other remains a personal choice (as convincingly argued by Polanyi, 2000). Yet, understanding this choice and the determinants affecting it is critical to interpreting the factors leading researchers to opt for specific research agendas and to devising policies that can support choices favoring the advancement of knowledge.

Based on the literature mentioned thus far, complemented by the literature on science and technology studies and on the sociology of science, a recent evaluation framework has characterized individual research agendas in terms of eight critical

dimensions, divided into twelve sub-dimensions (see Horta and Santos, 2016). This framework provides a conceptual and methodological instrument to characterize the research agenda setting of researchers in the field of higher education (Table 10).

Table 10: Dimensions and sub-dimensions of the Multi-Dimensional Research Agendas Inventory

Dimension	*Sub-dimension*
Scientific ambition	Prestige Drive to publish
Convergence	Mastery Stability
Divergence	Branching out Multidisciplinarity
Discovery	Discovery
Conservative	Conservative
Tolerance for low funding	Tolerance for low funding
Collaboration	Willingness to collaborate Invited to collaborate
Mentor influence	Mentor influence

The first dimension is *scientific ambition*, a researcher's desire to attain prestige and recognition by participating and contributing to the endeavors of a relevant research community, with whom he or she identifies (Latour and Woolgar, 2013; Bourdieu, 1999). This dimension is sub-divided into prestige – representing the desire for recognition – and the drive to publish, associated to the need to produce codified knowledge that can be easily disseminated and attain maximum visibility (an aspect in tune with the "publish or perish" trend in modern academia; Dobele and Rundle-Theile, 2015). The second dimension in the framework is *convergence*, which represents a preference for disciplinary approaches. This dimension is sub-divided into the concepts of mastery, representing expertise in a specific field, and stability, representing the investment in time and learning made into that field. This stands in opposition to the dimension of *divergence*, which indicates a willingness to expand beyond a single disciplinary approach. This dimension is sub-divided into branching out, representing the desire to expand into other fields of knowledge, and multidisciplinarity, or the propensity to work

in multidisciplinary projects. Both convergence and divergence are well established in the literature as potential strategies for both career and knowledge advancement (see Martimianakis and Muzzin, 2015, Rzhetsky et al., 2015; Schut et al., 2014).

Discovery and *conservative* are also competing dimensions, the former representing the preference for emerging fields carrying the potential for important discoveries and associated with more risk-taking; the latter indicates the preference to research well-established topics, which are considered to be safer (and thus indicating a more risk-adverse stance). The dimension *tolerance for low funding* represents how much the availability of funding conditions an individual's choice of research agenda, at a time when even academics who can undertake research without need of funding are pressed by national and institutional pressures to do so (Ion and Ceacero, 2017). The seventh dimension, *collaboration*, is considered to be an increasingly important factor in knowledge creation (Wang, 2016) and reflects the researcher's preference to set up research agendas that are collaborative in nature. This dimension is sub-divided into willingness to collaborate, indicating the propensity to collaborate with peers, and invited to collaborate, which measures the collaborative opportunities made available by others to the researcher. The final dimension in this framework is *mentor influence*, which reflects the degree to which an individual's agenda is influenced by his or her PhD mentor, an influence that is expected to decrease over time after the completion of the PhD (Platow, 2012). However, this tendency is not universal, and individuals can either drift away from their mentors early on, or pursue career-long partnerships with them. Mentor influence imbeds the transition of an academic to become an independent researcher, while testing the extent to which PhD mentors influence the research agendas set by their former students long after the conclusion of the PhD.

The field of Higher Education

Higher education is described as a field (rather than a discipline) that has gained visibility in recent decades due mostly to two major worldwide trends: 1) the massification of tertiary education worldwide, as several countries have engaged in a

rapid transition from elite higher education systems to mass higher education systems, while other countries have attained nearly universal higher education, which has brought new challenges including those related to internationalization, inequality, skill mismatches, and diversification (Mok, 2016); 2) the relevance of formal and organized learning, i.e. teaching and research, in sustaining competitiveness in the context of globalized, competitive and uncertain knowledge economies where intangibles overcome tangibles, and processes of innovation are transforming the role of higher education institutions in society, requiring analysis to better understand knowledge processes and institutions (e.g., Lo and Tang, 2017). In gaining more visibility, higher education research has continued to be closely linked to policymaking and institutional practice (Kehm, 2015), and generations of higher education researchers remain keenly aware of higher education related policy issues (Ashwin et al., 2016). The relative frequency of higher education reforms and changes to higher education systems means that higher education research is still defined by contributors as informing policymaking and practice and thus influencing the transformation of higher education systems (Altbach et al., 2006). This aspect has led scholars such as Malcolm Tight (2004) to interpret higher education research as a field of study and practice, which due to its object-focused rationale often calls for a multidisciplinary approach (see also Altbach et al., 2006).

Higher education research can be understood as an academic field with relatively blurred boundaries, bringing together researchers that identify themselves with a community and work within it on a multitude of higher education-related topics and issues (Kuzhabekova et al., 2015; Chen and Hu, 2012; Altbach et al., 2006). Higher education researchers have also been recognized as adopting different stances regarding policy issues (Ashwin et al., 2016), and the participation of contributors with various roles in the field tends to blur the distinctions between research and practice, which creates tensions between practically oriented problem solving and scientific reasoning (discussed by Harland, 2012).

This situation leads to two trends. On the one hand, it allows for some theoretical leeway, where theories are deployed because of their empirical applicability without challenging the conceptualization of the research object (Bligh and Flood, 2017). This presents an opportunity for researchers with disparate interests in a variety of topics,

methodologies, and levels of analysis to participate in the community based on common interest in higher education themes (Harland, 2012; Tight, 2008). Relative to this, Tight (2004) argues that higher education research is characterized by overlapping communities of practice, while MacFarlane (2012) describes it as an archipelago of theories, methods, and themes that prevents the field from becoming more coherent. Recent research identifies two main communities in the field of higher education – teaching and learning oriented and policy oriented – and emphasizes the relative compartmentalization between them (Kim et al., 2017; Horta and Jung, 2014); however, other aspects of compartmentalization are noted in the literature as well (see Tight, 2014).

On the other hand, this dynamic leads the field to be host to "part-timers", researchers making one-time contributions (e.g, those who only publish a single article in higher education literature); these interventions may relate to their professional practice or are made by researchers from other disciplines who happen to come across data sources or methods relevant to higher education (Harland, 2012; Clegg, 2012). These part-time researchers do not see themselves necessarily as located within the field of higher education studies (Healey and Jenkins, 2003) but contribute to the community alongside the regular contributors that are considered critical to the development of the field (Clegg, 2012). The characteristics of the field itself entail that research agendas in the field of higher education research may be set with more nuance (and bring in a wider range of factors) than if only researchers were examined having a background in, say, the discipline of education. Another important dimension is the generational change in higher education research, which reflects the same pressures as do other fields of knowledge. Today's new researchers must cope with different pressures when entering an academic career than those established researchers faced: they need to publish more (and more internationally), collaborate more (and more internationally), and raise more research funding to assure career progression and become established in national and global scholarly communities (Jiang et al., 2017). The introduction of tenure-track structures in many academic systems, combined with the lack of stable academic positions, are raising the stakes for the younger generation of higher education researchers, who may face different pressures and conditions than their predecessors, but could also modify their attitudes toward research itself (van der Weijden et al., 2016). Newer higher education

researchers may perceive the relationship between the research they conduct and policy less from the standpoint of membership in a higher education community and more from an individual perspective (Ashwin et al., 2016). These career challenges associated with evolving higher education systems undergoing rapid change are likely to influence differently the setting-up of research agendas by different generations of higher education researchers.

Method

Participants

Data for this study was gathered using an online survey deployed between May and November of 2015. Invitations to participate were sent to all corresponding authors of articles who published in higher education journals indexed in Scopus, between 2004 and 2014. The identification of the corresponding authors was done through a Boolean search in the Scopus dataset, which identified the journals in the field using the keywords "higher education" or "tertiary education" in the journal's title[8]. The resulting articles and equal number of corresponding authors represents the list of the 15 most influential higher education journals as proposed by Tight (2012), adding 23 other journals – some of them recent – in which higher education researchers publish their findings. This allows a representative sample of higher education journals, and follows the same process used in the literature to analyze higher education research communities (see Kim et al., 2017; Tight, 2014; Horta and Jung, 2014). The online survey contained socio-demographic questions and the Multi-Dimensional Research Agendas Inventory (MDRAI), an instrument with 35 Likert-style items to evaluate research strategies, priorities,

[8] The script of the Boolean search on Scopus was the following: "(SRCTITLE ("higher education") OR SRCTITLE ("tertiary education")) AND DOCTYPE (ar) AND PUBYEAR > 2003 AND PUBYEAR < 2015" – the search reported 40 higher education related journals, but 2 were excluded, the Chronicle of Higher Education due to characteristics that set its articles apart from other journals (see Horta, 2017) and the journal Art Design Communication In Higher Education, which only published two articles during the reference period.

influences, and goals along 8 dimensions and 12 sub-dimensions, which were validated by means of a Confirmatory Factor Analysis set out in the article that presents the MDRAI inventory (see Horta and Santos, 2016). A total of 1,348 higher education researchers agreed to participate in this survey, but 416 responses were excluded when the respondent left the survey without completing the MDRAI block. This led to a final sample size of 923 participants, of which 495 (53.6%) were females and the other 428 (46.4%) males. The age of participants ranged from 24 to 84 years (M = 50.97, SD = 11.17). A quarter of the participants were affiliated with United States institutions (230; 24.9%), followed in frequency by Australia (140; 15.2%) and the United Kingdom (126; 13.7%). This is proportionally aligned with the worldwide population of higher education researchers publishing in the international literature, which is still concentrated in native English-speaking countries (Kuzhabekova et al., 2015). Higher education researchers affiliated to institutions in 65 other countries accounted for the remaining 427 (46.2%) participants.

Variables

The variables used analytically in this article represent the sub-dimensions in the MDRAI, explained in the section "research agendas," above (see also Table 10). This was a conscious, methodological choice made to obtain greater detail in the clustering process and subsequent analysis. These sub-dimensions are: *prestige*, which indicates the researcher motivation to acquire the recognition of peers; *drive to publish*, which relates to the motivation to publish research; *mastery*, representing the researcher's perceived mastery in a specific field; *stability*, which indicates the level of investment in a single field; *branching out*, associated to setting-up research agendas that are likely to expand to other fields of knowledge; *multidisciplinarity*, which reflects the researcher's preference to engage in topics requiring multidisciplinary approaches; *discovery*, representing a preference for emerging fields and risk-taking behavior; *conservative*, suggesting a preference to research safer and well-established topics; *tolerance for low funding*, which measures to what extent the availability of funding influences the choice of research topics; *willingness to collaborate*, representing the researcher's willingness to start collaborative research projects; *invited to collaborate*, representing the incidence of research agendas started by invitations to collaborate; and *mentor influence*, which indicates the level of influence of the PhD mentor in designing research agendas.

Procedure

The first stage of the analysis employs cluster analysis to identify specific profiles and create a typology of research agendas. In the literature, cluster analysis has been used in a variety of contexts, including the study of behavioral patterns (e.g, Chou, 2008), science and technology indicators (e.g, Almeida et al., 2009), and profiles of the careers of researchers (Santos and Horta, 2015). In the analysis undertaken for this article, a TwoStep clustering algorithm is used, which offers several advantages over traditional clustering procedures. It allows for the use of both categorical and continuous variables, which is not possible with traditional clustering methods (Norusis, 2012); it is compatible with very large datasets (Zhang et al., 1996); and it is capable of statistically determining the optimal number of clusters (see Chiu et al., 2001 for a detailed description of this procedure). The clustering procedure used log-likelihood estimation, given that the reported Euclidean distance performed poorly in this context (see Santos and Horta, 2015). The model fit was evaluated by means of the average silhouette measure of cohesion and separation ranging from -1 to 1. The cutoff point of 0.2 (and above) was considered for determining whether or not the model has good fit (Kaufman and Rousseeuw, 2009).

The second stage of the analysis makes use of a regression, using input variables to gain additional insights regarding both the relative predictive power of each sub-dimension and their relation to the sub-dimensions that defined the clusters identified in the previous stage. This analysis concludes with a cross-validation that replicates the clustering procedure in sub-samples defined based on "real-life" grouping variables.

Strengths and weaknesses of using perception data

This study relies on self-reported data. Questionnaires represent one of the most practical cost-effective methods to obtain large amounts of data, and produce relatively robust evidence when adequate validation exercises are implemented. However, respondent bias remains an issue, especially regarding socially desirable responses (McDonald, 2008), which represents an inherent limitation of this method. Moreover, the fact that the analysis is based on perception data, means that it refers to respondents' interpretation of a phenomenon, which is inevitably informed by their previous beliefs

and experiences, as well as their effort to provide meaning to their experience (Lindsay and Norman, 1977). The way individuals interpret a phenomenon aligns not with reality as it is, but rather with a reality as they construct it. While this is potentially limiting from a methodological point of view, this limitation is mitigated according to a literature that describes self-perceptions as powerful influences defining human action (i.e., what is real is what one perceives it to be) which are highly correlated with actual behavior (Pickens, 2005). Self-perceptions are found to be compelling influencers of behavior and action in higher education settings. Studies showing how student perceptions of themselves (self-esteem) and of their skills guide their academic choices and their employment focus (e.g, Tavares and Cardoso, 2013), while for academics, how they perceive changing institutions and environmental factors alters and shapes their behaviors and their research productivity (e.g, Kwiek, 2015). Response bias under the form of social desirability, for instance, typically manifests as a skewing of the responses towards what is perceived as desirable (Philips, 1972). The instrument used for this analysis was previously validated and found to have normal distribution for all of the used predictors, with low values of skewness and kurtosis (Horta & Santos, 2016), further suggesting that there is little or no response bias.

Results

First stage analysis – Clustering

The clustering procedure yielded two clusters comprising of 605 participants (cluster 1) and 318 participants (cluster 2). The model fit, as evaluated by the silhouette measure of cohesion and separation, was 0.3, indicating a good fit. Table 11, Table 12, and Figure 4 describe the characteristics of these clusters based on the input variables[9]:

[9] For analytical purposes, standardized factor scores were calculated for the latent factors representing the dimensions under analysis (DiStefano et al., 2009) using full information maximum likelihood (FIML) estimation for purposes of data imputation (Enders and Bandalos, 2001). However, when descriptive statistics are reported, the simple mean for individual items comprising that factor is used instead, making it easier to read since these values are easier to be interpreted than Z-scores.

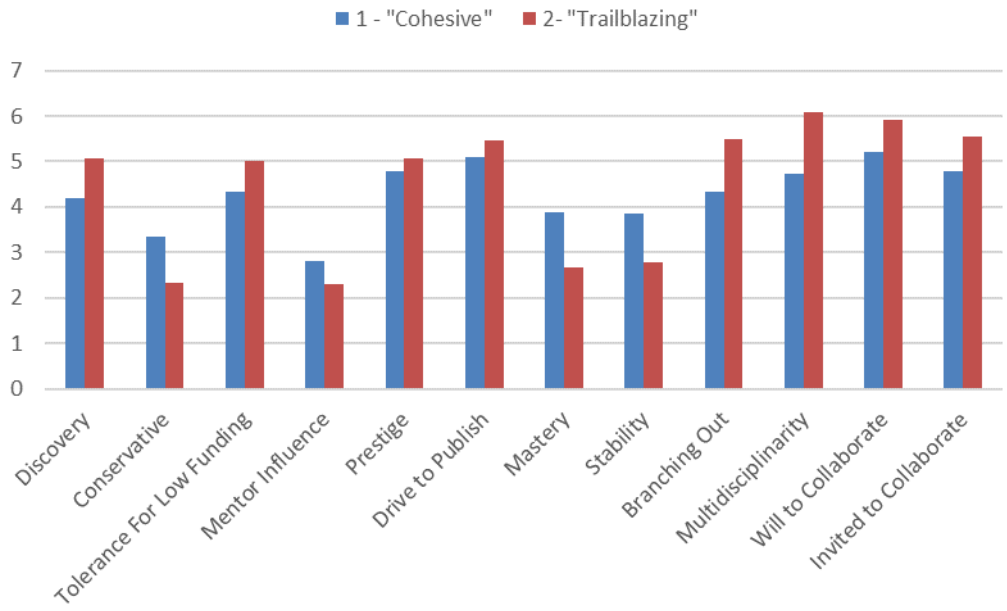

Figure 4: Comparative of variable means for each cluster.

Table 11: Quantitative descriptive statistics for the extracted clusters.

	1 – "Cohesive"		*2- "Trailblazing"*	
Variable	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*
Discovery	4.19	0.88	5.05	1.22
Conservative	3.36	0.90	2.32	0.92
Tolerance for Low Funding	4.34	1.14	5.02	1.40
Mentor Influence	2.82	1.23	2.29	1.32
Prestige	4.80	1.06	5.06	1.25
Drive to Publish	5.11	1.11	5.46	1.30
Mastery	3.88	0.97	2.67	0.96
Stability	3.85	0.86	2.79	0.90
Branching Out	4.34	0.94	5.50	0.90
Multidisciplinarity	4.74	1.07	6.08	0.95
Will to Collaborate	5.22	0.94	5.91	0.89
Invited to Collaborate	4.79	1.09	5.55	1.04
Age	50.56	11.37	51.74	10.84
N	605		318	

Table 12: Qualitative descriptive statistics for the extracted clusters.

	1 – "Cohesive"		*2- "Trailblazing"*	
Variable	*N*	*Column %*	*N*	*Column %*
Gender				
Male	328	54.1%	169	53.0%
Female	277	45.9%	149	47.0%
Country				
Other	87	14.4%	41	12.6%
Australia	88	14.6%	52	16.4%
Canada	26	4.1%	13	4.1%
Finland	13	2.2%	7	2.2%
France	4	0.7%	5	1.6%
Germany	8	1.3%	7	2.2%
Hong Kong	7	1.2%	6	1.9%
Ireland	5	0.8%	5	1.6%
Israel	5	0.8%	1	0.3%
Italy	7	1.2%	3	0.9%
Malaysia	9	1.5%	2	0.6%
Netherlands	22	3.6%	2	0.6%
New Zealand	20	3.3%	13	4.1%
Norway	11	1.8%	3	0.9%
Portugal	16	2.6%	4	1.3%
South Africa	22	3.6%	4	1.3%
Spain	18	3.0%	5	1.6%
Sweden	13	2.2%	4	1.3%
Taiwan	6	1.0%	3	0.9%
United Kingdom	78	12.9%	48	15.1%
United States	140	23.2%	90	28.4%
N	605		318	

Based on the characteristics of the identified clusters, cluster 1 was labelled as "cohesive agendas" and cluster 2 as "trailblazing agendas". The most evident differences between the clusters rest in the sub-dimensions of convergence and divergence, although other differences can be observed, as described below.

The cohesive agenda cluster accounts for two-thirds of the sampled higher education researchers, and represents researchers whose agenda-setting leans toward safer research endeavors. This is evidenced by their comparatively lower scores on the discovery dimension and higher scores on the conservative sub-dimension, indicating a preference for more established fields. Their research agenda setting process is somewhat tolerant to low funding, but less so than that of researchers leaning toward trailblazing

agendas. Researchers learning toward cohesive agenda setting also consider their research agenda setting to be more influenced by PhD mentors, while scoring slightly lower on both prestige and drive to publish than their more trailblazing agenda-oriented peers. More substantial differences are observed concerning mastery and stability, which are considerably higher for cohesive agenda-oriented researchers, indicating a preference to specialize and take roots in a single field of inquiry. Accordingly, cohesive agenda-oriented researchers score comparatively lower on branching out, multidisciplinarity, and both collaboration sub-dimensions, indicating less willingness to collaborate with peers and – probably as a consequence – fewer opportunities to partake in cooperative ventures started by others.

The competing cluster of the trailblazing agenda-oriented researchers represent one-third of the sampled researchers and highlight a different set of characteristics. They are more driven toward discovery and less toward conservative research agendas. They report a higher tolerance for low funding than cohesive agenda-oriented researchers, which can be explained by the fact that they are more willing to attempt exploratory research that does not demand too many resources, but they may also be constrained by research agencies, which tend to prefer to fund established fields (Carayol and Thi, 2005). The influence of the PhD mentor is relatively lower for the agenda setting of these researchers, which may indicate more independence but could also entail that after graduation they quickly shift the focus of their research agendas beyond the research interests of their PhD mentor. On prestige and drive to publish, they score comparatively higher than the cohesive agenda-oriented researchers. A lower score on both mastery and stability indicates that these researchers have less interest in focusing on a single field and prefer broad and multidisciplinary agendas, which is also evidenced by much higher scores than the cohesive agenda-oriented researchers in the branching out and multidisciplinarity sub-dimensions. Researchers following a trailblazing research agenda-setting approach also report a higher preference for collaborative agendas and are given more opportunities for collaboration.

The descriptive statistics for the clusters according to age, gender, and country do not show important differences. The mean age of researchers leaning toward cohesive research agendas is 51, while for those leaning toward trailblazing research agendas is 52.

The balance between males and females in both research agenda clusters is similar (54% males to 46% females in the cohesive agendas and 53% males to 47% females in the trailblazing agendas). The same holds true for differences between countries, with more researchers leaning toward cohesive agendas in all countries[10].

Second stage analysis – Linear modeling

The first analysis identifies two main trends in the setting of research agendas by higher education researchers, but cluster analysis as a technique provides limited information on the predictive capabilities of the determining variables. Therefore, a follow-up analysis was conducted using a multivariate General Linear Model, a commonly used procedure (see Parker et al., 2013). This analysis considers dependent variables the sub-dimensions mastery and stability (constituting the convergence dimension), and branching out and multidisciplinarity (constituting the divergence dimension). These sub-dimensions are used because they are the primary differentiators of the clustering structure. The independent variables used were the remaining sub-dimensions in the clustering analysis. The results are summarized in Table 13.

[10] With the possible exception of France, but the very small number of observations for that country do not permit even a tentative conclusion.

Table 13: Determinant effects on sub-dimensions of Divergence and Convergence

Variables	*Stability*	*Mastery*	*Multidisciplinarity*	*Branching Out*
Discovery	-0.016 (0.026)	-0.006 (0.029)	0.268 *** (0.042)	0.191 *** (0.032)
Conservative	0.347 *** (0.026)	0.404 *** (0.029)	-0.164 *** (0.042)	-0.192 *** (0.033)
Tolerance for Low Funding	-0.046 ** (0.021)	-0.057 ** (0.024)	-0.006 (0.035)	0.010 (0.027)
Mentor Influence	0.019 (0.023)	0.025 (0.026)	0.052 (0.037)	0.100 *** (0.029)
Prestige	0.137 *** (0.021)	0.170 *** (0.024)	-0.021 (0.035)	-0.009 (0.027)
Drive to Publish	0.013 (0.026)	0.016 (0.029)	0.060 (0.042)	0.067 ** (0.032)
Will to Collaborate	-0.121 *** (0.035)	-0.135 *** (0.041)	0.260 *** (0.058)	0.166 *** (0.045)
Invited to Collaborate	-0.004 (0.034)	-0.012 (0.038)	0.043 (0.055)	0.053 (0.218)
F(8, 911) ***	60.190	63.162	31.011	35.916
Adjusted R-Squared	0.339	0.350	0.207	0.233
Observations	923	923	923	923

Notes. A General Linear Model with fixed factors (coded as dummies) and covariates is shown. Standard errors are in parenthesis.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

These results show differences between trailblazing and cohesive agenda setting. Discovery – associated with risk-taking, and a research preference for emerging fields carrying the potential for disruptive discoveries – manifests itself as a statistically significant positive predictor of multidisciplinarity and branching out, while having no effect on stability and mastery. From a conceptual standpoint this is expected, since researchers performing cutting-edge research are likely to require knowledge from several existing fields (Martimianakis and Muzzin, 2015; Schut et al., 2014). Inversely, conservative is a statistically strong positive predictor of both stability and mastery, and a negative predictor of multidisciplinarity and branching out. Researchers pursuing conservative research agendas are more likely to specialize to the point where they are reluctant to engage in other fields. There is a key difference between discovery and conservative dimensions, however. Whereas discovery has a positive effect on divergence

without any significant effect on convergence, conservative has a positive effect on convergence while simultaneously having a negative effect on divergence. An interpretation for this is that trailblazing agenda-oriented researchers have lesser incentives and thus are neutral to the prospect of doing, for example, replication research, while cohesive agenda-oriented researchers actively avoid riskier endeavors. This may be an expression of the cumulative advantage effect (Allison and Steward, 1974), as researchers who are "ahead of the curve" have lesser incentives to engage in uncertain ventures. This has been shown to occur even in cutting-edge fields such as biomedicine, where researchers become more conservative as the overall risk of the field increases (Rzhetsky et al., 2015). This is co-substantiated by the tolerance for low funding variable, which is a negative predictor for both stability and mastery, meaning that the greater a researcher's tolerance to risk is, regarding research funding, the less likely it is that this researcher will engage in cohesive agenda setting. In this regard, it is also important to note that cohesive research agendas are more linked to disciplines, which research funding agencies prefer to fund (vis-à-vis multidisciplinary and interdisciplinary approaches), therefore making it likely that more research funding would be available for researchers opting for cohesive research agendas (Carayol and Thi, 2005). Tolerance for low funding has no effect on the divergence dimensions, meaning that it has the potential to draw researchers away from the cohesive agenda, while not necessarily pulling them toward adopting trailblazing agendas.

The influence of PhD mentors only has a positive impact on branching out, underlining the key role that mentors can have in encouraging their former students to expand their research agendas into other fields of inquiry. Prestige is a strong and positive predictor of stability and mastery, which are characteristics mostly associated with cohesive research agenda setting. This finding is aligned with literature suggesting that pursuing multiple research foci can be understood by research communities as a lack of thematic focus and engagement in the interests of that particular community, and thus detrimental to researchers desiring to accumulate prestige which, as a positional good, demands significant amount of time, focus, and effort (Bourdieu, 1999). Drive to publish, however, has a positive effect on branching out, which is expected since entering and expanding into different fields of knowledge requiring a tangible "presence" there that

implies a greater need to publish to be visible but also allows a broadening of publication venues. The collaboration sub-dimension is a significant predictor of all sub-dimensions, whereas a higher willingness to collaborate leads to less convergence and more divergence. This resonates with the literature stating that multidisciplinary ventures require higher levels of collaboration than disciplinary and specialized research foci (Leahey, 2016). This implies that those engaging more in trailblazing research agendas are likely to publish more publications in collaboration than those leaning toward cohesive research agenda setting. No statistically significant differences were found for the invited to collaborate variable.

Third stage analysis – Split-sample cross-validation

The literature review suggested potential differences between new and established cohorts of higher education researchers (Jiang et al., 2017; Ashwin et al., 2016), and between part-timers (one-time contributors to the field) and researchers making frequent contributions (Harland, 2012; Clegg, 2012; Healey and Jenkins, 2003). Therefore, a clustering procedure was conducted independently for each of the four groups. The first cross-validation was conducted with the sample divided between new and established researchers. Since differentiation between new and established researchers is not clear-cut, the analysis followed Bazeley's (2003) suggestion of using relative youth as an indicator of whether a researcher is early or late in his or her career (Bazeley, 2003). Therefore, researchers under 40 years old were labelled as new researchers. A related analysis comparing pre-tenured and tenured researchers would also have been of interest, to provide an assessment of new and established researchers complementary to the age-based criterion, but no appropriate data was available to perform it.

In each group, as in the main analysis, only the cohesive and trailblazing research agenda clusters emerged, each showing a fit of 0.3 on the silhouette measure. Figure 5 and Figure 6 juxtapose the two clusters' profiles on both groups. This shows that except for minor differences (such as the influence of PhD mentors being less for the established researchers leaning toward trailblazing research agendas than it is for established researchers leaning toward cohesive research agendas), new researchers, established researchers, part-time, and frequent contributors to the higher education research

community all show a similar structuring of their research agendas, leaning either toward trailblazing or cohesive research agendas. This analysis sustains the robustness of the main analysis and implies that contributors to higher education research at different stages in their academic career, or contributing to higher education research at differing frequency, maintain the same dynamics concerning the setting-up of research agendas.

Figure 5: Comparative variable means for each cluster, for new and established researchers in the field of higher education.

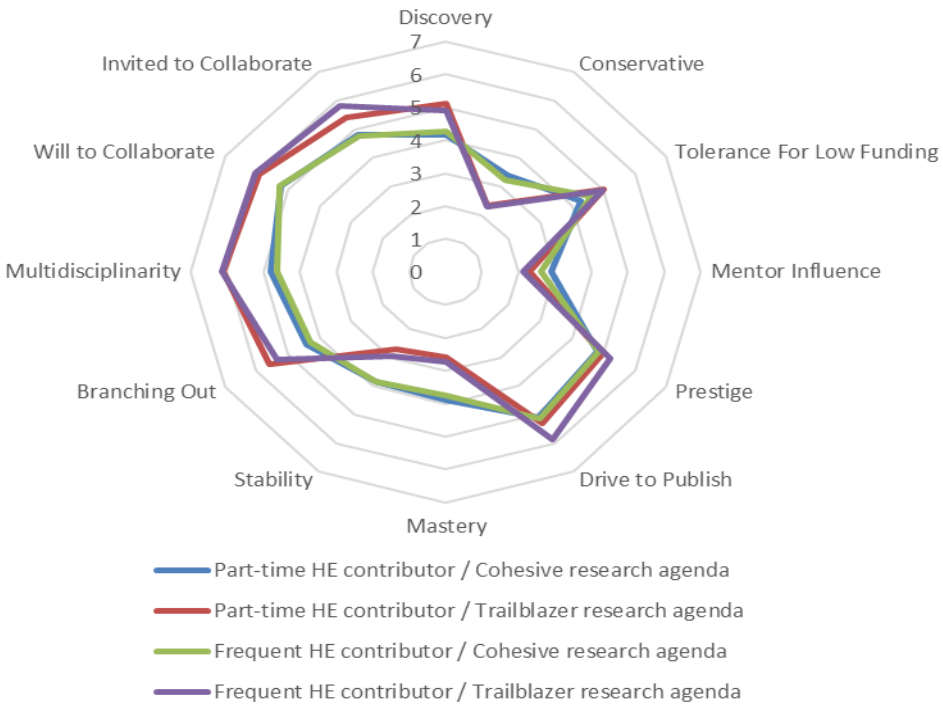

Figure 6: Comparative of variable means for each cluster, on part-time and frequent higher education researchers.

Conclusion

The setting-up of individual research agendas by higher education researchers is characterized by multidimensional features that can be clustered into two main clusters, cohesive and trailblazing. Cohesive research agendas are characterized by a greater focus on developing an expertise in a field, associated with a long-term investment of time and effort in driving forward knowledge on a specific topic, thus implying a level of topical specialization. This relates to the sense of convergence with the existing knowledge in the field but also to stability and safer risk-taking options. These agendas tend to be mostly disciplinary in nature and demand a lesser degree of collaboration, possibly due to the substantial influence of the PhD mentor on research agenda setting (particularly for new researchers), related to the topics or general field of inquiry of the PhD. Trailblazing research agendas, on the other hand, are characterized by a willingness to expand research into other fields of knowledge, to do multidisciplinary research, and to engage and be

engaged by others in collaborative projects from the start. This research agenda cluster is associated with risk-taking, since it implies a greater likelihood of leaving one's comfort zone and coping with potentially lesser availability of research funding (the propensity to do research with no funding is higher for those researchers opting for this research agenda).

Both research agenda clusters are strongly associated with peer recognition, although the strategy to attain this recognition from peers is different and relates to key characteristics defining each research agenda cluster. Those researchers leaning toward cohesive research agendas tend to have a desire for recognition that is associated to the mastery of knowledge in a specific field of inquiry as recognized by their peers, while researchers that lean toward trailblazing research agendas tend to do so through a greater drive to publish, evidencing the need to establish a "presence" through concrete research outputs on the many research topics that they engage in. These two different strategies to attain prestige defined in the two research agenda types are closely associated to the contextualization, legitimacy, and related challenges that disciplinary, multidisciplinary, and interdisciplinary researchers face in modern academia (Carayol and Thi, 2005). Research agendas should not be assumed to involve mutually exclusive approaches, but rather are subject to interplay across the continuum of dimensions that characterize them (see also Knuuttila, 2013). Nevertheless, the analysis of research agendas of new and established higher education researchers and part-time and frequent contributors to the field suggests that researchers in different situations in their career – and with varied opportunities to contribute to the field – exhibit a remarkably similar clustering of research agenda setting. This may indicate that some pressures – including those derived from academic capitalism – could be at work undermining expected differences in research agenda setting and underlining isomorphic pressures to conform and survive (particularly for the younger generations of researchers; see Cantwell and Taylor, 2015).

However, aside from the possible pressures pointed above that may be associated with a changing academia, the implications of this study on research agendas clusters for the advancement of knowledge in the field of higher education could be far reaching, particularly if one considers that two-thirds of researchers lean toward a cohesive research agenda while the others tend toward a trailblazing agenda. As one analyzes the

dimensions characterizing the research agendas, and the clusters that were formed around them, the dichotomies between them seem to find echo in the work of Kuhn (1970) concerning his reasoning about the paradigms to which groups of researchers adhere (as well as legitimize and protect), embedding specific values, identities, lines of thinking and acting (often dictated by disciplinary norms) in what Kuhn designated as "normal science". Meanwhile, often within the same research community, other groups of researchers try to create "small revolutions" that lead to paradigmatic shifts. The former can be associated with researchers leaning toward cohesive agendas, while the latter are associated with those leaning toward trailblazing agendas. This distinction can have substantial repercussions for the advancement of knowledge in the field of higher education, since those researchers engaged in what Kuhn (1970) terms as "normal science" – that is, the ones leaning toward cohesive agendas - tend not to find unprecedented results because the normal science does not aim to find novelties. Rather, and contrary to the perspective of Popper (1963) who argues that researchers constantly strive to scrutinize accepted knowledge and beliefs, Kuhn (1970) argues that researchers adhering to a paradigm do research mainly to reinforce what is already known, albeit perhaps from different angles or in differing contexts, and add little to the advancement of knowledge. This holds true even if paradigm-bound researchers stress that unknowns exist in normal science – which is a pre-condition for discovery - if they try to solve these questions mainly by improving existing explanatory models and not by searching for new ones.

This interpretation places those researchers leaning toward cohesive agendas as stabilizers of knowledge and identity in the field. However, and at the same time, these researchers may not be aligned with the growing call for more multidisciplinary, disruptive and encompassing research agendas to cope with the complex challenges the world is facing (Martimianakis and Muzzin, 2015). They are also expected to be resistant to engage in modes of knowledge production that are described as more transdisciplinary, hierarchically organized, and have a more transitory character (Nowotny et al., 2003). And yet, of greater concern, these would also be the researchers most likely to oppose change because paradigm shifts – entailing novelty and new knowledge leading to the emergence of new paradigms - bring along with them crises and what Kuhn describes as

the “end of normal science;” that is, they bring disruption to the field and undermine the scientific positioning of these researchers (who may lose positional power; see Kogan, 2005). Therefore, and in view of this line of argument, a greater balance is desirable between research agendas in the higher education research community, and should be sought in a way that on the one hand, ensures novelty and change in the field but, on the other hand, does not overly lean toward the preponderance of trailblazing agendas, because it is important to realize that fields of knowledge are social systems (Latour and Woolgar, 2013) and as such they require minimum levels of stability, organization, and sets of values and norms to sustain them as recognized fields of knowledge.

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Chapter 5
The Association of Thinking Styles with Research Agendas among Academics in the Social Sciences

Chapter based on: Santos, J. M., Horta, H., Zhang, L. F. (In press). The Association of Thinking Styles with Research Agendas among Academics in the Social Sciences. *Higher Education Quarterly*.

Abstract

Research agendas are understudied, despite being key to academic knowledge creation. The literature suggests that the ways that academics determine their research agendas are conditioned by individual, organizational, and environmental characteristics. This study explores the cognitive aspects of academics' research agendas in the social sciences by using a theory on thinking styles as an analytical framework. The results suggest that the research agendas of academics in the social sciences are significantly associated with their thinking styles. These findings aid understanding of how academics set their research agendas. This study also represents an important landmark in research on thinking styles, focusing on academic research work as a potential venue for further studies. The findings are relevant for policymakers, research funding agencies, university administrators, and academics because they have implications for academic research development processes, outcomes, and for research and academic identity socialization during doctoral studies.

Introduction

The processes of academic knowledge creation are undeniably complex, and studies focusing on these processes often underline issues of productivity or of macro-level factors related to policies, incentives, and resources (McGrail, Rickard, & Jones, 2006; Stephan, 2012). Individual academics (i.e., people involved in the production of knowledge) are usually analyzed in terms of socio-demographic factors, which can include age (Bonaccorsi & Daraio, 2003), gender (Abramo, D'Angelo, & Caprasecca, 2009), number of children (Stack, 2004), education (Shin & Jung, 2014), or factors associated with the academic and research environments (Kim & Kim, 2017; Kwiek & Antonowicz, 2015; Leisyte, Enders, & De Boer, 2008). Although relevant, these analyses have generally been unconcerned with the processes through which academics define their individual research agendas.

The individual nature of social science research agendas, which is indirectly mentioned in the seminal work by Polanyi (2012), needs to be further explored. The few existing studies that have focused on this topic have taken a limited perspective, focusing mainly on the psychological traits of academics in particular disciplines. This approach is somewhat outdated, and is overly concerned with discerning general personality profiles for academics in specific disciplines (Helson & Crutchfield, 1970; Rushton, Murray, & Paunonen, 1983). Moreover, these studies do not account for the changes to the academic profession and work in recent decades, which have been strongly influenced by research assessments, institutional pressures towards performativity, 'publish or perish' dynamics, and demands that research impact is evidenced (Kenny, 2018; Chubb & Watermeyer, 2017; Martin-Sardesai et al., 2017). These changes to the current working environment in academia are bound to influence academics' behaviors and strategies concerning their research agendas (e.g., Horta & Santos, 2019; Leisyte, 2016; Brew & Lucas, 2009). Considering this context, the present study sought to assess how psychological traits are associated with academics' research agendas. Furthermore, this was done while controlling for several variables that are known to influence research-related outcomes. Such variables included the participant's age, which is known to influence scientific outputs (Bonaccorsi & Daraio, 2003; Kwiek & Antonowicz, 2015);

the amount of time passed since conclusion of the doctorate degree, which accounts for career stage (Jung, 2014); and gender, an equally important variable in scientific processes (Stack, 2004). The participant's country of work was also considered a fixed-effect control variable, as policies are not constant across countries, and higher education systems in some countries place greater emphasis on research competition, performativity, and evaluative mechanisms than others (Hicks, 2012; Auranen & Niemiren, 2010). Finally, the field of science in which the academic was educated was taken into account because research training tends to have a long-lasting influence on ways of thinking and often on social scientists' current research (Podlubny, 2005).

It is reasonable to assume that individual research agendas are situated at the behavioral end of the triadic reciprocity (Bandura, 1978). The exogenous factors associated with the environmental sector have been intensively researched in the literature, and previous studies have found that a range of incentives or motivations can stimulate academics to engage in research or expand the boundaries of knowledge (Allison & Stewart, 1974). The endogenous factors, however, have not been fully investigated. Although other psychological models such as vocational personality (Holland, 1997) might also be used to characterize individual research agendas, the construct of thinking styles (Sternberg, 1988; Sternberg & Grigorenko, 1997) seems to be a more appropriate starting point, because the research tasks being investigated are largely intellectual by nature.

Literature Review

Thinking Styles

The concept of thinking styles was originally proposed by Sternberg in his theory on mental self-government (Sternberg & Grigorenko, 1997). Thinking styles are defined as individuals' preferred ways of using their abilities. Thinking styles are not abilities; rather, they relate to how people use the abilities they possess. As Sternberg (1999) explained, 'An ability refers to how well someone can do something. A style refers to

how someone likes to do something'. Thinking styles have been found to be independent of personality or intelligence (Grigorenko, 2009). In addition to the factors of intelligence and personality, these style preferences make unique contributions to human performance (Zhang, 2006; Zhang, 2017).

Sternberg (1988) initially proposed thirteen thinking styles, which Zhang (2002a) classified into three types. Type I styles tend to be more creativity-generating, and they require higher levels of cognitive complexity. These styles are deemed to carry more adaptive (i.e., desirable, positive) value because they are often found to be strongly associated with highly desirable human attributes and outcomes such as higher levels of creative thinking in approaching learning tasks (Davis, Kaufman, & McClure, 2011; Niu, 2007), teaching behaviors characterized by creativity (Dikici, 2014), and higher levels of emotional intelligence (Murphy & Janeke, 2009). Type II thinking styles denote a norm-favoring tendency, and they involve lower levels of cognitive complexity. These styles are considered to be more maladaptive because they have been empirically shown to display undesirable attributes and outcomes—ones that are the exact opposite of those that have been found to be associated with Type I styles. These undesirable attributes and outcomes include lower levels of creative thinking in approaching learning tasks (Davis et al., 2011; Niu, 2007), teaching behaviors that lack creativity (Dikici, 2014), and lower levels of emotional intelligence (Murphy & Janeke, 2009; Zhang, 2017). Type III styles may manifest the characteristics of either Type I styles or Type II styles, chiefly depending on the stylistic demands of the specific situation or task at hand. Consider the internal style (a preference for working on one's own)—one of the Type III thinking styles. An individual could work on his/her own either creatively (i.e., manifesting the characteristics of Type I styles) or in a conforming manner (i.e., showing the features of Type II styles), depending on the specific tasks he/she is dealing with. Indeed, the literature has suggested that the ways in which Type III styles are related to other attributes and outcomes have been largely inconsistent (see Zhang, 2017 for a comprehensive review). Such inconsistency suggests that the adaptivity of Type III styles is variable.

For three reasons, the present study adopted only 6 of the 13 thinking styles (three Type I styles and three Type II styles). First, because this study is part of a larger research

project, it was necessary to keep the length of the questionnaire short enough that the participants' concentration could be retained. Second, the selected Type I and Type II styles were anticipated to be more readily associated with the type of research agendas assessed. Third, similar segmentations of styles have been applied to good effect in other studies (Zhang, 2008).

The three Type I thinking styles assessed in this study included the legislative style (a preference for tasks that call for creative strategies), the liberal style (a preference for tasks involving ambiguity and novelty), and the hierarchical style (a preference for distributing attention among multiple tasks with differing priorities). The three Type II thinking styles included the executive style (a preference for implementing tasks according to set guidelines), the conservative style (a preference for completing tasks based on existing procedures and rules), and the monarchic style (a preference for tasks that allow complete focus on one thing at a time).

The construct of thinking styles has rarely been applied in studies of academics, and to the best of our knowledge, this construct has never been used to investigate academic research agendas. Two previous studies have considered the relation between thinking styles and academic work: one that focused on the research-teaching nexus (Zhang & Shin, 2015), and the other that considered academics' organizational commitments (Jing & Zhang, 2014). However, thinking styles have been extensively studied at the student level (Zhang, 2010) in terms of how these styles influence academic achievement, cognitive development, personality, and career preparation (Fjell & Walhovd, 2004; Morgan, 1997; Tsagaris, 2006; Zhang, 2002a). These studies have shown that thinking styles influence students' self-efficacy and their career choices. It is also possible that thinking styles have even more profound but as yet unstudied implications for the students' professional lives, especially for those pursuing careers that require creativity (Fan, 2016).

One particularly important aspect of thinking styles is their relation to modes of thought, which represent the ways that information is processed at a cognitive level. Specifically, it has been determined that more complex and creativity-driven thinking styles are positively correlated with holistic modes of thinking (also known as right-brain

dominance, which is characterized by processing information in a holistic manner), and that less complicated (and arguably more conservative) styles are correlated with the analytical mode of thinking (also known as left-brain dominance, which is characterized by processing information in a piecemeal fashion) (Zhang, 2002b). This pattern is further explored in the following sections, as it helps to substantiate some of the expected relations between research agendas and thinking styles.

Because the existing literature on thinking styles is mostly student-centered, this literature was mainly used to propose potential associations between the thinking styles and research agendas of academics. Despite the fact that these studies do not tackle the issue of research agendas *per se*, they demonstrate the potentially impactful nature of thinking styles on the features of academic reasoning involved in setting research agendas. Even though the bulk of the literature focuses on students, it has been shown that thinking styles are equally important for academics, as different styles influence the pedagogical practice of these individuals (Emir, 2013; Zhang & Sternberg, 2002). Thus, we considered it plausible that the effects of thinking styles on teaching could translate into similar effects on academics' research. Beyond this, as far as we are aware, very few previous studies were related to our investigation, which further highlights the need to pursue research in this direction.

Research Agendas

The research agendas of academics represent a combination of factors associated with social and individual interests and goals that are bound to influence the type of research engagement and topic choice (Santos and Horta, 2018). Research agendas are a personal choice (Polanyi, 2012), even though they are also influenced by the community of professionals in the field, and by other factors such as career considerations and organizational pressures (Kwiek & Antonowicz, 2015). Studies on academics' research agendas have begun to appear only recently, but a framework has been developed that characterizes these agendas as having 8 dimensions, which are further divided into 12 sub-dimensions (Horta & Santos, 2016a), as summarized in Table 14.

Table 14: Dimensions and sub-dimensions of the Multi-Dimensional Research Agendas Inventory

Dimension	*Sub-dimension*	*Definition*
Scientific Ambition	Prestige	The desire to acquire recognition and academic prestige in a given field (Brew et al., 2016; Bourdieu, 1999).
	Drive to Publish	Being motivated and driven towards the publication of research results (Horodnic and Zait, 2015; Allison et al., 1982).
Convergence	Mastery	Specializing into a single field or topic (Leahey, 2007).
	Stability	Preference for focusing on a single field or topic and avoiding shifts of research focus (Bourdieu, 1999).
Divergence	Branching Out	Desire to expand into other fields of study or topics (Geschwind & Melin, 2016).
	Multidisciplinarity	Preference for working in multidisciplinary research ventures (Horligns & Gurney, 2013).
Discovery	Discovery	Preference for working in fields or topics with the potential to lead to discovery (Popper, 2005; Merton, 1957).
Conservative	Conservative	Preference for working in mature and more stable fields or topics (Rzhetsky, Foster, Foster & Evants, 2015; Klavans, Boyack & Sorensen, 2013).
Tolerance to low funding	Tolerance to low funding	Willingness to develop research on fields or topics even if research funding for them is scarce (Ebady & Schiffauerova, 2015b).
Collaboration	Willingness to collaborate	Desire to engage in collaborative research endeavors (Uddin, Hossain, Rasmussen, 2013; Katz & Martin, 1997).
	Invited to collaborate	Invited to participate in collaborative research ventures (Uddin, Hossain, Rasmussen, 2013; Katz & Martin, 1997).
Mentor influence	Mentor influence	The PhD mentor holds a degree of influence over his or her research plans (Pinheiro, Melkers & Youtie, 2013).

Notes: Adapted from Santos & Horta (2018).

The first dimension in this framework is scientific ambition. This dimension represents the desire to acquire a position of authority in a field of knowledge but can also reflect the individual's socialization into, or a response to, environmental pressures placed

on academics to be more research-driven and research-active. This desire can be said to shape the tactics or even the explicit goals of an academic, as success in this endeavor allows access to further resources and greater academic freedom (Bourdieu, 1999). Scientific ambition is divided into the following two sub-dimensions: prestige, which reflects the explicit desire to obtain a position of research authority, and drive to publish, which reflects an interest in publishing, a goal that most academics involved in research processes wish to achieve (Latour & Woolgar, 2013). Drive to publish is arguably a requirement for obtaining or maintaining research authority in the field, especially given the current 'publish or perish' paradigm, and considering the well-known effects of cumulative advantage (Allison, Long, & Krauze, 1982; Dobele & Rundle-Theile, 2015; Merton, 1968). Publishing frequently and in high-ranked journals is also becoming a necessity in many countries to meet the conditions set by national research assessments, the results of which influence universities' levels of funding (Kelly & Burrows, 2011), and also to meet career progression criteria, which relies heavily on publication numbers and research profiles (Acker and Webber, 2017). Therefore, both sub-dimensions of scientific ambition are associated with success in today's academia. Since the legislative thinking style has been linked to academic success (Albaili, 2007), it was thought that this specific thinking style is likely to influence scientific ambition as well, as this dimension is among the most conceptually related to matters of success and achievement.

The next two dimensions, convergence and divergence, are somewhat intertwined, as they stand in concomitant opposition to one another. Convergence reflects a preference for single-discipline agendas. This approach can be considered desirable as a means to acquire research authority in a field, as this goal involves a process that takes a significant amount of time (Bourdieu, 1999). This consideration is reflected in the sub-dimensions of convergence, the first of which is stability, which indicates a preference for maintaining roots in a single discipline. The second sub-dimension, mastery, reflects the desire to obtain expertise in a single topic, rather than being a 'jack of all trades'. This tendency can also be advantageous, as shifting between topics and fields tends to incur hidden transaction costs (Leahey, 2007).

On the opposite side of the spectrum is divergence, which reflects a preference for multidisciplinary approaches. This pattern is also desirable, as many of the complex

issues in modern science require such a strategy (Martimianakis & Muzzin, 2015; Schut, van Paassen, Leeuwis, & Klerkx, 2014). The divergence dimension is sub-divided into branching out (which reflects the desire to gain a foothold in differing topics and disciplines), and multidisciplinarity (which involves a preference for research agendas that require expertise in multiple subjects to address a multitude of research topics). These two competing dimensions are particularly sensitive to an academic's career stage, as it has been shown that academics tend to focus on singular topics early and late in their careers, and they often diverge into varied research topics and disciplines at the middle stages of their careers (Horlings & Gurney, 2013). In this sense, these dimensions also relate to the positioning of academics relative to sometimes paradoxical sets of environmental incentives that can determine strategic research and career choices. On the one hand, policymakers provide incentives (including research funding) towards fostering greater engagement of academics in interdisciplinary and multidisciplinary research, not only to meet the increasingly complex challenges that research needs to tackle, but also to increase the potential to produce impactful research (de Raymond, 2018). On the other hand, these incentives tend to be counteracted by university structures that are rooted, and function, within mostly discipline-based organizational structures and mindsets (Leahey et al., 2019). These dimensions arguably have some degree of relation to the modes of thinking involved (Zhang, 2002b). It was therefore expected that Type I thinking styles (more adaptive) would be positive predictors of divergence agendas, and that the Type II styles (more normative) would be positive predictors of convergence agendas.

The next two dimensions also stand in opposition to each other. Discovery and conservative reflect, respectively, a preference for cutting-edge research or for work in an established field (Horta & Santos, 2016a). The choice between these preferences is not necessarily based on an explicit preference *per se*, but may reflect more intrinsic risk-tolerance or risk-aversion tendencies, as the outcomes of research in new and emerging fields are less certain (Cummings & Kiesler, 2005). Similar to the dimensions above, the strategic choice or positioning of individual academics towards one or the other dimension may also be influenced by environmental pressures, including those related to funding, considering that academics are generally aware that funding research agencies tend to favor standard (safer) rather than transformative (riskier) research projects (Banal-

Estañol et al., 2019). In terms of individual preferences, the discovery dimension can be argued to fit the holistic mode of thinking, with the conservative dimension more compatible with the analytic mode of thinking. Therefore, it was expected that the Type I thinking styles would positively predict a discovery agenda, and the Type II styles would positively predict a conservative agenda.

Related to these dimensions is the dimension tolerance to low funding, which is the degree of tolerance an academic has for doing research with limited funds. Clearly, the lack of effective or potential resources may affect an academic's risk assessment when determining a choice of agenda (Ebadi & Schiffauerova, 2015b). This funding-related concern can be compounded by the fact that even if the academic does not require funding to undertake his research endeavors, he or she might be subject to institutional pressure to seek fundable projects anyway (Ion & Castro Ceacero, 2017).

The dimension of collaboration is sub-divided into willingness to collaborate (reflecting an academic's desire to engage in collaborative works) and invited to collaborate (which indicates an academic's willingness to integrate research agendas of others and thus be involved in collaboration). Collaborative research can be considered desirable for three reasons. First, collaborations expand an academic's access to knowledge and resources (Ebadi & Schiffauerova, 2015a). Second, collaborations often serve to boost publications and citations (Horta & Santos, 2016b; Mamun & Rahman, 2015) and to benefit career progression (Hoffman et al., 2014). Collaboration is particularly important when tackling multidisciplinary endeavors, as a single academic is unlikely to possess all of the skills required to tackle the complex problems of modern-day science (Wang, 2016). Third, due to institutional and systemic changes, engaging in research collaborations has become a 'must-do' in academia and is increasingly central in defining the research identity of most academics (Brew et al., 2016). Because collaboration can be done either creatively or in a more conforming manner, no specific hypothesis was made regarding the relationship between the collaboration research agenda and specific types of thinking styles.

The final dimension is mentor influence, which measures the degree to which an academic is influenced by his or her mentor (i.e., PhD supervisor). This influence is

expected to be at its highest immediately after conclusion of the doctoral degree, and such influence has been shown to have beneficial effects on research output (Pinheiro, Melkers, & Youtie, 2014). The degree of influence from the mentor is expected to diminish over the academic career (Platow, 2012). Type I styles were expected to be negative predictors of the mentor influence dimension.

The above exposition provides the substantiation for some expectations regarding the degrees and directions of influence that these thinking styles have on research agendas. To summarize briefly, Type I styles were expected to influence agendas that require more creative thinking and conceptual complexity. Type II styles were expected to predict agendas that are more related to norm-following and maintenance of the status quo. This assessment provided a key conceptual basis for responding to our main research questions: 1) Is there an association between thinking styles and academics' research agendas? and, if so, 2) How are thinking styles and the research agendas of academics connected? Our assessment allowed us to propose four hypotheses:

H1a: Type I thinking styles have a positive impact on the divergence, scientific ambition, and discovery agendas.

H1b: Type II styles have a negative impact on the divergence, scientific ambition, and discovery agendas.

H2a: Type II styles have a positive impact on the convergence, conservative, and mentor influence agendas.

H2b: Type I styles have a negative impact on the convergence, conservative, and mentor influence agendas.

The literature on thinking styles and the possible associations with tolerance to low funding and collaborations is inconclusive, as both thinking styles can have either a positive or a negative association with both dimensions. As such, no specific hypothesis was established concerning these potential associations.

Method

Participants

The data for this study were obtained as part of a multi-study data-gathering exercise that took place between May and November of 2015. In the first step, we identified all corresponding authors who published in higher education journals indexed in Scopus between 2004 and 2014, which amounted to 6,086 potential participants distributed over 40 journals that matched our search criteria. The field of higher education studies is an appropriate field to examine for assessing the research agendas of academics engaged in the social sciences, because higher education journals receive contributions from academics with backgrounds in sociology, economics, psychology, political science, geography, management, history, education, linguistics, and anthropology. These disciplines apply a variety of theories and methodologies that encompass most (if not all) of the theories and methodologies used in the social sciences (Brennan & Teichler, 2008). Subsequently, invitations were sent to these corresponding authors to participate in an online survey. Those authors who accepted the invitation to participate were required to read and agree to an informed consent form before proceeding to the survey itself.

The survey contained questions of a demographic nature, and it used two validated instruments. The first instrument was the Multi-Dimensional Research Agendas Inventory (MDRAI), which includes 35 items. The MDRAI evaluates the characteristics of the participants' research agendas, and classifies them into 8 dimensions, which are further divided into 12 sub-dimensions (Horta & Santos, 2016a). The second instrument was the Thinking Styles Inventory–Revision II (TSI-R2) (Fan, 2016; Yuan, Zhang, & Fu, 2017; Zhang, 2009), which takes an inventory to evaluate the thinking styles initially defined by Sternberg (Sternberg, 1988). For this exercise, we used an abridged version of the instrument, which included only those items pertaining to the aforementioned six styles of thinking (Types I and II; see Appendix C for sample items). We felt that the complete version would make the online survey too long, and thus reduce the rate of completion. This abridged version was previously validated by Zhang et al. (2019) for a

population of PhD students, but considering that our population constituted academics, we conducted a confirmatory factor analysis to determine the factorial validity for this abridged version, as well as its reliability for academics. The results of this exercise can be found in Appendix D and demonstrate that the abridged version of TSI-R2 exhibits good psychometric properties in terms of both validity and reliability.

Of the 6,086 researchers who were invited to participate, a total of 1,348 agreed to complete the survey (response rate of 22.16%), but 416 of them were excluded from the analysis, as they failed to complete the MDRAI block. A further 403 participants were excluded for failing to complete the TSI-R2 section. The majority of drop-outs occurred at the second page of the survey, that is, at the beginning of the MDRAI block (and thus they never reached the TSI-R2 block), while some participants dropped out immediately at the demographics section, which followed the informed consent form. A possible reason for this could be that the participants, despite being informed of the length of the survey, experienced survey fatigue upon realizing that the survey was multiple pages long and they therefore did not go beyond the initial sections of the MDRAI. The final sample size was 529 eligible participants. Of these, 281 (53.1%) were female, and the remaining 248 (46.9%) were male. Their ages ranged from 29 to 83 years (M = 51.36, SD = 10.82). In terms of geographical distribution, the most highly represented countries were the United States (N = 144; 27.2%), Australia (N = 83; 15.7%) and the United Kingdom (N = 69; 13.0%). Considering the number of dropouts, we conducted an analysis to ascertain whether or not the participants who dropped out had different characteristics to those who completed the survey. Using a t-test and a chi-square test, we determined that both the final and drop-out groups of participants had no differences in terms of age, $t(1182{,}390) = 0.792$, $p = 0.429$, and gender, $\chi 2(1) = 0.134$, $p = 0.714$), thus mitigating the possibility of non-response bias in our sample.

Still this study has limitations as it uses self-reported survey data, which is a cost-effective method for obtaining large amounts of information. This method is particularly powerful when properly validated instruments are used, as is the case in this study. However, there is always a risk of respondent bias towards socially desirable responses (McDonald & Ho, 2002). Furthermore, the data gathered in this study are largely perception-based, meaning that the answers given by respondents are heavily based on

their own interpretations of the phenomena (Lindsay & Norman, 2013). Although previous studies have indicated that perceptions are typically aligned with behavior (Pickens, 2005), due consideration should be given to the potential issues associated with this method of data collection.

Variables

The first set of variables used in this study was the 12 sub-dimensions assessed by the MDRAI (Horta & Santos, 2016a), as described above. The second set of variables included the Type I and Type II styles assessed by the TSI-R2 (Fan, 2016; Yuan et al., 2017; Zhang, 2009), also as described above. Descriptive statistics for these scales are reported in Table 15.

Table 15: Descriptive statistics for the MDRAI and TSI-R2

Variables	*Mean*	*Std. Dev.*	*Min.*	*Max.*	*Sk*	*Ku*
Discovery	4.493	1.113	1.00	7.00	0.165	-0.167
Conservative	2.986	1.082	1.00	7.00	0.206	0.251
Tolerance to Low Funding	4.619	1.290	1.00	7.00	-0.151	-0.200
Mentor Influence	2.584	1.261	1.00	6.67	0.537	-0.460
Prestige	4.984	1.135	1.25	7.00	-0.268	0.086
Drive to Publish	5.345	1.150	1.00	7.00	-0.540	0.325
Mastery	3.456	1.138	1.00	7.00	0.192	-0.243
Stability	3.490	1.027	1.00	7.00	0.025	0.077
Branching Out	4.764	1.075	1.00	7.00	-0.279	0.501
Multidisciplinarity	5.209	1.198	1.00	7.00	-0.432	-0.021
Willingness to Collaborate	5.523	0.994	1.00	7.00	-0.944	2.062
Invited to Collaborate	5.145	1.161	1.00	7.00	-0.703	0.859
TS Legislative	5.305	0.914	2.40	7.00	-0.188	0.286
TS Executive	4.016	1.187	1.20	7.00	0.044	-0.399
TS Liberal	4.809	1.090	1.00	7.00	-0.161	-0.170
TS Conservative	3.515	1.267	1.00	7.00	0.221	-0.629
TS Hierarchical	5.142	0.910	2.60	7.00	-0.162	-0.367
TS Monarchic	3.842	1.276	1.00	7.00	0.076	-0.696

The remaining variables were used as controls. Age refers to the age of the academics, which is a known predictor of scientific outputs, as noted above (Bonaccorsi & Daraio, 2003). Age also serves as a proxy for the effects of career stage (Jung, 2014). Gender is a binary variable, indicating whether the participant is male or female, which is also known to have profound impacts on scientific initiatives (Abramo et al., 2009;

Stack, 2004); Country is a factor variable, indicating the country in which the academic is currently working, which controls for local differences in terms of the maturity of each country's higher education systems, local policies, and other regional aspects (Auranen & Niemiren, 2010). Time since PhD is a continuous variable, accounting for the years that have passed since each academic concluded his or her PhD studies. This variable controls for the effects of research experience on output (Jung, 2014). Finally, field of science is a factor that indicates the participants' field of expertise—defined as the field in which they concluded their PhD degree—based on the OECD's aggregation scheme (OECD, 2002). Including this variable helps to account for inter-field differences that may derive from the field of the academics doctoral studies (Podlubny, 2005) as some academics doing research in the field of higher education and in the social sciences in general are known to have been initially trained in disciplines outside the social sciences (Tight, 2013).

Procedure

As the critical variables involved were of a continuous nature, a general linear model (GLM) was applied for this exercise. The specific variety of GLM used is commonly known as a MANCOVA, because it uses multiple dependent variables (the MDRAI scores), and both fixed factors and covariates are used as predictors (Hair, Black, Babin, Anderson, & Tatham, 2007). An initial model with only the control variables was specified. Following this, we estimated the model with the full set of variables, with the goal of determining the relative increase in model fit.

Results

The GLM model and its results are split across two tables (Table 16 and Table 17) for readability, but all analyses were conducted concomitantly. The country variable was used as a control variable, but is not displayed in the tables, as it was not the focus of the analysis. Also, adding the numerous categories (i.e., countries) of this variable would significantly expand the tables' size without adding relevant content. The country variable

was found to have a significant effect only on the multivariate test ($F(240, 5928) = 1.182$; Pillai's $T = 0.548$; $p < 0.05$). At a univariate level, this variable's only direct effect was on tolerance to low funding ($F(20, 494) = 32.188$, $p < 0.05$), which highlighted the differences in availability of research funding between countries. Regarding the other control variables, at a multivariate level the field of science (FOS) was found to be significant ($F(60, 2435) = 1.366$, Pillai's $T = 0.163$, $p < 0.05$). Other significant variables were age ($F(12, 483) = 3.483$, Pillai's $T = 0.080$, $p < 0.01$) and time since PhD, ($F(12, 483) = 3.800$, Pillai's $T = 0.086$, $p < 0.01$). Gender was not found to be significant at the multivariate level ($F(12, 483) = 1.525$, Pillais' $T = 0.036$, $p = 0.111$).

All of the thinking style variables were highly significant at the multivariate level ($p < 0.001$) except for the executive style, which was found to have no multivariate significance $F(12, 483) = 1.303$, Pillai's $T = 0.031$, $p = 0.213$). The analysis given below focuses exclusively on the thinking style variables, as these are the focus of this study. The control variables are of interest in themselves, but they fall outside the scope of this analysis, and thus are mentioned only briefly.

Table 16: Determinant effects on Research Agendas (Part 1)

Dimensions	*Divergence*		*Collaboration*		*Scientific ambition*		*Discovery*
Variables	*Multidisc.*	*Branching Out*	*Invited to Collab*	*Will to Collab*	*Drive to Publish*	*Prestige*	
Gender (Female)	-0.016 (0.092)	-0.147 * (0.071)	0.055 (0.089)	0.091 (0.081)	-0.022 (0.086)	-0.093 (0.107)	-0.148 (0.079)
FOS (NS)	0.312 (0.209)	0.031 (0.162)	0.301 (0.202)	0.519 ** (0.185)	-0.013 (0.195)	-0.128 (0.244)	-0.193 (0.179)
FOS (E&T)	0.622 * (0.374)	0.056 (0.290)	0.543 (0.362)	0.747 * (0.332)	0.105 (0.350)	-0.063 (0.437)	-0.121 (0.322)
FOS (M&HS)	0.472 (0.326)	0.179 (0.253)	0.556 * (0.316)	0.560 (0.289)	-0.349 (0.305)	-0.658 * (0.381)	-0.156 (0.280)
FOS (AS)	0.527 (0.508)	0.161 (0.394)	0.097 (0.491)	0.279 (0.450)	0.48 (0.475)	-0.61 (0.593)	-0.468 (0.437)
FOS (SS)	0.093 (0.147)	-0.136 (0.114)	0.271 (0.142)	0.413 ** (0.130)	0.099 (0.137)	-0.032 (0.171)	-0.072 (0.126)
Age	-0.002 (0.006)	-0.015 ** (0.005)	-0.007 (0.006)	-0.013 * (0.005)	-0.022 *** (0.006)	-0.017 * (0.007)	-0.011 * (0.005)
TS Legislative	0.075 (0.073)	0.055 (0.057)	0.057 (0.071)	-0.046 (0.065)	0.196 ** (0.069)	0.308 *** (0.086)	0.196 ** (0.063)
TS Hierarchical	0.031 (0.065)	-0.035 (0.050)	0.179 ** (0.063)	0.222 *** (0.057)	-0.025 (0.060)	-0.015 (0.075)	-0.071 (0.056)
TS Liberal	0.227 *** (0.057)	0.205 *** (0.044)	0.140 * (0.055)	0.147 ** (0.050)	0.058 (0.053)	0.036 (0.067)	0.224 *** (0.049)
TS Executive	-0.009 (0.075)	0.026 (0.058)	0.031 (0.072)	0.069 (0.066)	0.064 (0.070)	0.097 (0.087)	-0.041 (0.064)
TS Conservative	0.021 (0.069)	-0.019 (0.053)	0.077 (0.067)	0.015 (0.061)	0.063 (0.064)	0.078 (0.080)	-0.081 (0.059)
TS Monarchic	-0.137 ** (0.041)	-0.102 ** (0.031)	-0.157 *** (0.039)	-0.191 *** (0.036)	-0.036 (0.038)	-0.028 (0.047)	0.009 (0.035)
Time Since PhD	0.005 (0.006)	0.005 (0.005)	0.017 ** (0.006)	0.017 ** (0.006)	0.012 * (0.006)	0.016 * (0.007)	0.010 (0.005)

Notes. A General Linear Model (MANCOVA) with fixed factors (coded as dummies) and covariates is shown. Standard errors are in parenthesis. The *Country* fixed factor is omitted from this table.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

We begin by evaluating Hypothesis 1a, which states that Type I styles (legislative, hierarchical, and liberal) would have a positive influence on the divergence, scientific ambition, and discovery agendas. First, we can observe that the legislative style (preference for tasks that call for creative strategies) is a positive and significant predictor of prestige ($b = 0.308$, $p < 0.001$) and drive to publish ($b = 0.196$, $p < 0.01$), both of which are sub-dimensions of the scientific ambition dimension. As the legislative thinking style

is related to creativity and autonomy, which are critical predictors of research productivity (see Enders, De Boer & Weyer, 2013), it can be argued that this style also leads to enhanced ambition to pursue scientific endeavors. Legislative-oriented academics have a preference for choosing their own topics, and as they stress autonomy and creativity above anything else, it is not surprising that the legislative style is found to be a positive and significant predictor of discovery ($b = 0.196$, $p < 0.01$).

The liberal style (a preference for tasks involving ambiguity and novelty) is shown to be a positive predictor of multidisciplinarity ($b = 0.227$, $p < 0.001$) and branching out ($b = 0.205$, $p < 0.001$), both of which are components of the divergence dimension. This style is also a significant and positive predictor of discovery ($b = 0.224$, $p < 0.001$), as liberal-oriented individuals are commonly attracted to agendas in which the effective discovery of truly novel knowledge is possible. As such, the results of the surveys largely confirm Hypothesis 1a.

Next, we evaluate Hypothesis 1b, which posits that Type II styles have a negative impact on the divergence, scientific ambition, and discovery agendas. The monarchic style (a preference for tasks that allow complete focus on one thing at a time) has a pattern of effects that to a large extent are the exact contrary of those found for the liberal style. The monarchic style is a negative predictor of the divergence sub-dimensions of multidisciplinarity ($b = -0.137$, $p < 0.01$) and branching out ($b = -0.102$, $p < 0.01$). The other two Type II styles have no significant effect. This set of results partially confirms Hypothesis 1b, which is only confirmed for the effects of the monarchic style on the divergence sub-dimensions.

Table 17 reports the next set of dependent variables, which associate the various thinking styles and research agendas in relation to Hypotheses 2a and 2b.

Table 17: Determinant effects on Research Agendas (Part 2)

Dimensions	*Mentor Influence*	*Tolerance to Low Funding*	*Conservative*	*Convergence*	
Variables				*Stability*	*Mastery*
Gender (Female)	-0.127 (0.078)	-0.180 * (0.083)	0.022 (0.082)	0.065 (0.062)	0.064 (0.071)
FOS (NS)	0.055 (0.178)	-0.543 ** (0.189)	0.375 * (0.186)	0.01 (0.141)	0.065 (0.161)
FOS (E&T)	-0.203 (0.319)	-0.685 * (0.338)	0.483 (0.333)	-0.036 (0.252)	-0.061 (0.289)
FOS (M&HS)	0.109 (0.278)	-0.694 * (0.295)	0.061 (0.290)	-0.067 (0.220)	-0.031 (0.252)
FOS (AS)	-0.040 (0.433)	-1.134 * (0.459)	0.166 (0.452)	-0.016 (0.342)	0.223 (0.392)
FOS (SS)	0.007 (0.125)	-0.187 (0.133)	0.056 (0.131)	0.14 (0.099)	0.184 (0.113)
Age	0.006 (0.005)	-0.002 (0.005)	0.006 (0.005)	0.008 ** (0.004)	0.009 * (0.005)
TS Legislative	-0.205 ** (0.063)	0.171 ** (0.066)	-0.216 ** (0.065)	-0.004 (0.049)	-0.008 (0.057)
TS Hierarchical	0.012 (0.055)	-0.011 (0.058)	-0.055 (0.058)	-0.067 (0.044)	-0.098 * (0.05)
TS Liberal	0.088 (0.049)	-0.002 (0.051)	-0.060 (0.051)	-0.103 ** (0.038)	-0.109 ** (0.044)
TS Executive	0.069 (0.064)	-0.139 * (0.067)	-0.039 (0.066)	-0.041 (0.05)	-0.019 (0.058)
TS Conservative	0.102 (0.059)	0.061 (0.062)	0.255 *** (0.061)	0.150 ** (0.046)	0.146 ** (0.053)
TS Monarchic	0.103 ** (0.035)	-0.042 (0.037)	0.048 (0.036)	0.099 *** (0.027)	0.128 *** (0.031)
Time Since PhD	-0.024 *** (0.005)	0.004 (0.006)	-0.017 ** (0.006)	-0.007 * (0.004)	-0.011 * (0.005)

Notes. A General Linear Model (MANCOVA) with fixed factors (coded as dummies) and covariates is shown. Standard errors are in parenthesis. The *Country* fixed factor is omitted from this table.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

We proceed with our analysis by testing Hypothesis 2a, which states that Type II styles will have a positive impact on the convergence, conservative, and mentor influence dimensions of the research agendas. We begin by observing that the conservative style (a preference for completing tasks based on existing procedures and rules) is a positive predictor of the convergence sub-dimensions, namely stability ($b = 0.150$, $p < 0.01$) and mastery ($b = 0.146$, $p < 0.01$). The conservative style reflects a preference for status quo

research, and thus it is understandable that this style translates into a preference for agendas focused on fields where the individual academic already has a foothold. This style is also a significant and positive predictor of conservative agendas ($b = 0.255$, $p < 0.001$), a finding which is self-explanatory due to the nature of both variables.

The monarchic style is found to be a positive predictor of the convergence sub-dimensions, namely stability ($b = 0.099$, $p < 0.001$) and mastery ($b = 0.128$, $p < 0.001$). The monarchic style is related to a preference for single-tasking (in opposition to multi-tasking). Thus, it is evident that juggling a variety of disciplinary fields can be anathema to a monarchic-oriented individual, who manifests preference for single-discipline endeavors. Finally, the monarchic style is a positive and significant predictor of mentor influence ($b = 0.103$, $p < 0.01$). Academics who score high on mentor influence tend to be more focused on single tasks, which are likely to be determined or heavily influenced by their mentors. These findings largely confirm Hypothesis 2a, as only the executive style (a preference for implementing tasks according to set guidelines) is found to have no significant effect on the expected variables.

Finally, we evaluate Hypothesis 2b, which proposes that Type I styles have a negative impact on the convergence, conservative, and mentor influence agendas. We begin by analyzing the legislative style. This style is found to be a negative and significant predictor of mentor influence ($b = -0.205$, $p < 0.01$), which is expected, as this style is linked to a preference for autonomous activities, which are curtailed by operating largely under a mentor's instructions. Additionally, the legislative style is a negative and significant predictor of conservative agendas ($b = -0.216$, $p < 0.01$). This finding is expected, as the legislative style is also linked with creativity, and thus it stands to reason that legislative-oriented academics would prefer to work on agendas that require more creative thinking rather than agendas that aim to reinforce established paradigms. The liberal style is a negative predictor of convergence, which includes the sub-dimensions of stability ($b = -0.103$, $p < 0.01$) and mastery ($b = -0.109$, $p < 0.01$). This set of findings resonates with past findings, which have positioned convergence and divergence as competing dimensions (Santos & Horta, 2018). However, the hierarchical style has no statistically significant associations with the convergence, conservative, and mentor influence dimensions of the research agendas. In summary, Hypothesis 2b is partly

supported, as the legislative and liberal styles behave as predicted, but the hierarchical style evidences no significant effects.

With a more exploratory focus, we find that the legislative thinking style is positively related with tolerance to low funding ($b = 0.171$, $p < 0.05$), but the executive style has a negative relationship to this dimension ($b = -0.139$, $p < 0.05$). These findings are somewhat expected, in that starting a research agenda with low funding requires some degree of creative strategizing to do things with little or no resources, and research funding typically comes with conditions that establish the rules of action. Without funding, there is no strict sense of guidelines to follow, and unfunded initiatives assume a more randomized dynamic.

The liberal style is also a significant and positive predictor of both collaboration dimensions: invited to collaborate ($b = 0.140$, $p < 0.05$) and willingness to collaborate ($b = 0.147$, $p < 0.01$). It can be argued that liberal-oriented academics, which have a preference for tasks involving ambiguity and novelty, are more receptive to outside ideas, and they are thus more willing and available to engage in collaborative work.

The hierarchical style is a significant and positive predictor of the invited to collaborate ($b = 0.179$, $p < 0.01$) and willingness to collaborate ($b = 0.222$, $p < 0.001$) dimensions. This style relates to a preference for triaging various tasks according to their relative importance. It can be argued that this tendency can lead to a preference for collaborative endeavors, as collaboration allows an academic team to make a more effective allocation of resources by assigning specific tasks to various academics. At the same time, academics who lean toward this thinking style feel comfortable working in teams, as they are able to allocate priorities to different tasks and minimize the potential transaction costs of research collaborations.

Additionally, the monarchic style is a significant and negative predictor of both the invited to collaborate ($b = -0.157$, $p < 0.001$) and the willingness to collaborate ($b = -0.191$, $p < 0.001$) sub-dimensions of collaboration. This effect can be interpreted as the opposite of the hierarchical style's effect (preference for distributing attention among multiple tasks with differing priorities). As the monarchic style is more oriented toward

focusing on single tasks, it finds collaborations less useful, and it is more likely to treat tasks as indivisible.

Conclusion

This study identifies the associations between individual academics' thinking styles and their research agendas in the social sciences. Our results show that research agendas are indeed associated with the academics' thinking styles. Our findings suggest that Type I styles are particularly associated with research agendas characterized as scientifically ambitious, multidisciplinary, collaborative, and riskier, as these styles of thinking are associated with values that may be conducive to a more disruptive advancement of knowledge (Zhang, 2000) and to holistic modes of thinking (Zhang, 2002c). Type II styles, in contrast, are more associated with research agendas characterized by disciplinary norms and research on well-established topics, and which are therefore safer in terms of reaching findings acceptable by the scholarly community. This set of findings on the dual nature of thinking styles resonates with past findings that have suggested the existence of two major archetypes of academics based on their research agendas, with their characteristics being quite similar to those identified in this study (Santos & Horta, 2018). That previous study found that both research agenda archetypes played key roles in both stabilizing and in creating new knowledge. Because thinking styles are attuned respectively with each archetype, our study suggests that thinking styles play a decisive role in this process as well.

Overall, these findings have several implications for both research and practice in the social sciences. First, this study expands the literature on thinking styles, which in the past was mainly focused at the student level, and it does so by demonstrating that thinking styles can also have significant relevance for academics and their work. In this context, environmental conditions given to academics to develop their work are important. Governments, research funding agencies and universities should be aware of this and support academics to pursue research agendas that are most in consonance with their thinking styles (and in so doing, also nurture academics' research autonomy). Studies

have demonstrated that organizations nurturing the research autonomy of academics not only promote the development of innovative and transformative findings, but also assure a stable conceptual and methodological development of fields of knowledge and disciplines by means of a mix of incremental and disruptive knowledge advancements (Santos and Horta, 2018; Hollingsworth and Hollingsworth, 2000).

However, current performativity, indicators craze, research assessments, and research projects' limited duration and expected deliverables, may be driving for publications *en masse* with short-term focuses, rather than fomenting research programs that are longer-term, stable, and focused on innovative and transformative research (Horta and Santos, 2019; Young, 2015). This means that some academics with specific thinking styles are likely to be at a disadvantage in the current academic environment, and also that some research agendas associated with these thinking styles may not reach the potential that they could possibly achieve, with potential detrimental consequences for knowledge advancement. In a world characterized by a multitude of complex challenges, a diverse body of academics involved in research may achieve better results than one that is more homogeneous, and in this the role of organizational policies and incentives is key (Saá-Pérez et al., 2017).

Second, it is relevant to consider that thinking styles come to fruition during a long development process partly informed by formal education throughout the years, and in this process, training that emphasizes and stimulates the further development of desirable thinking styles may be critical (Goodwin & Miller, 2013). As thinking styles are changeable and can be learned, they are influenced by the processes of socialization during formal education, and in this context, the socialization during doctoral studies may have a very important role, for it is the socialization during the PhD that informs the research and field identity of academics, influencing their thinking and behaviors throughout their careers (Brew et al., 2016). Considering the association of thinking styles with research agendas and the research environment that academics from the social sciences may find when starting their research careers in the future may be important in the design of doctoral education and in informing best practices on supervisory orientation.

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Chapter 6
Organizational factors and academic research agendas: an analysis of academics in the social sciences

Chapter based on: Horta, H., & Santos, J. M. (2019). Organisational factors and academic research agendas: an analysis of academics in the social sciences. Studies in Higher Education, 1-16.

Abstract

Academic research demands placed on contemporary universities are strongly related to the production of breakthrough research. Both governments and university management strive to make the production of academic research more cost-efficient and have implemented measures to ensure this. Top-down policies influenced by new public management and managerialism have been introduced, pushing for competitiveness and performativity in academic research setups. These policies and guidelines have been criticized by academics as having eroded collegiality and autonomy, which are considered necessary to achieve quality research. The focus of this study is on social sciences and aligns with this critique, demonstrating that autonomy and collegiality are the key organizational features in fostering multidisciplinary, collaborative and riskier research agendas leading to breakthroughs. Academics with high levels of organizational commitment are more likely to create research agendas that assume more conservative, discipline bound and risk-averse traits, having less potential to derive the intended research.

Introduction

Research performance has an increasingly central role in defining the prestige of contemporary universities and affects the level of resources academics can obtain for their research (Munch, 2014). Academics and their work are now closely scrutinized as calls for more accountability and transparency have been voiced, alongside government policies to ensure public expenditure in higher education is more efficient (Olssen, 2016). This efficiency drive is often linked to public budget constraints or to the reluctance of politicians to further increase funding for research, but it also demonstrates an increasing lack of trust in the work developed in universities and by academics (Woelert and Yates, 2015). Aligned with this is a shift in the perception and image of academia, in which the 'ivory tower' idea has been replaced by universities portraying themselves as entrepreneurial and more engaged with and attentive to societal needs (Pinheiro and Stensaker, 2014). Increased accountability and the need for efficiency have led to more competitive funding schemes for research, which encourage further collaboration and specify expected outputs such as publications in international English language peer-reviewed journals and outcomes that focus on the potential for practice and policy (Chubb and Watermeyer, 2017). A culture of measurement and performance has thus been established in universities and continues to be driven forward by university and departmental leaders, often in a top-down style that increasingly conflicts with academic autonomy and collegiality and that strives for improvements in the quality and practical use of research outputs (Sutton, 2017).

Research performance has become central to both academics beginning their careers and those facing tenure and promotion (Hammarfelt and Rushforth, 2017). Research productivity indicators, both old and new, are now commonly used to assess the evolving research performance of academics in increasingly competitive environments under the new dynamics of academic capitalism (Kyvik and Aksnes, 2015). This has influenced the way academic work is developed in universities by accelerating the research processes and highlighting the importance of deliverables from academic research (Levin and Aliyeva, 2015). Thus, it represents the triumph of Mertonian logic, and the full realization by policy makers and institutional leaders that extrinsic

motivations, as responses to field positioning and organizational incentives, function better as drivers of research engagement and production than the inner motivations of academics (Long and Krauze, 1982). Departmental management styles, leadership and culture that influence the attitudes of individual academics towards research further underline the effect of the environment on individual motivators (Edgar and Geare, 2013).

The increasingly competitive worldwide regime in which academic research is conducted, and the rise of performativity as part of a set of policies intended to promote research breakthroughs and 'useful' knowledge, has been debated and analyzed from several perspectives. However, the association of organizational characteristics with factors that influence the design and orientation of individual academics' research agendas has not yet been examined. Thus, the research question addressed in this study is as follows: how are organizational factors related to the working research environments of universities associated with the research agendas of academics in the social sciences? The novelty of this study is that instead of focusing on how the current organizational characteristics of departments/universities influence research outputs, the focus is on how these characteristics are associated with the research orientation decisions of academics. The analysis also reveals the extent to which the drivers behind managerial changes that are oriented towards more top-down management styles and research constraints are aligned with the expectations of transforming academic research so it is more multidisciplinary, collaborative and innovative. The analysis focuses on the social sciences field of higher education studies, as this includes a broad range of disciplines and hence many academics from different fields participate in it (Horta and Jung, 2014; Tight, 2013). In addition, top-down management policies, performativity practices and organizational influences on the research in this contemporary academic environment are commonly drawn from the hard sciences, and thus affect social scientists more significantly (Hammarfelt and Rushforth, 2017).

The remainder of this paper is organized as follows: the next section presents a brief literature review on the changing organizational characteristics influencing academic research in modern universities and the factors influencing the research agendas of academics. The methods section follows, and the empirical data are presented and discussed in the findings section. The last section concludes the article.

Literature review

Organization of contemporary academic research: new public management, managerialism and performativity

In response to a growing audit culture and increasing related government policies and competition, universities are adapting their structures and management styles and developing incentives organized around the logics of managerialism and new public management, which promote idealized concepts of corporate efficiency to enhance academic research performance and impact (e.g., Deem et al., 2008). The rules and guidelines of funding agencies, and the top-down management approaches of universities and departments that influence academic research activities, can interfere with the autonomy of academics, and thus their identification with the universities diminishes (Degn, 2018; Winter, 2009). In adopting bureaucratic-led performativity models, which have become central to the functioning of contemporary universities, evaluations and performance rationales become largely driven by simplistic indicators that cannot encompass the complexity associated with academic labor. This complexity includes a creative and serendipitous activity that demands much time and energy: i.e., research (Sutton, 2017). Performativity and its associated indicators become frameworks of judgement that measure the efficiency and productivity of academic labor (Hammarfelt and Rushforth, 2017; Ball, 2012). In this model, academics become exposed to nebulous and sometimes unrealistic corporate-minded priorities, and to shifting goalposts and whims that place them in positions of vulnerability, thus reducing their agency, autonomy and freedom (Oleksiyenko and Tierney, 2018).

The effects of this can then extend to a decreasing level of collegiality, which particularly affects early-career academics who are more vulnerable to the termination of contracts and more concerned with surviving/thriving in competitive environments that emphasize the role of individual success over other priorities (Giroux, 2016; Schrecker, 2012). The introduction of managerialism may also lead to this potential decrease in collegiality, which according to Yokohama (2006) is at the opposite extreme of the same continuum, as it institutionalizes competition among colleagues. The author suggests that the values of collegiality are embedded within the academic community and its

management characteristics are associated with informality, trust and low levels of hierarchy, but the values of managerialism involve strategies that are to a large extent dictated by external stakeholders, hierarchy, formality and assessment. The locus of power also rests with institutional leadership and centralized committees (Yokohama, 2006). However, the introduction of new public management, managerialism and performativity was intended by policy makers and university management to transform academic research so that the best were rewarded and that the research improved and was more effective. These transformations have certainly led to a greater number of publications and citations (Beerkens, 2013), and if the organizational incentives and managerial practices are focused on producing more publications, then academics (like anyone else in society) are bound to adapt to survive and eventually thrive, resulting in greater research output in terms of both the individual and the university (Brew and Lucas, 2009).

However, academics are known to conform to the characteristics of their organizational context (Long and McGinnis, 1981), so regarding these outcomes as solely or mainly resulting from managerial practices may be somewhat simplistic, and many other factors may be involved. Growing numbers of academics become more qualified and collaborative, more involved in research and dedicate more time to it (often to the detriment of teaching). To gain more visibility and to receive more citations, they are likely to publish articles in journals indexed by Scopus or the Web of Science rather than books or book chapters. Increases in research funding (national and institutional) and the size of research teams at universities that include more postdocs and PhD students who contribute to the research effort also have an effect (Júnior et al., 2018; Leisyte, 2016; Kwiek, 2016; Verbree et al., 2015). All of these organizational factors are known to positively affect research productivity (Carayol and Matt, 2004), particularly for academics based in research-oriented universities (Cattaneo et al., 2016), who have a greater capacity for research and a long-established research-focused culture (Verbree et al., 2015).

However, some organizational factors may not have a simple relationship with research productivity. The literature has demonstrated that size and team composition affect non-linearly both research productivity and novelty (Lee et al., 2015; Horta and

Lacy, 2011). Increasing levels of managerialism in research governance have also exacerbated the bureaucratization of research processes at organizational and individual levels, and has been found to negatively affect research productivity (Bacini et al., 2014), while also fostering the division of labor, industrialization of academic careers and output, and standardization of research (Walsh and Lee, 2015).

Other studies show that the quality of research productivity is undermined by performativity and management-by-results, as these constrain the intrinsic motivations of academics to engage in creative knowledge-intensive work (e.g, Kallio and Kallio, 2014), and are not conducive to research environments that strive for good research performance and have the characteristics of autonomy, egalitarianism and a strong cultural ethos that supports achievement and individualism (Edgar and Geare, 2013). The short-sightedness of policy makers in implementing policies that appear to ignore academic ethos and culture has been criticized, as this can lead to more output but less ground-breaking research being produced (e.g., Young, 2015). These analyses focus mainly on academic work, resources (competition) and research productivity, but overlook how organizational traits are associated with factors influencing the orientations of individual academics' research agendas.

Academic research organization and the potential influence on the research agendas of academics

A research activity begins with deciding on a research agenda (e.g., choosing a topic associated with a scientific challenge and deciding on how to pursue it). Academics' research agendas are a combination of individual interests shaped by narrow dimensions associated with the challenges of specifically doing the research from a conceptual and methodological standpoint, and of broader dimensions consisting of environmental, social and individual characteristics and interests, which influence the type of research engagement (Santos and Horta, 2018). Research agendas, as part of the broad academic research process, represent an activity framed by an institutional context and are shaped by institutional values, norms and resources (Bazeley, 2010). For example, universities/departments that highlight the importance of research grant funding may condition academics to pursue research agendas that funding agencies consider to be of strategic importance, and thus more advantageous from a financial standpoint (Leisyte

and Dee, 2012). Conformity to the institutional environment and the availability of resources in the department/university (Ebadi and Schiffauerova, 2015) can be critical in defining a research agenda, as can individual attitudes towards risk (Hillson and Murray-Webster, 2007). Leisyte (2007) shows that academics typically adapt to shifting institutional environments by taking a conservative stance and a posture of compliance with the institutional norms, aiming to reduce uncertainty while maintaining stability and thus safeguarding access to resources. Other studies also suggest that academics may adopt conservative stances and conform to the institutional environment due to career considerations (Rzhetsky et al., 2015).

Performativity and managerialism practices that increase vulnerability and introduce great uncertainty into the environment are also bound to influence academics, particularly those early in their careers. They may opt for 'safer' research agendas where funding is available, which tend to be of a disciplinary nature characterized by greater conformity and a conservative outlook (Smith, 2017). More disruptive types of research agendas may be perceived as too risky and strategically unsound (Young, 2015). This can also lead senior academics to adapt their research profile strategically to the departments/university's expectations, and thus they assume a more conservative and conforming stance to survive and thrive (Acker and Webber, 2017). The association of factors determining academics' research agendas with the organizational settings of universities may involve two other potentially significant issues. The first concerns the pressure exerted on the teaching research nexus by the need to publish and obtain grants, which takes time. This competes with the time required to focus on teaching and on students, and the new public management processes have exacerbated this dilemma (Leisyte, 2016). The second issue is the undermining of the autonomy of academics and their freedom to research what they choose and how, which is central to much of the literature cited in this article. The organizational settings of contemporary universities suggest that this autonomy is being reduced, and replaced by compliance with the new rules of the game (i.e., the regulated autonomy). This is associated with performativity and the escalating competition for more funding to publish more papers and present the case for greater impact (Oleksiyenko and Tierney, 2018; Leathwood and Read, 2013). The issue of professional autonomy is particularly relevant to the research agendas of

academics, as it relates to having agency (or not) in departmental/university settings (Stromquist, 2017), and because research is ultimately a matter of personal choice (Polanyi, 2000).

As research activities (including research agendas) result from an interplay between the academic and the university (i.e., the organization), the analysis in this study is guided by Bandura's (1978) social cognitive theory. This theoretical framework considers three combined factors that have a reciprocal effect (i.e., triadic reciprocity): personal, behavioral, and environmental. Individual research agendas are situated in the behavioral factor, as they relate to decisions and consequent actions that academics take when considering personal preferences and choices (Polanyi, 2012). They are influenced by personal characteristics such as age, gender or personality traits (Baccini et al., 2014), and by environmental characteristics, related to perceived values, norms and taken-for-granted attitudes (Edgar and Geare, 2013; Long and McGinnis, 1981). The organizational aspects are represented by the environmental factor, as they refer to how organizational structures, incentives and dispositions guide behaviors and shape considerations around personal characteristics (see Leisyte, 2016; Fox and Mohapatra, 2007). These two factors are central to the study in terms of its research question. The personal factor is also relevant and accounted for, but is mainly used to control the associations between organizational aspects (the environmental factor) and academics' research agendas (the behavioral factor).

Method

Combining two inventories: research agendas and organizational traits of research workplaces

Few studies focus on factors influencing the research agendas of academics, but a framework for examining them has been designed based on eight dimensions (Horta and Santos, 2016). 1) Scientific ambition is associated with the willingness to be recognized in a field of knowledge and thus to obtain prestige and increased access to resources, and other material and immaterial gains (Bourdieu, 1999). This is associated with the drive to

publish as a way to establish recognition through the effects of the cumulative advantage hypothesis in science (Long and Krauze, 1982). 2) Convergence refers to a preference for disciplinary bounded research agendas, and indicates a preference to avoid shifting the foci of research (stability) and to master a specific topic under research (mastery). 3) Divergence refers to a preference for research agendas that address themes from a multidisciplinary perspective (Shut et al., 2014), and involves a willingness to explore multiple research topics (branching out) and a preference for multidisciplinary work. Both convergence and divergence may be conditioned by departmental/university environments (Leisyte, 2016, 2007). 4) Discovery is associated with a preference for a risk-inclined research agenda, manifested in the choice of research topic or a propensity for emerging topics with uncertain outcomes. 5) Conservative refers to a risk-aversion preference for research, and to choosing topics and fields well covered in the literature where uncertainty is less prevalent. Leaning towards a discovery or a conservative approach is not necessarily a matter of preference but rather one of risk management (Cummings and Kiesler, 2015). 6) Tolerance to low funding is a measure of the risk tolerance associated with opting for a research focus that may have very little funding and is expected to be sensitive to organizational pressure towards the acquisition of competitive research funding (Ion and Castro Ceacero, 2017). 7) Collaboration refers to the interest in engaging in collaborative research agendas and can be influenced by institutional pressure to collaborate, but can be a desirable option that furthers access to resources (Ebadi and Schiffauerova, 2015), increases research productivity and its quality (Mamun and Rahman, 2015) and fosters career prospects (Hoffman et al., 2014). Engagement in collaborative research agendas may result from a willingness to collaborate, an invitation to collaborate, or both, and is affected by managerial models that actively foster collaborative endeavors (Towns et al., 2014). 8) Mentor influence refers to the degree to which individual research agendas are influenced by the PhD supervisor, and is expected to decrease over the lifespan of an academic career (Platow, 2012).

Whilst studies on the research agendas of academics are limited, many organizational studies focus on the research workplace (e.g., Perkmann and Walsh, 2008; Leisyte et al., 2008). The Multi-Dimensional University Research Workplace Inventory

is a recently created validating instrument used to measure the working research environment in universities (Santos, 2017). It consists of five dimensions and eight sub-dimensions and is used in the analysis of this study.

The first dimension is organizational commitment, which is a staple of organizational research and is used in various contexts, and several similar models appear in the literature (e.g., Meyer and Allen, 1991). Organizational commitment refers to the degree to which an individual identifies with and is committed to an organization. This dimension is sub-divided into belonging, reflecting the degree to which an individual's identity is aligned with that of his organization, and the willingness to stay, which is the manifest desire to remain in the current organization. These two dimensions are similar to concepts in other frameworks, such as affective and continuance commitment in Meyer and Allen's (1991) three component model, and attitudinal and behavioral commitment in the framework of Mowday et al. (1979). The dimension also has a third sub-dimension: satisfaction with the leadership, which reflects the literature suggesting that leadership has a substantial impact on organizational commitment (e.g., Avolio et al., 2004). The second dimension, resources, reflects the academic perception of access to resources in the department/university, which has been found to affect research productivity (Castro-Ceacero and Ion, 2018) and the lowering of satisfaction levels, as academics may need to choose topics that are not aligned with their interests (Henkel, 2000). The third dimension is social satisfaction, which refers to the level of satisfaction the academic has for his colleagues. This is also a measure of collegiality, encompassing the perceived professional benefits obtained from colleagues (thus the quality and collegiality of the organization is also scrutinized here; see Postiglione and Jung, 2015). The fourth dimension is autonomy, that is, the perceived level of autonomy the academic believes to have in the department/university. In this framework, autonomy is the relative amount of independence granted to the individual regarding how work should be conducted and is an essential dimension as it is necessary in creativity driven environments (Hemlin et al., 2008). Autonomy is strongly related to the fifth and final dimension, unconstraint, which measures the lack of institutional constraints and obligations unrelated to research (particularly teaching). Both dimensions are associated with the existence (or lack of) perceived hierarchical constraints, which are known to hinder the freedom to conduct

research (Latour and Woolgar, 2013), and feelings of a lack of academic empowerment within the department/university (Henkel, 2000).

Participants

The analysis in this study is based on data obtained via an online survey conducted between May and November 2015. The procedure for data collection was first to identify the corresponding authors of all articles published in Scopus-indexed Higher Education journals in the past 10 years. These authors were then invited to participate in the online questionnaire. After accepting the invitation, they were asked to sign an informed consent form before they could participate in the study.

The questionnaire began with a set of demographical questions, followed by a series of instruments. First, the Multi-Dimensional Research Agendas Inventory (MDRAI) was included, comprising 35 Likert-style questions aimed at evaluating various aspects of the participants' research agendas measured in 8 dimensions (Horta and Santos, 2016). The second instrument, the Multi-Dimensional University Research Workplace Inventory (MDURWI), measures organizational features of an academic research workplace. This is comprised of 27 items organized into 5 dimensions, of which 1 can be de-aggregated into 3 sub-dimensions (Santos, 2017). A third instrument was also included – the BFI-10 questionnaire, which evaluates personality traits using the Big Five framework (Rammstedt and John, 2007). This was mainly included for exploratory purposes, and to add value to the analysis by controlling for the personality of academics in relation to the research agendas they choose.

A total of 1,348 researchers agreed to participate in this study. However, 613 were excluded due to their failure to complete the required instruments, resulting in a final sample size of 735 participants with complete data. The large number of participants who dropped out was mainly due to the length of the survey, which took up to 40 minutes to complete, an issue that was noted by a few participants in the comments box at the end of the survey. This final sample was reasonably divided between females (53.7%; N = 395) and males (46.3%; N = 340). The participant's ages ranged from 24 to 84 years (M = 50.64; SD = 10.95). Finally, in terms of geographical distribution, the majority of participants were based in the United States (24.9%; N = 183), followed by Australia

(15.5%; N = 114) and the United Kingdom (13.7%; N = 101), with the remainder distributed in other countries. They all experienced identical neo-liberal performativity related reforms and pressures towards academic research, which condition their research engagement. The full list of participating countries is given in Appendix E.

Variables

The dependent variables in this study were the eight dimensions of the MDRAI, and the explanatory variables were the seven sub-dimensions of the MDURWI. The five traits from the BFI-10 inventory were used as the control variables. These are openness to experience, which can be broadly considered as a preference for novelty and new experiences; conscientiousness, a measure of meticulousness and organization; extraversion, measuring how outgoing the individual is; agreeableness, reflecting the degree of cooperation exhibited by the individual; and neuroticism, which is a measure of emotional stability. Other control variables were age, gender and early career, a dummy variable indicating whether the researcher is early (< 40 years old) or late in his career (> 40 years old), following the cut-off proposed in the literature (Bazeley, 2003). Research oriented university was also included as a control variable, aimed at controlling for differences derived from the host institution; this is a dummy variable that assumes the value of 1 if the participant's institution is ranked in the top 500 universities of the Shanghai World University Ranking, and 0 otherwise. A further variable, hard-soft, was included. This is a continuous variable ranging from -1 to 1 and indicates the relative weight of articles published by the author on fields considered as 'hard science' (-1) or 'soft science' (1). This was computed by adding all of the articles published in soft science fields such as social sciences, and subtracting all articles published in hard science fields such as engineering, and then dividing the result by the total number of articles published. Authors contributing to the social sciences do not necessarily have a complete background in the field and may publish in and outside the social sciences (as happens in the field of higher education studies; see Horta and Jung, 2014). Finally, included but not shown in the tables (for the sake of readability) were country variables operating as fixed effects.

Procedure

Due to the continuous nature of the dependent variables, a multivariate ordinary least squares model was used for this analysis (Hair et al., 2007) and qualitative predictors were coded as dummies to enable it to be used in the regression equation.

Results

The findings are given in Table 18. Most significantly, autonomy was found to be the most relevant condition for academics in the social sciences, enabling them to develop ambitious, multidisciplinary, collaborative and risk-taking research agendas, with the highest potential for research breakthroughs. Autonomy has a positive impact on ambition, divergence, discovery, collaboration and tolerance to low funding ($p < 0.01$; $p < 0.05$ for discovery and collaboration) and a negative impact on convergence, conservative and mentor influence ($p < 0.01$). Equally important is the role of social satisfaction, which relates to collegiality. This organizational variable has a positive effect on divergence, discovery, collaboration and mentor influence ($p < 0.05$; $p < 0.01$ for collaboration), variables that again highlight research agendas with characteristics related to risk-taking, collaboration and multidisciplinary work. Thus, they are aligned with policy makers' expectations for research produced in contemporary universities, although not with new public management and managerialism policies that can curtail both autonomy and collegiality (Yokohama, 2006).

Belonging has a modest negative effect on divergence and mentor influence ($p < 0.1$). Willingness to stay has much more negative effects on ambition ($p < 0.05$), divergence ($p < 0.01$), discovery ($p < 0.1$) and collaboration ($p < 0.05$), but positive effects on convergence ($p < 0.01$) and conservative ($p < 0.01$). Organizational commitment, including commitment related to following up organizational managerial criteria and policies, may therefore lead to organizational conformity, preventing the emergence of riskier research agendas that lead to potentially disruptive advancements in knowledge and fewer multidisciplinary approaches. The institutional pressure to maintain 'safer'

avenues of research may lead to this, as the desire of the academic to remain in the institution and to be acquiescent can lead to such conformity.

Other variables present interesting findings, such as the negative impact of unconstraint on divergence ($p < 0.01$) and collaboration ($p < 0.01$). The perceived lack of pressure to do work unrelated to research activities decreases the propensity to conduct multidisciplinary and collaborative research endeavors. Although counter-intuitive, this can be interpreted as the need for academics to be engaged in other scholarly activities (such as teaching), which may positively influence the design of research agendas (through contact with students and the exchange of ideas with them; see Mitchell and Rebne, 1995). The positive effect of perceived resources on convergence and conservative ($p < 0.1$) suggests that an abundance of financial resources may lead to setting more conservative research agendas. Thus, despite institutional pressures to apply for research grants, funding for research may not be as critical in the social sciences as it is in other disciplinary fields. The more resources academics in the social sciences perceive they have, the more disciplinary and less risky the research agendas, because the researchers adapt their agendas to the needs of the funding bodies and agencies that are typically disciplinary and conservative by nature (Siler at al., 2015). Finally, satisfaction with the leadership has a limited influence on the research agendas of academics, with only a positive effect on mentor influence ($p < 0.05$).

The analysis of the control variables focuses first on the Big Five personality traits. Extraversion is found to be a positive predictor of collaboration ($p < 0.01$), because outgoing academics are more able to establish social connections, which is likely to translate into a higher capacity for engaging in scientific collaborations. Conscientiousness has a positive albeit modest impact on ambition ($p < 0.1$), probably reflecting higher degrees of thoughtfulness regarding one's work. Neuroticism has a positive impact on convergence ($p < 0.05$) and conservative ($p < 0.01$). This dimension represents emotional instability, but not necessarily to a pathological degree. The relationship does suggest, however, that researchers with less emotional stability may prefer mature fields and may specialize in single topics, in which change and uncertainty are less likely. This is the opposite of openness, which has a negative impact on convergence ($p < 0.01$) and conservative ($p < 0.01$), while having a positive impact on

divergence ($p < 0.05$), discovery ($p < 0.01$) and tolerance to low funding ($p < 0.05$). Academics with high levels of openness to experience may actively shun more conservative endeavors while seeking riskier ventures and newer topics of research. Agreeableness does not exhibit any significant impact on research agendas.

Male academics lean more towards discovery and tolerance to low funding ($p < 0.05$) than females but engage less with collaborative research agendas (collaboration; $p < 0.1$). Age has no significant impact on the research agendas of academics. Social sciences academics who operate more in 'softer' fields gravitate towards disciplinary endeavors, despite a higher tolerance of the lack of funding and higher scientific ambition [a positive impact on ambition ($p < 0.1$), convergence ($p < 0.01$) and tolerance to low funding ($p < 0.01$)]. Working in a research-oriented university has a negative effect on tolerance to low funding ($p < 0.05$), probably because academics in these universities are more used to having the resources available to them that enable them to engage in any research agenda that they may be interested in pursuing, thus making it nonsensical to engage in research agendas with little to no funding available. Finally, the H-index has a positive impact on ambition ($p < 0.01$) and collaboration ($p < 0.01$), as the more publications academics have and the more visibility they provide, the more ambitious their research agendas become, along with their desire for collaboration.

Table 18: Organizational Factors Effects on Research Agendas

Variables	*Ambition*	*Convergence*	*Divergence*	*Discovery*	*Conservative*	*TTLF*	*Collab.*	*Mentor*
Unconstraint	-0.029	0.002	-0.094***	-0.033	-0.041	-0.017	-0.078***	0.087*
	(0.035)	(0.031)	(0.032)	(0.038)	(0.035)	(0.044)	(0.028)	(0.045)
Autonomy	0.123***	-0.117***	0.135***	0.093**	-0.140***	0.159***	0.083**	-0.185***
	(0.042)	(0.036)	(0.039)	(0.045)	(0.042)	(0.052)	(0.034)	(0.056)
Social Satisfaction	0.055	-0.054	0.100**	0.115**	0.073	-0.019	0.449***	0.143**
	(0.052)	(0.045)	(0.048)	(0.056)	(0.052)	(0.065)	(0.042)	(0.066)
Resources	0.0073	0.048*	-0.049	0.044	0.063*	0.060	-0.019	0.030
	(0.033)	(0.029)	(0.030)	(0.036)	(0.033)	(0.041)	(0.027)	(0.043)
Belonging	0.029	0.025	-0.087*	-0.032	0.055	-0.018	-0.021	-0.111*
	(0.049)	(0.042)	(0.045)	(0.053)	(0.049)	(0.061)	(0.040)	(0.063)
Willingness to Stay	-0.088**	0.080**	-0.099***	-0.074*	0.097***	0.008	-0.061**	-0.029
	(0.036)	(0.031)	(0.033)	(0.039)	(0.036)	(0.045)	(0.029)	(0.047)
Satisf. Leadership	-0.026	0.041	0.001	-0.030	-0.010	0.052	-0.003	0.107**
	(0.039)	(0.034)	(0.036)	(0.042)	(0.039)	(0.049)	(0.032)	(0.050)
Early Career	0.315**	0.139	-0.120	0.104	0.071	-0.114	-0.057	0.470***
	(0.127)	(0.112)	(0.118)	(0.138)	(0.128)	(0.160)	(0.104)	(0.164)
Male	0.018	-0.106	0.104	0.208**	-0.020	0.245**	-0.116*	0.090
	(0.079)	(0.069)	(0.073)	(0.085)	(0.079)	(0.098)	(0.064)	(0.103)
Age	-0.002	0.006	-0.006	0.005	-0.009	-0.005	-0.003	-0.005
	(0.005)	(0.004)	(0.005)	(0.005)	(0.005)	(0.006)	(0.004)	(0.007)
H-Index	0.041***	0.005	-0.009	0.015	-0.009	0.016	0.028***	-0.015
	(0.009)	(0.008)	(0.009)	(0.010)	(0.009)	(0.011)	(0.007)	(0.012)
HardSoft	0.150*	0.206***	-0.265***	-0.006	0.076	0.459***	-0.069	0.170
	(0.081)	(0.071)	(0.075)	(0.0878)	(0.081)	(0.102)	(0.066)	(0.106)
Research Oriented U.	0.121	0.059	0.007	-0.041	0.018	-0.216**	0.036	-0.007
	(0.080)	(0.070)	(0.073)	(0.086)	(0.080)	(0.010)	(0.065)	(0.104)
Extraversion	0.033	-0.037	0.044	-0.011	0.002	-0.008	0.089***	0.042
	(0.037)	(0.032)	(0.034)	(0.040)	(0.037)	(0.046)	(0.030)	(0.048)
Agreeableness	0.027	-0.060	0.077	-0.021	-0.025	-0.017	0.040	0.060
	(0.056)	(0.049)	(0.052)	(0.060)	(0.056)	(0.070)	(0.045)	(0.073)
Conscientiousness	0.113**	0.006	-0.061	0.009	-0.026	0.088	0.054	0.019
	(0.055)	(0.049)	(0.051)	(0.060)	(0.056)	(0.069)	(0.045)	(0.072)
Neuroticism	0.038	0.092***	-0.058	-0.020	0.109***	-0.003	-0.034	0.068
	(0.041)	(0.036)	(0.038)	(0.044)	(0.041)	(0.051)	(0.033)	(0.053)
Openness	0.044	-0.110***	0.086**	0.293***	-0.188***	0.117**	-0.052	-0.068
	(0.045)	(0.040)	(0.042)	(0.049)	(0.046)	(0.057)	(0.037)	(0.059)
Observations	735	735	735	735	732	732	735	678
R-squared	0.147	0.142	0.143	0.120	0.129	0.121	0.299	0.128

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Conclusion

This study shows that organizational characteristics are associated with and can influence the research agendas of academics. This finding is aligned with the results of other studies emphasizing the relevance of the organizational environment in shaping the research behavior and output of academics (Leisyte, 2016; Edgar and Geare, 2013). However, this study further contributes to the critique that policies that attempt to condition and regulate the research produced by academics, and encourage the production of breakthrough research, may be counterproductive and may have the opposite effect to what policy makers and university managers intend (an argument also put forward by Young, 2015). Our findings show that from an organizational standpoint, giving more autonomy to academics and immersing them in a collegial environment encourages the development of research agendas that are bound to be more multidisciplinary, collaborative and disruptive. Their agendas are therefore also more risk-taking and thus having the potential to garner unexpected and high-value findings (although they may also lead to failure, which is normal in research processes and a requirement for knowledge advancement; see Firestein, 2015). In addition, the more autonomy academics feel they have in their organizations, the more ambitious in terms of research agenda they become, and thus they are potentially more productive in terms of research output and more determined to be recognized by their field community. This resonates with the classical literature on science and technology, which suggests that academics should be free to pursue their own topics and to operate relatively independently of outside influences (Polanyi, 2000).

However, universities that have implemented new public management and managerialism practices in their research organizations undermine these two important organizational traits in academic research (e.g., Oleksiyenko and Tierney, 2018; Hammarfelt and Rushforth, 2017; Ball, 2012; Yokohama, 2006). The findings highlight the importance of organizational traits and policies for academics' research agendas, and the caution (and probable need for constant assessment) required from those implementing them. The impact of resources and commitment in the context of conservative and convergent agendas of academics in the social sciences is particularly

interesting. Evaluation frameworks, for example, may constrain the freedom to choose research agendas, as institutions may pressure academics into choosing topics that maximize the performance indicators (Martin, 2011). In addition, pressure from managerialism and those related to the 'institutional need' to obtain research grants may aggravate tensions related to the research-teaching nexus (Leisyte, 2016), and a greater availability of research funding is associated with research agendas that are more contained within disciplines and focus on established topics (that can hamper research at disciplinary borders where breakthrough research can occur; Martimianakis and Muzzin, 2015). Institutional pressure focusing on grant competition cause a migration towards safer research, as neither funding nor results are guaranteed for cutting-edge topics (see also Young, 2015) and research funding agencies favor traditional mainstream disciplinary bound research (Siler at al., 2015). Although it is not possible to claim causality using the current research design – or even the direction of such causation – these results support the findings of Leisyte (2007), suggesting that academics respond to increasing uncertainty by 'falling in line' with institutional demands to maintain access to resources, while attempting to maximize work stability. This suggests that the current academic research governance paradigm pushes academics towards more conservative endeavors by encouraging them to pursue such agendas, while only in the absence of such pressure can ground-breaking agendas thrive.

Two further issues are of relevance. The first is the negative impact of unconstraint on divergence and collaboration. This suggests that the lack of pressure to do work unrelated to research activities (as can be the case in teaching) decreases the propensity to engage in multidisciplinary research endeavors and collaborations. This highlights the importance of academics remaining involved in teaching activities and the benefits that teaching can have for research, although the relation is usually perceived as being from research to teaching (Hajdarpasic et al., 2015). The second issue concerns the findings associated with willingness to stay and belonging, which have a strong negative effect on divergence and discovery. This suggests that academics who feel 'comfortable' in their current institutions tend to gravitate towards more conservative research agendas. Academics may accommodate and acquiesce to institutional pressure, which is typically manifested as pursuing 'safer' research rather than cutting-edge topics (Young, 2015).

This also highlights the difference between academic settings and non-academic settings in which organizational commitment is perceived as a benefit (Madsen et al., 2005). In academic settings, this commitment can have the opposite effect, which underlines the need for mobility so other academic environments and contact with other ideas, knowledge and ways of doing research can be experienced.

In conclusion, the limitations and implications for future studies of this study should be noted. In terms of the limitations, first, it makes use of self-reported survey data. This method has several logistical benefits, as it allows for large-scale data collection exercises in a cost-effective manner. However, it then carries the risk of respondent bias like any survey, typically manifested as socially desirable responses (McDonalds and Ho, 2002). The questions used as a basis for this study are perception-based, which means that the participants' responses are based on their individual construction of reality (Lindsay and Norman, 2013). The literature suggests that perceptions tend to align with behavior (Pickens, 2005), but it is still important to note that potential issues can emerge through this method. This issue was mitigated as the findings of this study rely on two validated measurement instruments. In terms of future research, although this study contributes to a more thorough understanding of the interplay between academics and universities, further work is required as scholars have suggested this area is under-researched (Antonelli et al., 2011). From this study, inquiry can extend in three directions. The first is to conduct the same type of analysis in other fields of knowledge and disciplines, which may not be as vulnerable to recent institutional and organizational changes influencing research practices as the social sciences (Hammarfelt and Rushforth, 2017). The second is to consider organizational factors when defining the research agendas of new types of academics, such as entrepreneurial academics, who work alongside 'traditional academics' but who are more active in engaging with partners outside academia (and thus it is more likely that their research agendas are influenced by them), but also engage in practices that position them in overlapping organizational arrangements, leading to a variety of purposes including knowledge exchange and commercialization (D'Este and Perkmann, 2011). Similarly, the third direction is to focus on those academics who increasingly engage in participatory research and include non-experts and civic communities in their research activities, which

can potentially enable them to develop research agendas with a high level of social impact (Doberneck et al., 2010).

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Chapter 7
Research agendas of male and female academics: A new perspective on the gender gap in academia

Chapter based on: Santos, J. M., Horta, H, Amâncio, L. (Under review). Research agendas of male and female academics: A new perspective on the gender gap in academia. *Gender and Education*.

Abstract

The presence of gender disparities in academia is assessed by analyzing the characteristics of the research agendas of academics. Multivariate analysis of variance and structural equation modelling coupled with multi-group analysis are used to identify differing gender trajectories. The research agenda preferences of women are less risky and less focused on fields with the potential to lead to scientific discovery but organized in a more collaborative way than those of men. Institutional characteristics are found to influence the research agenda preferences of both women and men. However, the amount of perceived autonomy allowed by the university is more important for female academics to develop more ambitious, collaborative, risky and multidisciplinary endeavors than it is for men. Female academics also need more time after concluding their PhDs to develop a preference for riskier research agendas, but past research output, number of co-authors and mobility do not seem to effect changes in their agendas.

Introduction

During the 1970s, the feminist movement brought to light the idea that several fields of knowledge were shaped by the exclusion of or discrimination against women (Keller and Longino 1996). This idea was in alignment with Kuhn's (2012) argument that not only is knowledge non-neutral, but research as a process is also sensitive to context (e.g., Santos and Amâncio 2016). Gender differences in research activities and knowledge domains have been a prominent topic in both science, technology and society studies and higher education studies for decades (e.g., Arensbergen, van der Weijden and Besselaar 2012; Cole and Zuckerman 1984). These studies show that women tend to publish less and are less cited than men (Abramo, D'Angelo and Caprasecca 2009; Arensbergen, van der Weijden and Besselaar 2012; Prpić 2002; Stack 2004), as academic and scholarly work takes place in and is generated by gendered organizations (Acker 1990).

The aforementioned studies evidence structural challenges in academia, notably gender differences in terms of career progression and overall opportunities (Linková 2017; Teelken and Deem 2013; van den Besselaar and Sandström 2016, 2017), which are self-perpetuating (van den Besselaar and Sandström 2017) and begin at the academic job market recruitment stage (van den Brink 2010). Gender theorists underline individual perceptions of abilities as a means of fostering female agency in academia and challenging the status quo (O'Meara, 2015; Allen, 2013). They also identify autonomy in defining workloads, social interactions with colleagues and alignment between individual values and expected career goal criteria as ongoing structural constraints to the development of such agency (Terosky, O'Meara and Campbell 2014).

A key issue conditioning the agency of women in gendered organizations is that the self-assessments that women and men make of themselves, which are bound to affect their career decisions and frame their agency in academia, are culturally informed by workplace structures (Correll 2001). However, these ingrained gender-related power structures and cultural beliefs in the academic workplace, which are part of gendered regimes (including a gendered division of labor, which places men in advantageous positions; Connell 1990), are not the only issue. A complex process also exists in which

women and men make differing assessments of their own competence when engaged in career-relevant tasks; these self-assessments contribute to the formation of different career aspirations based on the competencies believed to be required to engage and be successful in such tasks (Correll 2004). These structures tend to benefit men, who are perceived by the dominant socio-culturally informed organizational structures to be better at tasks that matter the most for career advancement (Ridgeway and Correll 2004). Due to greater confidence in their self-assessment and easier integration into key male-dominated networks (which also give them easier access to resources, one of the pillars upon which the gendered regime rests; Ridgeway and Correll 2000), male academics are also better informed about what matters for academic success and have a clearer understanding of how to foster cumulative advantages in current academia. This was demonstrated in a study that found that men self-cited 70% more frequently than women (King et al. 2017).

Beyond structural issues, other possible reasons for the gender disparities in academia have been discussed in the literature, such as family- and child-related career interruptions (Prozesky 2008), differences in the career life-cycle (Fritsch 2016; Long 1992) and access to collaboration networks (Fisher and Kinsey 2014; Rotchford, McNamee and Willis 1990). Gender-related differences are consistent across fields of knowledge, which demonstrates that the hierarchical differences between women and men are also dominant in society (Fox 2001). Particularly disturbing is the evidence of a 'spillover' effect, as men who publish mostly with women tend to be less cited themselves (Beaudry and Larivière 2016). The prevalence of these issues in academia highlights the importance of research into their nature.

A substantial proportion of the research on the gender differences in academia has been focused on research productivity differentials between women and men (e.g., Aiston and Jung 2015). These differentials are related to professional practices and aligned with structurally discriminatory issues towards women in academic settings (Savigny 2014). Although this focus on research outputs and outcomes may be relevant, it is related to the products of successful research processes. Yet, as suggested by the literature, the disadvantage of female academics relative to their male counterparts is already evident at the initial stages of academic and research-related processes (Van den Brink 2010).

Therefore, the characteristics of the individual research agendas of women and men, focusing particularly on the processes that influence them, are analyzed from a novel angle in this study. Little work has been done on the characteristics of individual academics' research agendas. However, it is known that they are a combination of individual interests shaped by narrow dimensions, associated with the challenges of doing the research itself, which requires specialized knowledge and the appropriate conceptual and methodological tools, and broad dimensions associated with environmental, social and individual characteristics (e.g., Horta and Santos 2016; Santos and Horta 2018). Research agendas are embedded in broader research and academic processes that are influenced by the academic workplace. Thus, they may be shaped by values and norms concerning gendered issues that are then reflected later in research outputs and outcome differentials (Fox, Whittington and Linkova 2017). In this study, this assumption is tested and the differences in the research agendas of women and men working in academia are identified. Two research questions are explored: 1) do the research agendas of women and men in academia differ? and 2) how are the research agenda preferences of women and men influenced by their workplaces?

The remainder of this paper is structured as follows. In the second section, a brief literature review of gender in academia and an overview of what constitutes a research agenda are provided. In the third section, the method used for the analysis is described. In the fourth section, the results are presented. In the final section, the findings are discussed.

Literature Review

Gender disparities in academia

Women and men face different challenges in academic research settings. Women are substantially underrepresented in academia, constituting only 28.8% of the total number of academics globally as of 2015 (UNESCO 2018). Furthermore, the number of female academics tends to dwindle over the career lifecycle, a phenomenon known as the

'leaky pipeline' (Jensen 2006). The leaky pipeline is a metaphor for the process through which women tend to drop out of academic careers over time, a phenomenon particularly noted in science, technology, engineering and mathematics (Etzkowitz and Ranga 2011). This complex phenomenon cannot be attributed to a single cause. Some potential causes have been dismissed over time, such as biological differences and academic preparation. However, societal factors are known to contribute to the disparity in female and male academics' career paths. Such factors include cultural aspects and informal social norms that reinforce the stereotype of science and research as jobs mostly suited to men, which has been reinforced by 'old boys' networks'. These networks have helped to create a male-dominated academia, as male-dominated recruiting committees tended to restrict their search to recruits from their own networks, creating disadvantages for women who aspire to academic careers (Van den Brink 2010).

When entering academia, women tend to find themselves in mostly male-dominated environments, with values, norms and taken-for-granted attitudes that have been made by the numerically prevalent group, men, and that are embedded in the organizational culture. As a minority, women are forced to adapt to survive and be visible in organizational settings defined by the men's cultural identity and social logics. This is known as the 'invisibility paradox' (Faulkner 2007). It can isolate women, who may encounter a 'chilly climate' in their academic workplace (Blickenstaff 2005). For female academics, this chilly climate is related to the devaluation of themselves and their work, informal exclusion and often marginalization. It also tends to manifest through the exclusion of women from committees, departmental grants and decision-making positions (Biggs, Hawley and Biernat 2018; Maranto and Griffin 2011). The chilliness may persist even for women working in academia who overcome the initial challenges and reach top positions at their institutions, as women in higher management positions in universities report feeling a lack of trust and visibility, isolation and a lack of respect for their leadership (Fritsch 2015). The chilly climate is related to the abovementioned old boys' networks and dynamics (Amery et al. 2015). This homosocial culture is prevalent in many institutions. It is one through which men's interests are enforced via the systematic exclusion of women (Fisher and Kinsey 2014) and that leads to the latter's social and intellectual isolation (Gardiner et al. 2007). As a result, women find themselves

with less access to networking opportunities with key communities, which is an important driver of modern scientific advancement (Abramo, D'Angelo and Di Costa 2008). Less networking results in fewer opportunities to collaborate and acquire research funding (Leberman, Eames and Barnett 2016). Ultimately, the successive barriers to promotion that women face result in a 'glass ceiling' that prevents their equal career progression (Henley 2015). Women are then less likely than men to obtain tenure, which is one of the reasons for abandoning their academic career (Goulden, Mason and Frasch 2011), creating a vicious cycle linking back to the leaky pipeline.

This cycle has been noted in the literature as one of the causes of female academics' lower productivity and the smaller research impact of publications authored by women than men (van den Besselaar and Sandström 2017). Gender inequalities in all fields of knowledge have been extensively studied from a bibliometric perspective, with similar findings from a wide variety of countries (e.g., Abramo et al. 2009; Aiston and Jung 2015; Prpić 2002). This suggests that the phenomenon occurs at a global level. Family-related factors, such as motherhood, have not been identified as a main cause of the research productivity differential between women and men, which has been attributed instead to professional practices inherent to research processes (Aiston and Jung 2015). This underlines the need to focus on institutional issues in academia as better explanations for the gender inequalities found in academic research. Overall, it stands to reason that given the different challenges faced by women and men, their working strategies and pursuits also take divergent paths. Studies using nationally representative samples have suggested that women differ from men in terms of their working strategies and research preferences. For example, González Ramos, Fernández Palacín and Muñoz Márquez (2015) found that women are more interested than men in issues of social innovation, teaching and knowledge exchange focusing on social rather than technical impact. Women also judge their research work more critically, which is associated with low self-confidence and less research funding, and tend to be engaged in research groups populated mostly by other women, which disadvantages their positioning in terms of resource allocation, career progression and visibility. One of the goals of this study is to expand on the literature by analyzing whether and how the research agendas of women and men in academia differ via a recently developed and fully validated framework on

research agendas – the Multi-Dimensional Research Agendas Inventory (MDRAI; Horta and Santos 2016). This framework comprises eight distinct dimensions, which are summarized in Table 19.

Table 19: Dimensions of the Multi-Dimensional Research Agendas Inventory

Dimension	*Definition*
Scientific ambition	The desire to acquire recognition and academic prestige in a given field (Bourdieu 1999). Being motivated and driven by the publication of scientific articles (Allison, Long, and Krauze 1982).
Convergence	Specialising in a single field or topic (Leahey 2007). Preference for focusing on a single field or topic and avoiding shifts of focus (Bourdieu 1999).
Divergence	Desire to expand into other fields of study or topics (Horlings and Gurney 2013). Preference for working in multidisciplinary research ventures (Horlings and Gurney 2013).
Discovery	Preference for working in fields or topics with the potential to lead to scientific discovery (Merton 1957; Popper 2005).
Conservative	Preference for working with mature and more stable fields or topics (Klavans et al. 2013; Rzhetsky et al. 2015).
Tolerance to low funding	Willingness to work on fields or topics for which research funding is scarce (Ebadi and Schiffauerova 2015).
Collaboration	Desire to engage in collaborative scientific ventures (Katz and Martin 1997; Uddin, Hossain, and Rasmussen 2013). Having the opportunity and receiving invitations to participate in collaborative scientific ventures (Katz and Martin 1997; Uddin, Hossain, and Rasmussen 2013).
Mentor influence	The researcher's mentor (PhD or otherwise) holds a degree of influence over his or her work (Pinheiro, Melkers, and Youtie 2014).

Note: adapted from Santos, Horta and Zhang (2019).

Dimensions of gender-based differences in research agendas

Based on the reviewed literature, differences across genders can be expected for some or even all of these dimensions. For example, a chilly climate may cause scientific ambition to decrease in the research agendas of women, eventually causing them to seek other lifestyles (leaky pipeline) or change profession (a phenomenon known as the 'vanish box'; Etzkowitz and Ranga 2011). Furthermore, scientific prestige, which is a

component of scientific ambition, is more difficult for female than male academics to achieve (Coate and Howson 2016).

Tolerance to low funding may also have different effects for women and men in academia, as the success rate of grant applications is lower for women than men (Ley and Hamilton 2008). As a result, women may funnel their efforts into 'safer' topics for which funding is more abundant. This condition is also associated with the chilly environment that female academics face not only in academia, but also in science (Biggs, Hawley and Biernat 2018). Considering that tolerance to low funding is associated with the divergence and discovery characteristics of research agendas (Santos and Horta 2018), the research agendas of women are likely to assume traits associated with the conservative (working in stable fields of knowledge and less risky research areas) and convergence (mainly disciplinary, same topic focus) dimensions of the research agenda framework. For men, the opposite is predicted because they are expected to have a more supportive institutional environment (both from the knowledge field communities and the universities in which they work). As a result, men may have the confidence and encouragement to engage in riskier research agendas more dominated by the discovery (working on novel fields and topics) and divergence (multidisciplinary focus and expanding to varied topics) dimensions of the research agenda framework. These expectations are in alignment with González Ramos and colleagues' (2015) identification of different working strategies and research preferences between women and men.

Collaboration is another dimension that can differ between the genders. As a result of old boys' networks and dynamics (Amery et al. 2015; Fisher and Kinsey 2014), women face the additional challenge of securing access to key networks that men may have access to from the start of their academic careers. This can manifest as fewer opportunities for women to engage in collaborative ventures or the need for women to dedicate further efforts to integrating into research networks to further develop their research agendas. Finally, mentor influence may have both positive and negative impacts on female academics, for various reasons. In a chilly environment, developing a research agenda under the influence of a former PhD mentor may be a safe option (even if it has potentially adverse consequences in terms of scientific maturity and research independence). Research has shown that having a mentor, typically a senior woman, can assist women at

their early and mid-career stages to overcome the hurdles they face throughout their careers (Davies and Healey 2017; Ooms, Werker and Hopp 2018). However, it can also have negative effects in terms of diminished autonomy and a delay in obtaining research independence, scientific maturity, prestige and recognition by others in the research and academic communities.

Academic organizational context

Considering the importance of the institutional environment in explaining the gender bias in academia and the effects of the chilly climate experienced by women in academic settings, the analysis in this study also includes components of the Multi-Dimensional University Research Workplace Inventory (MDURWI; Santos 2018). The MDURWI measures several key organizational variables that have explanatory power in relation to gender disparities, specifically through the dimensions of autonomy, organizational commitment and social satisfaction. Autonomy is particularly critical, as it is one of the cornerstones of science and a requirement of academic researchers (Marginson 2008). However, it is often curtailed both by hierarchy (Latour and Woolgar 2013) and by institutions (Young 2015), causing attrition between institutions and academics (Cuthbert 1996). Such attrition is related to the concept of organizational commitment, which can be defined as the degree of closeness and identity between an academic and his or her institution (Mowday, Porter and Steers 1982). Social satisfaction is a measure of collegiality, encompassing social engagement with peers at the university and the perceived professional benefits they can provide. Social satisfaction is an important aspect to consider because it can conceivably influence and be influenced by access to networks and collaborations, which are critical for academic endeavors (Ebadi and Schiffauerova 2015).

Methods

Participants

The data collection for this study was part of a multi-study exercise that began in May 2015 and ended in November 2015. All corresponding authors who published in Scopus-indexed journals in the field of higher education studies between 2004 and 2014 were contacted and invited to participate in the study. Those who accepted the invitation were presented with an informed consent form, which they were required to read and agree to before being able to proceed. The field of higher education studies was chosen to represent the social sciences, in which the participation of women relative to men is more balanced than in fields associated with the hard sciences, health sciences, technology and engineering and in which the development of research is much more personalized (Santos and Horta 2018). The relative balance between women and men in this field has the potential to create a more inclusive working and research environment (as it is not dominated by men). Furthermore, the responsibility for the choice of research agenda lies much more with the individual and thus so do the corresponding stresses, hurdles and eventual success or failure (Whitchurch 2018).

The first section of the survey included demographic questions. These questions were followed by the MDRAI (Horta and Santos 2016) and the MDURWI (Santos 2018) to evaluate the characteristics of the participants' research agendas and work environment, respectively. The complete validation exercises are reported in the studies cited above; the psychometric properties of both instruments are summarized in Table 20.

Table 20: Validity and reliability

Factor	*Composite Reliability*	*Average Variance Extracted*	*Maximum Shared Variance*	*Average Shared Variance*
MDRAI				
Scientific Ambition	0.751	0.603	0.099	0.040
Convergence	0.923	0.857	0.511	0.129
Discovery	0.764	0.525	0.164	0.076
Conformity	0.828	0.706	0.212	0.094
Tolerance for Low Funding	0.806	0.582	0.072	0.023
Collaboration	0.857	0.750	0.132	0.044
Mentor Influence	0.905	0.616	0.153	0.031
Divergence	0.780	0.643	0.511	0.131
MDURWI				
Organizational Commitment	0.904	0.761	0.241	0.176
Autonomy	0.899	0.749	0.227	0.160
Unconstraint	0.833	0.630	0.241	0.142
Social Satisfaction	0.909	0.629	0.239	0.103
Resources	0.917	0.653	0.072	0.040

An optional section was included in which the participants were asked questions about their employment history and career paths.

A total of 1,349 individuals accepted the invitation to participate. However, only the participants who completed the optional employment history section were included in the current study, as it was not plausible to impute this type of missing data. As such, 574 of the participants were eligible for the working dataset. Of these, 278 (50.3%) were women and the remaining 285 (49.7%) were men. The participants' ages ranged from 29 to 83 (M = 51.69; SD = 11.24). Regarding geographical distribution, the most represented countries were the United States (N = 133; 23.2%), Australia (N = 85; 14.8%) and the United Kingdom (N = 85; 14.8%), with the remaining participants distributed across several other countries.

Variables

Several variables were used for this analysis. The dependent variables were the research agendas that comprise the MDRAI framework described in the literature review section: Scientific Ambition, Collaboration, Conservative, Convergence, Discovery, Divergence, Mentor Influence and Tolerance to Low Funding. For the independent

variables, a set of dimensions from the MDRWI framework also described in the literature review were included in the model: Autonomy, Organizational Commitment and Social Satisfaction. Bibliometric variables were also included in the form of Publications, representing the total number of career publications in Scopus-indexed journals, and Co-Authors, measuring the total number of non-unique co-authors in publications by the participant. Career mobility was measured via Academic Job Count, representing the number of jobs held by the participant in the academic sector, and Job Country Changes, indicating the number of job changes that involved a change of country (e.g., Horta, Jung and Santos 2018). Finally, career seniority was measured via Time Since PhD, indicating the number of years since the participant concluded his or her PhD. Grouping was done using a dummy variable indicating whether the participant was female or male.

Procedure

The study was conducted in two steps. First, an initial multivariate analysis of variance (MANOVA; Hair et al. 2007) was conducted to identify the existence of research agenda differences between the genders. With the goal of identifying structural differences between the genders with regards to the relations between variables, structural equation modelling – specifically, path analysis (Kline 2016) – was coupled with multi-group analysis to identify differing paths. Multi-group analysis consists of fitting separate models for each group – in this case, women and men (Marôco 2010). This two-step approach made it possible to determine not only which research agendas differed, but also how the predictors of these agendas differed between genders. For the model specification, all of the independent variables were regressed on all of the dependent variables. This was done as a result of this study's largely exploratory nature (i.e., no sufficient information was available to postulate meaningful hypotheses). Furthermore, no latent variables were used. Functionally, the model specification was a multiple regression, with the sole difference of using maximum likelihood estimation (Marôco 2010), and could conceivably be conducted using a standard ordinary least squares regression, were it not for the need to conduct a multi-group analysis. Given the objective to identify differing effects across women and men rather than global effects, a path-by-path analysis using Gaskin's (2016) Stats Tool Package macro, which tests for differences in regression weights across genders using a Z-test, was implemented. This procedure

tests only for differences across coefficients and not significance levels. This means that it is possible for the test to indicate no significant differences for a path that is significant for one gender but not significant for the other, if the coefficients themselves are similar. As such, this analysis cannot substitute for a comprehensive analysis of both groups for each path (Marôco 2010). Such an analysis would require the path coefficients for each path and each group to be observed and the differences therein to be interpreted.

Results

Differences in the research agendas of female and male academics were identified through a MANOVA omnibus test (Pillai's trace = 0.033, $F(8, 552) = 2.343$, $p < 0.05$). As shown in Table 21, gender differences were found for Discovery ($F(1, 559) = 6.157$, $p < 0.05$), with women scoring lower for this dimension than men, and for Collaboration ($F(1, 559) = 4.407$, $p < 0.05$), with women scoring higher for this dimension than men. Tolerance to Low Funding was very close to obtaining statistical significance and thus merits attention ($F(1, 559) = 3.758$, $p = 0.053$). Women scored lower for this dimension. These findings suggest that the main differences between the research agendas of female and male academics reside in the former's engagement in more potentially disruptive and risk-taking research themes than female academics. This finding seems to be in alignment with Tolerance to Low Funding, for which male academics also scored higher than female academics, in consonance with riskier attitudes. As shown in Table 21, female academics prefer to engage in research agendas that involve collaboration, underlining a more collaborative stance in developing research-related processes. Ghiasi, Harsh and Schiffauerova (2018) also made this finding. This may be positive in that research is becoming increasingly collaborative. However, it may also have less beneficial effects in terms of recognition, as researchers may have more difficulty standing out if their work is always developed with others. Collaborative research does not allow the community to assess the individual scholarly value of an academic, which is usually demonstrated by independently authored work. It may also be that women's greater collaboration dynamics rest with feminized research groups, which tend to be less visible and

recognized by academic and scholarly communities (Beaudry and Larivière 2016; González Ramos, Fernández Palacín and Muñoz Márquez 2015).

Table 21: MANOVA for gender comparison

	Gender		
Variable	*Female*	*Male*	*F*
Scientific Ambition	4.973	5.073	0.269
Convergence	3.505	3.398	1.611
Divergence	5.003	5.067	1.494
Discovery	4.392	4.669	6.157 *
Conservative	3.020	2.884	2.427
Tolerance to Low Funding	4.548	4.750	3.758
Mentor Influence	2.624	2.605	0.000
Collaboration	5.483	5.295	2.427 *

Note: * p-value < 0.05

An overview of the differences in the research agendas of women and men in the social sciences is provided in Table 21. As a second step, path analysis was used to determine the existence of differences in the underlying processes that may affect the research agendas of academics of both genders (Table 22).

From an institutional perspective, the workplace context has a clear influence on the research agendas of academics. This result is expected, as the literature suggests that the organizational environment affects academic work (Edgar and Geare 2013). However, the results of this study are evidence of more than this. They show that the workplace context influences the research agendas of women and men in a dramatically different fashion. Autonomy was one of the variables with the most divergent effects. It had a significant and positive impact on Scientific Ambition, Collaboration and Discovery ($p < 0.001$) in the research agendas of female academics. This effect was not present for their male peers. The regression coefficients for Collaboration also exhibited significant differences ($p < 0.05$), further highlighting the contrast. Conversely, Autonomy had a modest negative effect on Mentor Influence for men ($p < 0.05$). This effect was absent for women. This highlights the importance of academic workplace environments in providing autonomy for women to freely develop research agendas that lead them to aim for higher research prestige levels, to potentially publish more (drive for publication is a

sub-dimension of scientific ambition; Horta and Santos 2016), to collaborate more and to engage in research agendas that incorporate several topics and are riskier. Social Satisfaction concerns the workplace environment and is related to the social dynamics of the organization but also includes the academic quality of peers and collegiality. This variable had two effects that differed between genders. Specifically, Social Satisfaction had a positive impact on Scientific Ambition ($p < 0.01$) and Discovery ($p < 0.001$) for men, but no equivalent effect for women. This indicates that even in supportive academic environments, men are the ones who mainly benefit – possibly because of the male-dominated structures that characterize such environments. Organizational Commitment (the final workplace context variable) was associated with only one significant difference between the genders, which concerned Mentor Influence. Women were positively affected by Organizational Commitment ($p < 0.05$) regarding this variable, whereas no such effect was present for men.

Only modest effects were noted concerning the bibliometric variables affecting the research agendas of women and men. These effects reveal the challenges faced by female academics to become prominent in international academic and research communities. First, having more publications led to higher Scientific Ambition in the research agendas of men only ($p < 0.05$). The regression coefficient was significantly different between the genders ($p < 0.05$). Second, having a higher number of co-authors was associated with research agendas based on Collaboration, but, again, only for men ($p < 0.05$). Neither number of publications nor co-authors had any other significant effect on the research agendas of women or men. These findings suggest that publishing more or publishing with more co-authors does not necessarily lead women to change their established research agendas. Thus, bibliometric indicators (and policies based on promoting them for female academics) may not be the factors that trigger women to engage in more challenging and far-reaching research agendas.

The career-related variables demonstrated several interesting effects. Academic Job Count was a negative predictor of Conservative ($p < 0.01$) and Mentor Influence ($p < 0.001$) for men, with no equivalent effect for women. It was also a positive predictor of Discovery for men ($p < 0.05$). Job Country Changes was a negative predictor of Discovery, but only for men ($p < 0.001$), with significantly different coefficients between

genders ($p < 0.05$). This highlights the different effects that academic job mobility, including transnational academic job mobility, can have for women and men. Men tend to benefit from job mobility, whereas women face more difficulties and sometimes even glass ceiling policies when moving abroad (Leung 2014). Time Since PhD was a positive predictor of Collaboration for women ($p < 0.05$) but not for men, with significant differences in regression coefficients ($p < 0.05$). This time variable had a negative effect on Mentor Influence for both women ($p < 0.001$) and men ($p < 0.05$), but the effect was significantly stronger for women ($p < 0.01$). For women, Time Since PhD increased the Discovery score ($p < 0.05$). The findings concerning Time Since PhD seem to indicate that women need more time than men to fully develop research agendas that are more collaborative in nature, riskier in scope and outside the influence of the PhD mentor. For men, this time does not seem to be a necessity, possibly because they have the environmental support to establish these characteristics in their research agendas at an earlier stage in their careers.

Interestingly, some effects were identical across genders. Autonomy had similar negative effects on Conservative and Convergence for both women ($p < 0.001$) and men ($p < 0.01$), with no relevant differences between genders. Autonomy also had similar positive effects on Tolerance to Low Funding for both women and men ($p < 0.001$). Organizational Commitment exhibited interesting effects, most of which were similar across genders. It had identical negative and significant effects on Scientific Ambition for both women and men ($p < 0.01$), which were also observed in both groups for Collaboration ($p < 0.01$), Discovery ($p < 0.001$ for women; $p < 0.01$ for men) and Divergence ($p < 0.001$). Conservative had significant and positive effects for both women ($p < 0.001$) and men ($p < 0.01$), as did Convergence ($p < 0.001$). Several effects were found for Social Satisfaction. It had positive effects for both genders on Collaboration ($p < 0.001$) and Divergence ($p < 0.05$ for women; $p < 0.001$ for men). Job Country Changes was a negative predictor of Scientific Ambition for both genders ($p < 0.05$). Finally, Time Since PhD had equally negative effects on Conservative for the two genders ($p < 0.05$).

Table 22: Path analysis with multi-group comparison

Independent Variable	*Dependent Variable*	*Women*	*Men*	*z-score*
Autonomy	Scientific Ambition	0,075 ***	0,091	0,265
	Collaboration	0,091 ***	0,003	-1,996 *
	Conservative	-0,124 ***	-0,177 **	-0,861
	Convergence	-0,085 ***	-0,142 **	-1,126
	Discovery	0,103 ***	0,041	-1,020
	Divergence	0,102 ***	0,123 **	0,457
	Mentor Influence	-0,046	-0,134 *	-1,504
	TTLF	0,135 ***	0,184 ***	0,808
Organisational Commitment	Scientific Ambition	-0,144 **	-0,166 **	-0,284
	Collaboration	-0,102 **	-0,116 **	-0,241
	Conservative	0,217 ***	0,175 **	-0,521
	Convergence	0,144 ***	0,196 ***	0,794
	Discovery	-0,208 ***	-0,165 **	0,543
	Divergence	-0,184 ***	-0,253 ***	-1,150
	Mentor Influence	0,119 *	-0,014	-1,686
	TTLF	0,023	-0,089	-1,411
Social Satisfaction	Scientific Ambition	0,117	0,209 **	0,941
	Collaboration	0,330 ***	0,433 ***	1,490
	Conservative	-0,104	0,014	1,165
	Convergence	-0,072	-0,097	-0,305
	Discovery	0,099	0,218 ***	1,204
	Divergence	0,136 *	0,209 ***	0,984
	Mentor Influence	-0,072	0,126	2,028 *
	TTLF	-0,131	0,017	1,501
Publications	Scientific Ambition	0,000	0,006 *	2,094 *
	Collaboration	0,000	0,000	0,171
	Conservative	0,000	-0,003	-0,996
	Convergence	0,000	0,002	0,762
	Discovery	0,000	-0,001	-0,411
	Divergence	0,000	-0,001	-0,655
	Mentor Influence	0,000	-0,001	-0,428
	TTLF	0,000	0,005	1,672
Co-Authors	Scientific Ambition	0,005	-0,003	-1,784
	Collaboration	0,003	0,006 *	0,984
	Conservative	-0,002	0,002	0,851
	Convergence	0,000	-0,004	-1,142
	Discovery	0,000	0,002	0,473
	Divergence	0,000	0,004	1,278
	Mentor Influence	-0,002	-0,001	0,080
	TTLF	-0,003	-0,006	-0,757
Academic Job Count	Scientific Ambition	0,022	0,031	0,183
	Collaboration	-0,011	0,022	0,966
	Conservative	-0,080	-0,077 **	0,060
	Convergence	0,011	-0,019	-0,751
	Discovery	0,060	0,064 *	0,073
	Divergence	-0,032	0,018	1,365
	Mentor Influence	-0,028	-0,106 ***	-1,619
	TTLF	0,010	0,009	-0,005
Job Country Changes	Scientific Ambition	-0,156 *	-0,057 *	1,226
	Collaboration	-0,036	-0,019	0,292
	Conservative	-0,011	-0,017	-0,062
	Convergence	-0,082	-0,005	1,163
	Discovery	0,091	-0,095 ***	-2,242 *
	Divergence	0,052	-0,027	-1,271
	Mentor Influence	-0,038	0,037	0,894
	TTLF	-0,051	0,045	1,143
Time Since PhD	Scientific Ambition	0,001	-0,009	-1,408
	Collaboration	0,009 *	-0,001	-1,973 *
	Conservative	-0,015 *	-0,015 **	0,004
	Convergence	-0,008	-0,006	0,390
	Discovery	0,012 *	0,005	-0,932
	Divergence	0,004	-0,001	-0,935
	Mentor Influence	-0,034 ***	-0,011 *	3,160 **
	TTLF	0,007	0,002	-0,595

Notes: *** p-value < 0.001; ** p-value < 0.01; * p-value < 0.05. TTLF: Tolerance To Low Funding.

Discussion and Conclusions

The goal of this study is to further explore the gender inequalities in academia from a novel perspective, by observing how exogenous dynamics differentially affect the research agendas of women and men. The results suggest that some factors (e.g., the impact of autonomy on scientific ambition and discovery) have different effects between the genders, whereas others have similar effects. These findings shed new light on the enacting of gender in academia by revealing how these differences may constrain the professional growth and, indirectly, scientific progress of women and men. In this section, the main findings are discussed and linked with gender-related literature concerning academia.

The most critical finding is that the impacts of autonomy on scientific ambition, collaboration, discovery and mentor influence in academic settings may be exclusive to women. Autonomy is particularly beneficial to women, as it has the potential to increase their scientific ambition, collaborative efforts and pursuit of multidisciplinary and discovery-driven agendas that incur higher risk (but also greater potential intellectual and professional rewards and prestige). Autonomy is universally considered essential in work environments that thrive on creativity, such as academia (Hemlin, Allwood and Martin 2008), but is not always present (Latour and Woolgar 2013). If working environments are not conducive to promoting and guaranteeing the autonomy of academics or if they promote constrained autonomy, such as those of neoliberal universities (e.g., Oleksiyenko and Tierney 2018), then it is the women in academia who stand to lose the most in already gendered and unequal academic and research environments. This is felt already in the research agenda thinking of female academics, not considering the other factors that loss of autonomy brings in terms of decreasing academic agency and career progression obstacles, which also tend to affect women the most (Terosky, O'Meara and Campbell 2014). Greater levels of autonomy may have further dual interlinked effects that benefit the research activities of women and their careers and positioning in knowledge domains. First, greater autonomy detaches female academics from their overdependence on patriarchal organizational settings (i.e., chilly environments) Second, this detachment permits them to gain agency in possibly following innovative research paths, allowing

them to build on their confidence to challenge the organizational settings that informally still constrain them (Allen 2013; Okkolin 2016; Savigny 2014; Terosky, O'Meara and Campbell 2014).

Organizational commitment may drive both women and men towards more conservative and convergent research agendas that are less ambitious, collaborative, based on discovery and divergent. This suggests that overly committing to one's institution may have negative effects on one's research progress in academia, as suggested by research on 'academic inbreeding' (Horta 2013). For women, it also indicates the greater influence of their mentor in directing their research agendas. This presupposes a potential loss of individual autonomy in research agenda decisions through and increased dependency on mentor guidance, which may be helpful but may also delay the full development of scientific maturity. Specifically, this delay may lead to one never being recognized as an independent academic but continuing to be perceived as a 'student' under the wing of a supervisor even long after concluding one's PhD. Academic mobility has no effect on the research agendas of women and international mobility can even decrease the scientific ambition shown in their agendas, possibly reflecting the difficulties felt by women in situations of academic mobility (Leung 2014).

Notable differences are also identified regarding social satisfaction, which was a positive predictor of discovery and scientific ambition for men but not for women. Men experience increased levels of ambition and propensity to engage in discovery-driven research when they are satisfied with their peers, whereas women are unaffected by their level of social satisfaction. Social satisfaction in men can lead to or be a consequence of the old boys' network effect (Amery et al. 2015). For women, social satisfaction does not seem to relate to such networking. Linked to this are the differing effects found for the bibliometric variables, such as the number of co-authors being associated with higher collaboration for male academics but not for female academics. It is important to note that collaboration represents both the opportunity and the willingness to engage in collaborative ventures. Thus, it is plausible that for men, both willingness and opportunity present themselves due to their integration into established, powerful and influential networks, leading to increased co-authorship. For women, opportunities may be more limited due to the male-dominated nature of academic networks; as such, no equivalent

effect occurs. This can be likened to similar situations found in other highly qualified professions, such as medicine and politics, in which men tend to acknowledge and yet naturalize these inequalities (Santos and Amâncio 2016; Santos, Amâncio and Roux 2015).

The effects of two variables (Time Since PhD and Publications) on the research agenda characteristics of female and male academics reveal the unequal starting-line positions of women and men at the beginning of their careers and the difficulties that women face throughout their academic careers. First, Time Since PhD was a positive predictor of Collaboration for women. This finding suggests that given enough time, women in the late-career stage are able to overcome the limited access to male-dominated networks. The other relevant finding is that it takes longer for women to have their research agendas less influenced by their PhD mentor, underlining their more dependent relation with their PhD mentor than men. Thus, mentoring seems to be a double-edged sword, rather than purely beneficial. This contrasts with some findings in the literature, which tend to present a more positive picture (Davies and Healey 2017; Ooms et al. 2018). Time to PhD also increased the Discovery score for women only. This finding suggests that the women who reach the late-career stage do eventually develop a higher propensity for discovery-driven ventures. However, this may also be related to what is known as the 'scissor effect' (Macha 2011), as fewer women actually reach the late-career stage. Second, the limited effect of Publications on Scientific Ambition for women is quite likely to be the result of the accumulation of constraints faced by women, especially if they feel they have limited agency or career prospects despite their research productivity and thus do not develop higher levels of ambition (Etzkowitz and Ranga 2011). This finding contradicts the Mertonian logic of science and research productivity.

It is hoped that the findings of this study broaden the explanation of gender differences by anchoring them in the male-dominant and structural aspects of the academic research environment. The research questions of this study are directly addressed. First, differences between the research agendas of women and men do exist. Men prefer to engage in research topics that have a greater potential for scientific disruption, that are riskier and that also have the potential for higher rewards. Women prefer more collaborative research agendas. These preferences are in alignment with

gender theories that highlight the existing conditions for men in academia to try and fail and try again, which may not be present or may be more punishing for women. Furthermore, the collaborative proclivity of women, although positive, may be based in feminized research groups with less visibility and impact (Beaudry and Larivière 2016; González Ramos, Fernández Palacín and Muñoz Márquez 2015). Second, the perceptions of the organization where one works influences gendered research agenda preferences. Women must be particularly aware of these organizational constraints if they want to improve their situations and become more agentic in academia. The findings seem to indicate that the agency of women in academia needs to be develop towards promoting and sustaining a culture of research autonomy in universities. At the same time, women should avoid overly committing to universities, particularly if such commitment involves placing them in roles that minimize their contribution, informally marginalize them and exclude them from decision-making and career promotion roles (Biggs, Hawley and Biernat 2018).

Like all research, this study has limitations that should be considered in follow-up research. The first limitation is the use of self-reported data to measure the research agenda and work environment variables had its own set of limitations. Notably, such data can be influenced by social and stereotypical desirability (McDonald and Ho 2002). However, perceptions do tend to converge with actual behavior (Pickens 2005). Nevertheless, such an influence must be kept in mind when observing self-reported data. The second limitation is the lack of family-related data, which could provide further insight into the nature of the differing gender dynamics. Questions related to these aspects were excluded for both logistical reasons, as the survey was already quite extensive, and out of respect for the privacy of the participants, who may have felt uncomfortable revealing sensitive personal data in an online survey.

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Chapter 8
The Multi-Dimensional Research Agendas Inventory – Revised (MDRAI-R): factors shaping researchers' research agendas in all fields of knowledge

Chapter based on: Horta, H., & Santos, J.M. (2019). The Multi-Dimensional Research Agendas Inventory – Revised (MDRAI-R): factors shaping researchers' research agendas in all fields of knowledge. *Quantitative Studies in Science,* (Just Accepted), 1-38.

Abstract

This study creates a novel inventory that characterizes factors influencing the research agendas of researchers in all fields of knowledge: the Multi-dimensional Research Agendas Inventory-Revised (MDRAI-R). The MDRAI-R optimizes an initial inventory designed for the social sciences (the MDRAI) by reducing the number of items per dimension, improving the inventory's psychometric properties, and including new dimensions ("Academia Driven" and "Society Driven") that reflect the greater influence of social and organizational structures on knowledge production and demands for research impact. This inventory enhances our ability to measure research activities at a time when researchers' choices matter more than ever, and will be of interest to researchers, policy makers, research funding agencies, and university and research organizations.

Introduction

With research playing an increasingly central role in driving knowledge creation in fast-paced, globalized, connected, uncertain, and technology driven contemporary societies, it is critical to better understand the factors that influence researchers' research agendas, particularly those based in academic settings. This is important not only for researchers, but also for those looking to create added value from the available research, such as policy makers, research funding agency managers, and university and research laboratory administrators (Ciarli & Ràfols, 2018; Franzoni & Rossi-Lamastra, 2017; Wallace & Ràfols, 2018). Understanding the factors that influence researchers' research agendas is ultimately relevant to the development of science itself at a time when researchers are facing global, multifaceted, and increasing complex challenges, and more and more research output is being produced without necessarily leading to breakthroughs (Young, 2015). Today, a key premise in science is that researchers' strategic research choices matter, because these choices (which are to some extent personal in nature) shape the knowledge produced and the general orientation of the broader research efforts and future research directions (Polanyi, 2012). Although researchers' choices of research agendas have been examined in seminal works in the sociology of science (Zuckerman, 1978), the area remains underexplored and has mostly been analyzed from a qualitative perspective (Luukkonen & Thomas, 2016; McGrath, 1981; Shwed & Bearman, 2010).

The literature shows that the cultures, traditions, and dispositions of fields of knowledge have a fundamental influence on researchers' choices of research (Becher & Trowler, 2001). Disciplinary cultures become embedded in the *habitus* of researchers, as they feel that they belong to and identify with specific knowledge-based research communities and abide by these communities' values, norms, and attitudes (Bourdieu, 1975). This occurs as part of a path dependent process that begins with the researchers' socialization through their doctoral studies to become independent researchers (Jung, 2018; Mantai, 2017). During this time, the researchers learn how to conduct research while accumulating expertise and developing, under supervisory guidance, research interests that are likely to resonate with and influence the current and future research choices (Åkerlind & McAlpine, 2017; Brew, Boud, & Malfroy, 2017). Research agendas

can be influenced by students' mentors during their doctoral studies and in the years after completion. Collaboration with peers and other stakeholders can also influence the design of research agendas, as collaborations bring novel information, expertise, and perspectives, and the possibility of serendipitous opportunities to engage in innovative, disciplinary, and multidisciplinary research (Kingdon, 2013; Shi, Foster, & Evans, 2015).

The patterns of collaboration are increasingly likely to influence the research agendas of researchers at a time when their career trajectories are increasingly non-linear (Hancock & Walsh, 2016). Nonetheless, prestige and recognition by peers in the field continue to be critical signals of important contributions to the pool of knowledge and tend to drive successful careers (Kim & Kim, 2017). In the "publish or perish" research environment, where performativity has become central to career survival and progression, researchers might well be encouraged to engage in research agendas that promise prolific research output (i.e., publications) with high levels of visibility and recognition (i.e., citations), and possibilities of funding. According to the Mertonian rationales of science (e.g., the Matthew effect and cumulative advantage in science), such output can lead to further publications, visibility, funding, and collaboration, including invitations to collaborate in others' research agendas (Allison, Long, & Krauze, 1982; Merton, 1968). These activities and dynamics define and are defined by the research agendas of researchers through interactive processes, as researchers position themselves (and their interests) within their research communities (Whitley, 2000).

A few recent studies add to our understanding of researchers' choices of research agendas from a quantitative perspective (Foster, Rzhetsky, & Evans, 2015; Horta & Santos, 2016; Santos & Horta, 2018; Ying, Venkatramanan, & Chiu, 2015). These studies mainly focus on a single field of knowledge or disciplinary area, such as biomedicine (Foster et al., 2015) or higher education (Santos & Horta, 2018). Interestingly, these studies examine the tensions between the two main research strategies identified by Kuhn (2012), that is, between the conservative research strategies that are part of "normal science," and are characterized as safe and representing incremental contributions over time, and riskier strategies that tend to be more innovative and disruptive in searching for new paradigms. Only one of these quantitative studies offers an inventory for identifying the factors that influence the research agendas of researchers (Horta & Santos, 2016).

Although, to the best of our knowledge, this inventory, which is termed the "multi-dimensional research agenda inventory" (MDRAI), is the first of its kind, it was designed with social science researchers in mind. Our study aims to extend the MDRAI. Using a dataset on over 12,000 researchers located all over the world and from all fields of knowledge who provided key information about their research agendas in an online survey carried out in 2017 and 2018, we develop a novel instrument that identifies the key factors influencing the research agendas of researchers in all fields of knowledge. Our MDRAI-R optimizes the initial MDRAI developed by Horta and Santos (2016) by reducing the number of items in each dimension of the original inventory, and including new dimensions relevant to fields of knowledge not considered in the original instrument. Moreover, our revised MDRAI-R is valid for all fields of knowledge.

This study largely focuses on the methodological development of the MDRAI-R. To a lesser extent, it also stresses, wherever applicable, the substantive insights that underline its evaluative applicability in current knowledge producing settings. The methodological development of the MDRAI-R is based on a pilot study and a comprehensive psychometric evaluation that includes exploratory factor analysis, confirmatory factor analysis, validity, reliability, and sensibility evaluations, and tests of measurement invariance.

From MDRAI to MDRAI-R

The MDRAI is based on the classical tenets of the sociology of science and focuses on researchers' personal and environmentally influenced motivations. It is also based on the literature on academic research and work, and the changing world of science, research, and academia that underlines the increasing importance of networking, competitiveness, and resources (Horta & Santos, 2016). The MDRAI covers eight dimensions, four of which have sub-dimensions. The first dimension is Scientific Ambition, which refers to the desire for recognition by peers, as most researchers strive to have their contributions to knowledge acknowledged by their peers and gain prestige by doing so (Latour & Woolgar, 2013). This dimension has two sub-dimensions. Prestige,

which represents the researcher's desire for recognition and Drive to Publish, associated with the need to produce concrete evidence of the creation of new knowledge through the proper channels recognized by the knowledge community as appropriate for disseminating and increasing the credibility and visibility of knowledge. The second dimension, Convergence, relates to the researcher's preference for research agendas that have a clear disciplinary focus. This dimension refers to a researcher's decision to build a position of authority in a sole disciplinary field. Although this usually takes a substantial amount of time (Allison et al., 1982), it can be part of a specialization strategy linked to higher research productivity gains because it avoids the transaction costs of disciplinary mobility (Leahey, 2007). Convergence has two sub-dimensions: Mastery, representing the expertise of a researcher in a given field, and Stability, the investment of time and effort in a specific discipline to become an expert in the field. The third dimension, Divergence, stands in opposition to the second dimension, as it represents the researcher's preference for research agendas that integrate or make use of more than one discipline. This dimension also has two sub-dimensions: Branching out, which refers to expanding the research agenda towards other fields of knowledge (including the use and application of theories and methods from one field to another), and Multidisciplinarity, which is associated with the inclination to engage in multidisciplinary projects (Schut, van Paassen, Leeuwis, & Klerkx, 2014).

Discovery and Conservative, the fourth and fifth dimensions of the MDRAI, are also in opposition to each other, although these dimensions do not have sub-dimensions. Discovery refers to a researcher's preference for a research agenda that is riskier but has the potential to create new knowledge in a disruptive way, possibly creating new paradigms (Kuhn, 2012). Conservative measures the preference for pursuing a research agenda that is focused on well-established themes, and a more incremental knowledge creation perspective. This preference is deemed to be safer and within the bounds of normal science, according to Kuhn (2012), and thus entails less risk of encountering research dead-ends or a lack of acceptance by the research community. The sixth dimension, Tolerance of Low Funding, measures a researcher's willingness to pursue a research agenda even when little or no funding is available to support it. This dimension is relevant because it is associated with the competitive drive for research funding that

universities and other institutions exhibit even when their researchers do not necessarily need such funding to do their research (Roumbanis, 2018). However, this dimension also illuminates how researchers can engage in research agendas without having access to resources at a time when the distribution of resources is characterized by inequality and increasing concentration (Hicks & Katz, 2011). The seventh dimension, Collaboration, plays an increasingly key role in the contemporary research dynamics (Kwiek, 2018), and refers to the preference for engaging in collaborative research agendas. This dimension also has two sub-dimensions, which represent how engagement in collaborative research can occur: Willingness to Collaborate, which indicates the propensity to collaborate, and Invitations to Collaborate, which refers to the collaborative opportunities provided by others (i.e., research projects started by others). The final dimension of the MDRAI is Mentor Influence, which measures the extent to which researchers are influenced by their mentors when designing their research agendas. The influence of a mentor on an individual's research agenda is to some extent a proxy for scientific independence, but can also attest to good professional relationships forged during a researcher's PhD study, even though the mentor's influence is expected to wane over time (Ooms, Werker, & Hopp, 2018).

The MDRAI covers these critical dimensions and can be complemented by additional dimensions that are likely to shape the way that research is thought about and considered. Based on the literature, three dimensions are considered. First, the research agendas of researchers in the fields of science, technology, mathematics, and engineering (STEM) are known to be more influenced by their field communities in which consensus on the significant questions that should be addressed tends to be reached collectively and holistically. This consensus is expected to influence a researcher's choices in those fields when defining a research agenda (Becher & Trowler, 2001). However, the research preferences of researchers in the social sciences and humanities tend to relate more strongly to personal interests. Although these personal interests are linked with issues significant to the researchers' field communities, the field communities are not expected to influence individual researchers to the same extent that they do in STEM fields (Collins, 1994). Second, with the rise of performativity, managerialism, and metrics associated with world university rankings and competitive national funding schemes,

universities and other institutions are playing an ever greater role in influencing the research agendas of researchers (Kenny, 2018). These organizationally determined metrics establish the goals and targets related to research careers, and influence decisions on salary increases and tenure and promotion (Acker & Webber, 2017). The recent literature shows that the increasing institutional pressure is influencing academic work and the way that researchers use these institutional constraints and incentives to orient their intellectual interests and career trajectories (Brew, Boud, Crawford, & Lucas, 2018). Third, as research funding agencies and other institutional bodies (including universities, through policies related to research exchange) are increasingly highlighting the impact and social relevance of research, it is becoming increasingly likely that forms of research practice such as "action research communities" or "participatory research" are chosen. In these practices, researchers work collaboratively or consult lay communities about the challenges that they may face, and structure their research from this perspective (Mendes, Plaza, & Wallerstein, 2016; Wooltorton et al., 2015). As a result, researchers may increasingly seek the opinions of non-experts about social and technical problems, and build research agendas that deal with "real problems" and are likely to have a strong societal impact.

Method

This section provides information relevant to the various analyses presented later in this study, such as the methods of determining validity.

Structural Equation Modeling

This sub-section provides a brief introduction to structural equation modeling (SEM) to enable readers unfamiliar with this methodology to better understand the remainder of the study. Readers already familiar with SEM may wish to skip this sub-section.

In the pilot and main studies, SEM was implemented using AMOS 24, with the goal of conducting confirmatory factor analysis (CFA) as a follow-up to a previously

implemented exploratory factor analysis (EFA). The AMOS software package was developed by IBM as a companion to the more well-known SPSS, focusing on SEM. Although there are other software packages dedicated to SEM, AMOS has the distinct advantage of being largely graphics-based and is thus easier to use.

SEM has the capacity to include latent variables to account for factors that cannot be directly observed (Bentler & Weeks, 1980) while also providing linear modeling procedures such as analysis of variance and linear regression (Marôco, 2010). It has also the advantage of providing significantly more fit indicators than those available for general and generalized linear modeling, which can be used to re-estimate the model to achieve optimal fit, such as by allowing for covariance between the error terms (Bollen, 2014; Marôco, 2007; Marôco, 2010).

SEM typically comprises two components: the measurement model and the structural model. The measurement model examines the trajectories from the manifest variables to the latent variables, with the dependent or endogenous variables being represented as follows (Bollen, 2014; Marôco, 2007; Marôco, 2010):

$$y = \Lambda_y \eta + \varepsilon$$

where y is the vector for the manifest variables, Λ_y is the matrix for the factorial weights of η in y, η is the vector for the latent variables, and ε is the error term for y. The independent or exogenous variables are given by:

$$x = \Lambda_x \xi + \delta$$

where x is the vector for the manifest variables, Λ_x is the matrix for the factorial weights of ξ in x, ξ is the vector for the latent variables, and δ is the error term for x.

The second component in SEM, the structural model, defines the relations between the various latent variables, and is given by the following (Bollen, 2014; Marôco, 2010):

$$n = \mathrm{B}\eta + \Gamma \xi + \zeta$$

where B is the matrix for the coefficients of η in the structural model. β_ii=0, Γ is the matrix for the coefficients of x in the structural model, and ζ is the vector for the disturbance terms in the structural model.

CFA is a specific type of SEM that is largely centered around the measurement model, because the structural section, if it exists, is largely reserved for second-order constructs. CFA is frequently used as a follow-up analysis to EFA. In EFA, the variables are allowed to freely load onto any extracted factors (Marôco, 2003), whereas CFA requires that the researcher specifies the structure to be tested (Brown, 2015). Thus, EFA can provide initial insights into how to specify the model, and this specification can subsequently be tested through CFA.

Rather than relying on ordinary least squares, various methods can be used to estimate the parameters in SEM. The de facto standard in SEM estimation is maximum-likelihood (ML) estimation. ML estimation was used in all of the SEM analyses in this study because it is robust to deviations from the multivariate normality, and is generally considered to be the most useful estimation method (Arbuckle, 2007; Jöreskog & Sörbom, 1989; Marôco, 2010).

Considerations when using SEM with a large sample

The main study used a much larger sample than is typically encountered in studies or referred to in statistical textbooks. Although this increases statistical power, it also creates issues in SEM due to the method's reliance on the χ^2 statistic. χ^2 is a mathematical function of the sample size, and is generally inflated by large samples (Hair, Black, Babin, Anderson, & Tatham, 2007). This makes the underlying test almost always significant, and other indicators that are dependent on this statistic are likewise influenced. In other words, the χ^2 statistic reflects the sample size rather than the model fit (Browne & Cudeck, 1993). As Iacobucci (2010) states, "as N increases, χ^2 blows up," with quasi-exponential gains in the χ^2 statistic reached for sample sizes as low as 500. As our sample represented a more extreme scenario than those frequently encountered in the literature, we verified this in our own dataset. Specifically, we found that drawing smaller sub-samples from the working dataset, with no other changes, caused very sharp decreases in the χ^2 statistic. When it became apparent that we could attain a good fit (as measured by χ^2 alone) simply

by decreasing the sample size, we decided that the χ^2 statistic could not realistically be used for the analysis reported here. As a result, fit evaluation was conducted using a suite of alternative fit indices (AFIs) (Barrett, 2007; Browne & Cudeck, 1993; Kline, 2016; Putnick & Bornstein, 2016), which are detailed in the following section. There was also an issue with the modification indices (MI), which are also based on the χ^2 statistic (Whittaker, 2012). Due to the sample-related inflation of the statistic, trivial changes were signaled as highly significant by the MIs, thus rendering the usual MI thresholds (Marôco, 2010) functionally useless. As a result, MIs were used in a limited manner. More details on how they were implemented are provided in the relevant section. Finally, the measurement invariance could not be tested using χ^2 comparisons, for the same reasons. Instead, AFIs were used (Meade & Lautenschlager, 2004; Putnick & Bornstein, 2016) in accordance with the stated guidelines for best practice in the literature (Cheung & Rensvold, 2002; Milfont & Fischer, 2010).

Fit evaluation

Following model estimation, it is necessary to evaluate the model fit. Due to the large number of fit indicators, each representing different features of goodness-of-fit, it is usual to select one indicator for each category of indicators rather than report the entire suite of indicators (Bentler, 1990). The most common measure of fit is the χ^2 goodness-of-fit test (Barrett, 2007), which tests the null hypothesis that the population's covariance matrix is identical to the covariance matrix estimated by the model. However, due to the sample-related issues noted above, our evaluation relied heavily on the AFIs listed below.

The first category of fit indices is the *absolute indices*, which provide a measure of fit (Marôco, 2010). Traditionally, this is done using χ^2/df, the ratio of the chi-square statistic to the degrees of freedom. However, due to the large sample, it became necessary to use an alternative indicator for this category. We used the goodness-of-fit index (GFI), which is also commonly used in the literature. The second category of indices is the *comparative indices*, which compare the model fit with the fit of the independence and the saturated model (Bentler, 1990; Marôco, 2010). In this case, we used the comparative fit index (CFI) (Bentler, 1990). For the category of *parsimony-adjusted indices*, which penalize more complex models (Marôco, 2010), we used the parsimony-adjusted

counterpart to the CFI, the PCFI. The fourth category comprised the *population-discrepancy indices*, which compare the model fit as calculated by the sample moments, where the model fit is calculated through population moments (Marôco, 2010). For this category we used the commonly used root mean square error of approximation (RMSEA), which is a popular choice because it is relatively insensitive to index inflation (Steiger, Shapiro, & Browne, 1985). The final category of *information-theory indices* is also dependent on the χ^2 statistic, but in this scenario this is less problematic as the values of these indices are devoid of meaning on their own. Rather, they are used to compare multiple models and are read as "less is better" (Anderson, Burnham, & White, 1998; Marôco, 2010). For this category, we used the modified expected cross-validation index (ECVI), which does not require the competing models to be nested (O'Rourke & Hatcher, 2013) and is considered to be particularly useful for CFA purposes (Bandalos, 1993). We used the modified version of ECVI because it is preferable under ML estimation (Marôco, 2010).

Modification Indices

To increment the model fit, it is possible to carry out model re-specifications. The first approach to re-specification eliminates non-significant trajectories and trajectories with low loadings, which has the additional advantage of increasing the factorial validity (Marôco, 2010). The second strategy involves MIs, which estimate the discrepancy or delta in the χ^2 statistic when certain adjustments are made to the model. It is important that these adjustments are coherent at a conceptual level, as otherwise a model can statistically have a good fit but be theoretically implausible (Arbuckle, 2007). This is usually performed by drawing covariances between error terms within the same factors, and eliminating variables with cross-loadings, which tend to manifest as high MI values connected to the covariances between error terms of variables in different factors (Marôco, 2010). In AMOS 24, the MIs use the Lagrange multipliers method (Bollen, 2014). MI analysis is usually conducted iteratively. The adjustments are first specified with an MI of 11 or higher, corresponding to a type I error probability of 0.001, and then with an MI of 4 or higher, representing a type I error probability of 0.05 (Marôco, 2010). In the main study, MIs were used sparsely due to the sample size.

Imputation

Missing values were imputed via Markov Chain Monte Carlo multiple imputation, which produced five complete datasets. EFA was carried out for each of the five complete datasets, and pooled estimates were then produced. In the CFA stage, because AMOS does not have built-in integration with the SPSS multiple imputation module, we used a single complete dataset.

Scale level

The original MDRAI and the new MDRAI-R items are scored on a 7-point Likert scale ranging from "completely disagree" to "completely agree." Although Likert scales are technically ordinal, the data are treated as continuous throughout the entirety of the analysis. The rationale for this is as follows. First, various studies indicate that at the 5-point range and beyond, Likert scales can simply be treated as continuous (e.g., Johnson & Creech, 1983; Norman, 2010; Sullivan & Artino Jr, 2013; Zumbo & Zimmerman, 1993). In the context of SEM specifically, Kline (2016) only recommends using alternative estimation methods (i.e., not ML) when the range of the scale is 5 points or smaller. Indeed, this is precisely why we opted to use a 7-point scale, which is less common than the 5-point scale. Second, the skewness and kurtosis values for the individual items indicate that they are sufficient approximations of a normal distribution (as we demonstrate in a later section), further indicating that the items can reasonably be treated as continuous.

Procedures

We conducted several searches on the Scopus database from June 2017 to August 2018 to identify the corresponding authors of articles from all fields of knowledge (based on the Scopus disciplinary area classifications) published from 2010 to 2016. As the Scopus database only shows the results for the first 2,000 matches, several sorting strategies were used to maximize coverage, namely, default sorting, most relevant, least relevant, and highest cited. No further sorting strategies were used, as significant numbers of duplicate records had been obtained by this point. We found 915,447 corresponding authors.

The survey was carried out electronically through an online surveying platform. Invitations to participate were sent out by e-mail in batches from June 2017 to August 2018 (this included an additional wave of invitations to the authors that did not respond to the initial invitation). The invitation included a description of the project and the survey aims, and an opt-out link for participants who did not wish to be contacted again about the project. Those who accepted the invitation were directed to a page with an informed consent letter describing the scope, objectives, and purposes of the survey in further detail. The participants were required to give informed consent before they could proceed to the survey itself.

In total, 21,016 individuals agreed to participate. Of these, 8,883 dropped out before completion and were thus removed from the subsequent analysis. The final sample comprised 12,183 participants, of whom 4,153 (34.1%) were female and 8,030 (65.9%) were male. The mean age was 49.994 years (SD = 12.285). In regard to geographical distribution, the most represented countries were the United States (N = 2235; 18.3%), Italy (N = 806; 6.6%), the United Kingdom (N = 760; 6.2%), Spain (N = 554; 4.5%), and France (N = 548; 4.5%). The remaining participants were distributed across a range of other countries, ensuring global coverage. Table 23 summarizes the descriptive statistics for the sample. The geographical distribution is shown in Appendix F, due to its size.

Table 23: Descriptive statistics for the sample

Qualitative variables		*N*	*%*
Gender	Female	4153	34.1
	Male	8030	65.9
Field of knowledge	Natural and agricultural sciences	3309	27.2
	Engineering and technology	2553	21.0
	Medical and health sciences	3118	25.6
	Social sciences	2854	23.4
	Humanities	349	2.9
Quantitative variables		*M*	*SD*
Age		49.994	12.285

Finally, for cross-validation purposes, the working dataset was randomly divided into two sub-samples (see, e.g., Johnson & Stevens, 2001): a training dataset, comprising

roughly 10% of the participants (N = 1203), to be used in the EFA, and a holdout dataset, comprising the remaining 90% of the participants (N = 10980), to be used for the CFA.

Analytical roadmap

We describe our analytical strategy as follows. We begin by reporting the results of a pilot study that was conducted prior to the main survey and the subsequent analysis. We then report the EFA results for the main study, which was conducted with the goal of obtaining a preliminary data structure for the new scales to be included in the model. EFA was followed by CFA, where the model was further refined through iterative re-specification until an optimal fit had been attained. After reporting the results of CFA, we describe the findings of our validity, reliability, and sensibility analyses, conducted to demonstrate the psychometric properties of the instrument. We conclude with measurement invariance analysis, which was performed to demonstrate that the instrument has similar measurement properties across all fields of knowledge.

Results

Pilot study

A pilot study was conducted in May and early June 2017 in preparation for the primary survey and the subsequent validation exercise. The pilot study aimed to (1) reinforce any weak pre-existing scales (i.e., those with the minimum number of items per dimension or items with relatively lower loadings in the MDRAI); (2) develop new questions related to entirely new themes that had emerged since the development of the original MDRAI; and (3) ensure that the global number of items was reasonable by filtering out unnecessary items without compromising the factorial structure (as an excessively lengthy survey can discourage participants from completing it).

A pool of 92 questions was developed based on these criteria. This pool comprised 22 items unchanged from the original MDRAI, and 13 items that were edited for clarity based on the comments by the participants in the pilot study. The 57 remaining items were original. Of these, 35 items were intended to reinforce the pre-existing scales, with

the remaining 22 related to novel themes, most notably orientation (towards institutions, community, or society) and external metric-driven pressure.

Participation in the pilot study was by invitation. The authors sent invitations to several researchers from a variety of fields of knowledge and institutions around the world. A public invitation was posted on the project's ResearchGate page. Ninety-seven researchers agreed to participate in the pilot study. The questions were presented in random order to each participant.

The data obtained in the pilot study were analyzed using EFA and then CFA. Each scale was analyzed independently due to a) the small sample size for the pilot study and b) the expectation of relative independence for each scale (they are meant to be able to be used individually if desired, as each scale measures a separate facet of a research agenda). For the new themes, EFA was conducted using Varimax rotation (Ebrahimy & Osareh, 2014), and the optimal number of factors was determined using the following criteria: a) Kaiser's criterion, b) the scree-plot's "elbow," and c) the percentage of extracted variance. The extracted structure was then specified in the CFA stage for further evaluation.

The two main conclusions of this study relate to the new themes. The item elimination, although necessary, was less interesting and the results are summarized in a later section. The items related to the new orientation scale originally revealed three factors explaining 67.38% of the variance. Based on their content, the items seemed to be related to the field orientation (e.g., "My choice of topic is determined by the field community"), society orientation (e.g., "I decide my research topic based on societal challenges"), and institutional orientation (e.g., "My research agenda is aligned with my institution's research strategies"). Thus, the CFA specified a model with three lower-order latent variables in accordance with this structure. The field and institutional orientation dimensions had reasonable loadings (0.72) and (0.91), but society orientation loaded poorly onto the higher order factor (0.39). We interpreted this as indicative that a society orientation can sometimes be at odds with an academic orientation, or in practical terms, that the society orientation factor might be independent of the other two orientation factors. We decided to reinforce the society orientation factor (which had only three items) with an additional three items and repeat the EFA for this factor in the main study.

This generated two new sub-scales: one comprising the field and institutional orientation scales (which we termed “Academia Driven”), and a second comprising the society-related items (which we termed “Society Driven”). Our second conclusion concerns the metric-driven pressure scale, which identified two factors explaining 55.87% of the variance: one related to publication pressure and the other to evaluation metrics pressure. This sub-scale was tentatively termed “Publish or Perish.” The pilot study concluded with a preliminary version of the revised survey comprising 68 items, which was used in the main study as described below.

EFA

Before conducting the CFA, a new EFA was conducted on the new scales (Academia Driven, Society Driven, and Publish or Perish) using the training dataset, similar to the EFA in the pilot study, to obtain a tentative factorial structure for the CFA stage (Bentler & Weeks, 1980). Accordingly, three independent EFAs were conducted, one for each scale. Although we could have conducted a single EFA, we decided to use identical procedures to the pilot to ensure consistency and reflect the modular nature of the inventory.

The EFA for the Academia Driven sub-scale largely matched that observed during the pilot study, with two extracted factors explaining 69.43% of the variance. Semantic interpretation of the items loading onto each factor exhibited similar behavior to that previously observed, with a factor related to institutional orientation and another to field orientation. The Society Driven scale, with the reinforcement items added in the previous stage, showed that two factors explained 79.26% of the variance. Semantic analysis of the items suggested that one of the factors was related to society (e.g., “I decide my research topics based on societal challenges”), while another was related to interactions with non-academics (e.g., “I choose my research topics based on my interaction with my non-academic peers”). We tentatively named these two factors “Society” and “Non-academic.” Finally, in contrast with the observations from the pilot study, the Publish or Perish scale revealed that a single item explained 47.77% of the variance. Due to the previous findings and because the analysis scree plot suggested a possible 2-factor solution, a forced 2-factor extraction was attempted. However, this revealed significant

cross-loadings on both factors from multiple items, thus confirming that the 1-factor solution was optimal. As such, we decided to use the 1-factor solution in the CFA stage, and re-evaluate the structure of this scale based on the findings. Table 24 summarizes the results of these analyses.

Table 24: Exploratory Factor Analysis for the new scales

	Factor	
Academia Driven scale	*1*	*2*
My choice of topics is determined by my field community.	0.152	**0.747**
I adjust my research agenda based on my institution's demands.	**0.847**	0.197
My research agenda is aligned with my institution's research strategies.	**0.789**	0.207
My institution defines my research agenda.	**0.835**	0.211
I often decide my research agenda in collaboration with my field community.	0.210	**0.804**
My research agenda depends on the field community.	0.238	**0.827**
Society Driven scale	*1*	*2*
I decide my research topic based on societal challenges.	**0.867**	0.196
I choose my research topics based on my interactions with my non-academic peers.	0.243	**0.821**
I consider my research topics myself, but this consideration often occurs after I hear what my non-academic peers have to say about these topics.	0.137	**0.852**
Societal challenges drive my research choices.	**0.885**	0.253
I often strive to engage in issues that address societal challenges.	**0.871**	0.227
I consider the opinions of my non-academic peers when I choose my research topics.	0.287	**0.836**
Publish or Perish scale	*1*	
I do not choose research topics that receive poor project evaluations.	**0.653**	
I often choose research topics that lead to many publications.	**0.607**	
Publish or perish defines my research agenda.	**0.701**	
If research topics do not warrant the potential for many publications and citations, I do not choose them.	**0.748**	
My choice of research topics is aligned with expected research evaluations.	**0.749**	
My work is constrained by evaluation frameworks.	**0.592**	

Note: standardized loadings from Varimax rotation are reported. Bolded values indicate the factor with the highest loading.

Model Specification

From this section onwards, the holdout sample is used for the reported analysis. The initial specification strategy replicated the structure obtained during the CFA for the original version of the instrument for the changed scales (Horta & Santos, 2016), and replicated the structure obtained during the EFA stage (see the previous sub-section) for the new scales (Marôco, 2010). This specification resulted in a model with an

inadmissible solution due to a non-positive definite covariance matrix. This is a difficult issue to address, as it does not have a clear cause or method of diagnosis. In the literature, this is attributed to small sample sizes, insufficient numbers of manifest variables for each latent variable, misspecification of the model, and multicollinearity (Hair et al., 2007; Kline, 2016; Marôco, 2010). However, the issue needed to be resolved before proceeding with the analysis. As the sample for this exercise was not small and the recommended number of items per latent variable was met or exceeded in each case (Marôco, 2010), the only plausible remaining solutions were misspecification of the model or multicollinearity. As this was a CFA exercise, rather than path analysis, multicollinearity was somewhat expected and desirable (despite conceptual expectations of varying degrees of independence of some of the scales). Nevertheless, we speculated that there could be some degree of overlap leading to a misspecification issue. To diagnose this, we re-ran an EFA, but this time with the entire pool of items. The issue then became apparent. In the original validation exercise, some competing dimensions had loaded onto separate factors (Horta & Santos, 2016), but in this exercise they exhibited different behaviors. Some of the items in the Conservative scale loaded onto the same factor as the Convergence scale, while some items for the Convergence scale loaded onto the Divergence scale, albeit with a negative loading, while simultaneously exhibiting cross-loadings with the remaining items of the Convergence scale. This strongly suggests the redundancy of these scales, in the sense that Convergence/Divergence and Discovery/Conservative can be measured on a spectrum using a single scale rather than independent scales. As such, it was decided to remove the Convergence and Conservative scales entirely and instead measure these concepts through the Divergence and Discovery scales (i.e., lower scores for Divergence translate to higher scores for Convergence characteristics). An additional issue emerged in the new Publish or Perish scale, which exhibited substantial cross-loadings across the board, and thus was considered unviable for inclusion in the instrument. The removal of these scales addressed the issue and allowed an admissible solution to be estimated. An incidental benefit was that this further assisted the stated goal of reducing the number of items in the instrument.

The second step for specification was scanning for items with poor loadings (under 0.50), which indicate poor factorial validity (Kline, 2016; Marôco, 2010). The only

such item was one of the new items in the Discovery scale ("I invest most of my time in research that I believe is at the forefront of knowledge"), with $\lambda = 0.44$. All of the other items were above the required threshold. This item was removed, and the model was re-estimated.

The third step involved removing redundant items, in line with the stated goal of reducing the number of items. The main candidate scales for item reduction were Mentor Influence, Tolerance of Low Funding, and Discovery, all with six items each. Observing the MIs, it was evident that there were substantial within-scale correlations between the error terms for the respective items, suggesting the redundancy of some of these items and providing grounds for their removal. Although there is no consensus on the optimal number of items for measuring a latent factor, similar analyses have been carried out with as few as two manifest variables (Rammstedt & John, 2007). However, most scholars consider this to be the absolute minimum, with a recommended minimum of three (Hair et al., 2007; Marôco, 2010). We opted to reduce the number of items in these scales to four. We decided to remove the two worst performing items in each of the scales (due to either poor loadings or high cross-loadings). For the Tolerance of Low Funding scale, the two items removed were "I try not to worry about funding availability when I plan my research," with $\lambda = 0.65$, and "I think I can progress in my career doing research with limited funding," with $\lambda = 0.58$. For the Discovery scale, the items were "I have a preference for new research topics," with $\lambda = 0.62$, and "I prefer to work on topics that have a high degree of novelty," with $\lambda = 0.77$. Finally, for Mentor Influence, the removed items were "My PhD mentor's opinion carries much weight in my research choices," with $\lambda = 0.71$, and "My PhD mentor still often works alongside me," with $\lambda = 0.69$. In addition, one of the items on the Prestige sub-scale of the Scientific Ambition scale ("Standing out from the rest of my peers is one of my goals") performed somewhat worse than its peers, with $\lambda = 0.68$. As the Scientific Ambition scale was already measured by seven items (four for Prestige and three for Drive to Publish), we decided to also remove this item. After this round of removals, the model was re-estimated.

The fourth and final step was evaluating the MIs. This was a daunting task, as MI values are based on the χ^2 statistic (Whittaker, 2012). As noted in the methods section, this statistic was substantially inflated by the sample size, which also caused the MIs to

be inflated by proxy, resulting in trivial model changes to be flagged as highly significant by the MIs. Specifically, the threshold value of 11, which corresponds to a Type I error probability of 0.001 (Marôco, 2010), applied to nearly all of the proposed changes. We opted to implement modifications following the usual convention of creating covariances between error terms loading onto the same factor (Kline, 2016; Marôco, 2010), and evaluate the effective fit gain through the AFIs. Other than the within-factor error disturbances, two items were removed due to substantial cross-loadings evident from very high MI values, both from the Academia Driven scale: "I often decide my research agenda in collaboration with my field community" and "My institution defines my research agenda." As the χ^2 statistic could not be used to gauge the quality of the model changes, we opted to evaluate improvements through the CFI instead. For each implemented MI change, the model was re-estimated and re-evaluated in an iterative manner until a CFI above 0.950 was reached. This level is considered the highest possible qualitative threshold for model fit using this index (Hu & Bentler, 1999).

This multi-stage specification strategy yielded notable gains in model fit ($MECVI_{initial}$ = 1.941 *versus* $MECVI_{final}$ = 1.103), accomplished the goal of item reduction, and addressed all of the specification issues. The fit evaluation at each stage is summarized in Table 25.

Table 25: Model fit evaluation

Model	*GFI*	*CFI*	*PCFI*	*RMSEA*	*MECVI*
I	0.921	0.929	0.862	0.040	1.941
II	0.924	0.932	0.863	0.040	1.841
III	0.938	0.942	0.855	0.040	1.315
IV	0.950	0.953	0.850	0.037	1.103

Notes: Model I: initial admissible model; Model II: model without items with poor loading; Model III: model without redundant items; Model IV: model with MI implementations.

CFA

Full information ML was used to estimate the final model. For this final iteration, the model was as significant as the various trajectories ($p < 0.001$). Based on the fit evaluation, and using the common thresholds (Barrett, 2007; Hair et al., 2007; Hooper, Coughlan, & Mullen, 2008; Kline, 2016; Marôco, 2010), it was determined that the model

fit could be qualitatively assessed as very good (GFI = 0.950; CFI = 0.953; PCFI = 0.850; RMSEA = 0.037). Table 26 indicates the factorial loadings for the final model, and Figure 7 provides a visual representation of the model. Finally, Table 27 provides item-level descriptive statistics; from which it can also be observed that all of the items follow univariate normality, following Kline's (2016) criteria for skewness and the kurtosis thresholds.

Table 26: Factorial loadings for the MDRAI-R

Code	*Item*	*Loading*
A1	I aim to one day be one of the most respected experts in my field.	0.802
A2	Being a highly regarded expert is one of my career goals.	0.802
A3	I aim to be recognized by my peers.	0.704
A5	I feel the need to constantly publish new and interesting papers.	0.782
A6	I am constantly striving to publish new papers.	0.873
A7	I am driven to publish papers.	0.792
DV1	I look forward to diversifying into other fields.	0.720
DV2	I would be interested in pursuing research in other fields.	0.781
DV4	I would like to publish in different fields.	0.737
DV5	I enjoy multi-disciplinary research more than single-disciplinary research.	0.851
DV6	Multi-disciplinary research is more interesting than single-disciplinary research.	0.877
DV8	I prefer to work with multi-disciplinary rather than single-disciplinary teams.	0.874
COL2	My publications are enhanced by collaboration with other authors.	0.604
COL4	I often seek peers with whom I can collaborate on publications.	0.655
COL5	I enjoy conducting collaborative research with my peers.	0.734
COL7	My peers often seek to collaborate with me in their publications.	0.741
COL8	I am often invited to collaborate with my peers.	0.908
COL12	I am frequently invited to participate in research collaborations due to my reputation.	0.827
M2	Part of my work is largely due to my PhD mentor.	0.787
M3	My research choices are highly influenced by my PhD mentor's opinion.	0.852
M4	My PhD mentor is responsible for a large part of my work.	0.892
M6	My PhD mentor largely determines my research topics.	0.931
TTLF1	Limited funding does not constrain my choice of topic.	0.822
TTLF2	Highly limited funding does not constrain my choice of topic.	0.865
TTLF3	The availability of research funding for a certain topic does not influence my decision to conduct research on that topic.	0.696
TTLF4	I am not discouraged by the lack of funding on a certain topic.	0.616
D2	I would rather conduct revolutionary research with little chance of success than replicate research with a high probability of success.	0.684
D3	I prefer "innovative" research to "safe" research, even when the odds of success are much lower.	0.687
D4	I would rather engage in new research endeavors, even when success is unlikely, than safe research that contributes little to the field.	0.701
D9	I am driven by innovative research.	0.678
O1	My choice of topics is determined by my field community.	0.600
O9	I often decide my research agenda in collaboration with my field community.	0.803
O6	I adjust my research agenda based on my institution's demands.	0.759
O7	My research agenda is aligned with my institution's research strategies.	0.733
S1	I decide my research topic based on societal challenges.	0.807
S4	Societal challenges drive my research choices.	0.904
S5	I often strive to engage in issues that address societal challenges.	0.843
S2	I choose my research topics based on my interactions with my non-academic peers.	0.769
S3	I consider my research topics myself, but this consideration often occurs after I hear what my non-academic peers have to say about these topics.	0.732
S6	I consider the opinions of my non-academic peers when I choose my research topics.	0.868

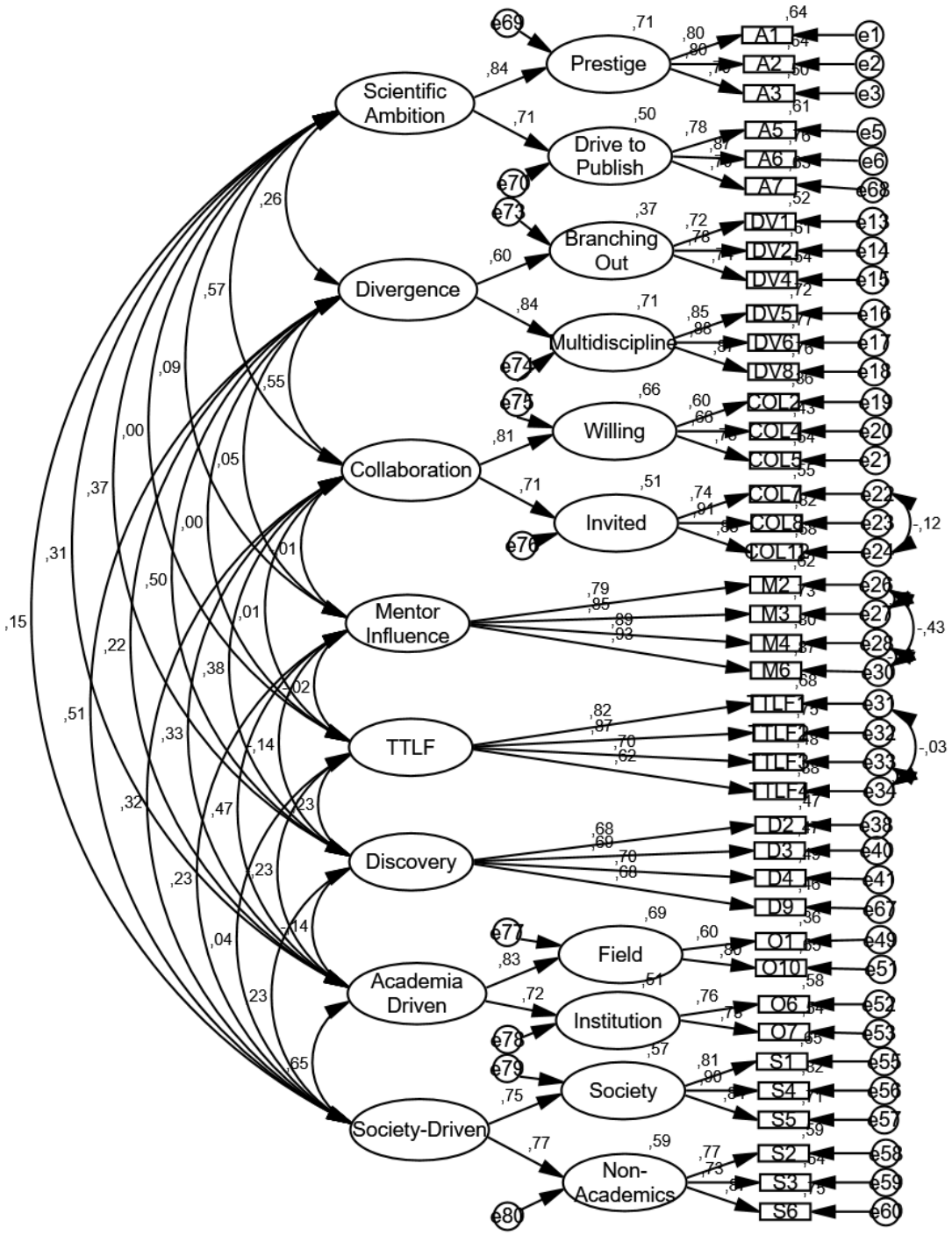

*Figure 7***:** CFA model for the MDRAI-R.

Table 27: Item-level descriptive statistics

Code	*Item*	*Mean*	*Std Dev*	*Skewness*	*Kurtosis*
A1	I aim to one day be one of the most respected (…)	4.858	1.380	-0.364	-0.003
A2	Being a highly regarded expert is one of my (…)	5.168	1.321	-0.615	0.343
A3	I aim to be recognized by my peers.	5.135	1.142	-0.559	0.993
A5	I feel the need to constantly publish new (…)	5.046	1.243	-0.553	0.448
A6	I am constantly striving to publish new papers.	5.009	1.237	-0.473	0.373
A7	I am driven to publish papers.	5.033	1.265	-0.595	0.621
DV1	I look forward to diversifying into other fields.	4.987	1.286	-0.515	0.272
DV2	I would be interested in pursuing research (…)	4.818	1.205	-0.498	0.553
DV4	I would like to publish in different fields.	4.769	1.166	-0.431	0.546
DV5	I enjoy multi-disciplinary research more than (…)	5.305	1.227	-0.498	0.151
DV6	Multi-disciplinary research is more interesting (…)	5.297	1.209	-0.513	0.364
DV8	I prefer to work with multi-disciplinary rather (…)	5.136	1.238	-0.431	0.194
COL2	My publications are enhanced by collaboration (…)	5.885	1.179	-1.257	2.062
COL4	I often seek peers with whom I can collaborate (…)	4.919	1.275	-0.484	0.244
COL5	I enjoy conducting collaborative research with (…)	5.572	0.990	-0.503	1.093
COL7	My peers often seek to collaborate with me in (…)	4.832	1.143	-0.391	0.535
COL8	I am often invited to collaborate with my peers.	4.901	1.126	-0.445	0.734
COL12	I am frequently invited to participate in (…)	4.777	1.200	-0.394	0.409
M2	Part of my work is largely due to my PhD mentor.	3.403	1.678	0.166	-0.829
M3	My research choices are highly influenced by (…)	3.063	1.567	0.355	-0.537
M4	My PhD mentor is responsible for a large part (…)	2.776	1.543	0.554	-0.323
M6	My PhD mentor largely determines my (…)	2.645	1.504	0.607	-0.205
TTLF1	Limited funding does not constrain my choice (…)	4.119	1.761	-0.016	-0.986
TTLF2	Highly limited funding does not constrain my (…)	4.033	1.660	-0.005	-0.856
TTLF3	The availability of research funding for (…)	4.214	1.499	-0.022	-0.644
TTLF4	I am not discouraged by the lack of funding on (…)	4.475	1.449	-0.327	-0.356
D2	I would rather conduct revolutionary research (…)	4.812	1.273	-0.112	-0.271
D3	I prefer “innovative” research to “safe” (…)	5.101	1.223	-0.379	0.008
D4	I would rather engage in new research (…)	4.937	1.167	-0.249	0.158
D9	I am driven by innovative research.	5.237	1.025	-0.260	0.542
O1	My choice of topics is determined by my field (…)	4.220	1.414	-0.229	-0.368
O9	I often decide my research agenda in (…)	4.271	1.271	-0.384	0.050
O6	I adjust my research agenda based on my (…)	3.789	1.525	-0.062	-0.696
O7	My research agenda is aligned with my (…)	4.253	1.393	-0.364	-0.135
S1	I decide my research topic based on societal (…)	4.545	1.509	-0.431	-0.297
S4	Societal challenges drive my research choices.	4.452	1.453	-0.454	-0.173
S5	I often strive to engage in issues that address (…)	4.564	1.404	-0.442	-0.033
S2	I choose my research topics based on my (…)	3.623	1.422	0.030	-0.444
S3	I consider my research topics myself, but (…)	3.644	1.412	-0.026	-0.483
S6	I consider the opinions of my non-academic (…)	3.754	1.426	-0.162	-0.502

In addition to the factorial loadings, initial insights regarding the interplay of the various dimensions can be obtained by observing the correlations in Figure 7. First, a moderately strong correlation can be observed between the Academia-Driven and Society-Driven scales (r = 0.646). A possible explanation is that institutions (and indeed the academy) currently place emphasis on society-focused research, causing them to be somewhat aligned, even if they are still independent (and, as mentioned in the pilot study

section, sometimes at odds with each other). The Society-Driven scale also exhibits a moderate correlation with Divergence (r = 0.508), which suggests either that the society-focused challenges are requiring more multidisciplinary approaches or that researchers who have a preference for diverging research are also more likely to engage in society-driven research. Divergence also exhibits a moderate correlation with Discovery (r = 0.503), which is expected because these two agendas are core traits of the trailblazing doctrine that was identified in the previous iteration of the MDRAI (Santos & Horta, 2018). Similarly, Collaboration exhibits moderate correlations with Scientific Ambition (r = 0.568) and Divergence (r = 0.554), and thus also resonates with the characteristics of the trailblazing doctrine. Several other correlations, which are not covered here but are relatively easy to interpret, can be identified, but they are not as strong. Overall, the observed correlational matrix can provide insights into how to use the MDRAI-R in future studies.

Validity, Reliability, and Sensitivity

Three types of validity were assessed in this study: factorial validity, convergent validity, and discriminant validity (Hair et al., 2007; Marôco, 2010). James Gaskin's Stats Tool Package (2016), specifically the Validity Master macro, was used for the assessment. This also reflects the same types of validity evaluated in the validation exercise for the first version of the MDRAI. *Factorial validity* can be attained when the standardized loadings for all items exceed the 0.50 threshold (Marôco, 2010). One of the steps in the previous section ensured that this criterion was met, so the model had factorial validity.

The second type, *convergent validity*, relates to high loadings from the manifest variables onto the latent variables, and is evaluated through the average variance extracted (Fornell & Larcker, 1981). The AVE for a given factor is given by:

$$\widehat{AVE_J} = \frac{\sum_{i=1}^{k} \lambda_{ij}^2}{\sum_{i=1}^{k} \lambda_{ij}^2 + \sum_{i=1}^{k} \varepsilon_{ij}}$$

Based on this calculation, convergent validity is confirmed when the AVE exceeds the 0.50 threshold (Hair et al., 2007). This was the case for all of the factors, with the

exception of Discovery, with a slightly lower AVE of 0.473. Although this could conceivably have been increased by eliminating the lowest-loading item, a minor shift from the threshold is likely to be irrelevant at a practical level. Therefore, we argue that convergent validity was largely demonstrated, although the abovementioned issue must be taken into consideration when using the Discovery scale. We proceeded by evaluating the *discriminant validity*, which reflects the degree of extra-factorial correlation. Discriminant validity is demonstrated when the square root of the AVE for a given pair of factors *i* and *j* is equal to or greater than the correlations between those two factors. Furthermore, the AVE must be equal to or greater than both the maximum shared variance (MSV) and the average shared variance (ASV) (Fornell & Larcker, 1981; Hair et al., 2007; Marôco, 2010). All of the factors met this criterion, demonstrating the discriminant validity of the instrument.

Following the validity evaluation, we proceeded with the analysis of *reliability*, which is a measure of consistency (Marôco, 2010). This was done using the composite reliability (CR) (Fornell & Larcker, 1981), which for a given factor *j* with *k* items is given by:

$$\widehat{CR}_j = \frac{(\sum_{i=1}^{k} \lambda_{ij})^2}{(\sum_{i=1}^{k} \lambda_{ij})^2 + \sum_{i=1}^{k} \varepsilon_{ij}}$$

The proposed threshold of 0.7 is considered to indicate scale reliability (Hair et al., 2007). All of the factors exceeded the required threshold, with the exception of Divergence (CR = 0.695). However, as before, a millesimal difference is likely to be trivial. Despite this slight deviation, the instrument can be considered reliable. Table 28 summarizes the validity and reliability findings, and the correlations between the factors.

Table 28: Validity and Reliability evaluation

					Correlations							
	CR	*AVE*	*MSV*	*ASV*	*Ambi*	*Acad*	*Soci*	*Disc*	*TTLF*	*Ment*	*Coll*	*Dive*
Ambition	0.751	0.604	0.323	0.094	0.777							
Academia	0.750	0.601	0.417	0.138	0.314	0.775						
Society	0.732	0.577	0.417	0.130	0.152	0.646	0.760					
Discovery	0.782	0.473	0.253	0.097	0.370	-0.139	0.234	0.688				
TTLF	0.840	0.572	0.052	0.015	-0.004	-0.229	0.037	0.228	0.756			
Mentor	0.924	0.752	0.222	0.043	0.094	0.471	0.227	-0.136	-0.024	0.867		
Collab	0.738	0.586	0.323	0.141	0.568	0.331	0.323	0.381	0.013	-0.010	0.766	
Divergence	0.695	0.539	0.307	0.134	0.257	0.219	0.508	0.503	-0.003	0.052	0.554	0.734

Note: the diagonal of the correlation matrix indicates the square root of the AVE.

The final factor is *sensitivity*, which refers to the capability of an instrument to differentiate between two individual items. This is demonstrated when all of the individual items have a reasonably normal distribution (Marôco, 2010). Items are considered to have a reasonable approximation to the normal distribution when their skewness and kurtosis are under the absolute value of 3 (Kline, 2016). All of the items were below this threshold for both parameters, thus demonstrating the sensitivity of the instrument and completing the validation exercise.

Measurement Invariance

In this step, the goal was to assess and eventually demonstrate measurement invariance across the major fields of knowledge. The fields of knowledge were the Exact and Natural Sciences, Health and Medical Sciences, Engineering and Technology, Social Sciences, and Humanities. Measurement invariance indicates that the operationalization of a construct has the same meaning in different contexts (Meade & Lautenschlager, 2004). In other words, its metric is universal wherever invariance is tested. To achieve this, we used a multi-group analysis following the procedure outlined by Marôco (2010) and Kline (2011), which involves comparing the unconstrained model with progressively more constrained models. Typically, this is done using χ^2 tests for difference. However, as noted in the literature and observed in our own dataset, this statistic becomes unreliable with larger samples, as all trivial differences are deemed to be significant (Chen, 2007; Cheung & Rensvold, 2002; Kline, 2016; Meade, Johnson, & Braddy, 2008; Putnick &

Bornstein, 2016). Scholars have proposed using AFI in these scenarios instead (Putnick & Bornstein, 2016). Cheung and Rensvold (2002) propose that a CFI change of less than 0.01 indicates measurement invariance. Thus, we estimated the multi-group analysis for fields of knowledge using progressive levels of constraints, based on the hypotheses for testing measurement invariance proposed by Cheung and Rensvold (2002) and following the guidelines recommended by Milfont and Fischer (2010).

We began by testing hypothesis H_{λ}. Metric invariance was demonstrated for the first model, with a ΔCFI of 0.000 (Model II), indicating that the constructs manifest identically across fields of knowledge (Cheung & Rensvold, 2002). For the next hypothesis, $H_{\Lambda,\Theta(\delta)}$, residual variances and covariances were also demonstrated, with a ΔCFI of 0.002 (Model III), indicating that the internal consistency is identical across the fields of knowledge (Cheung & Rensvold, 2002). The threshold for hypothesis $H_{\Lambda,v}$, scalar invariance, was not met, with a ΔCFI of 0.012 (Model IV). Following the guidelines in the literature for best practice in testing measurement invariance, we then tested for partial scalar invariance (Byrne, Shavelson, & Muthén, 1989; Cheung & Rensvold, 2002; Milfont & Fischer, 2010). This required us to determine which intercepts varied to the greatest degree across the fields of knowledge. Due to the large number of intercepts and groups, a more efficient method than simple visual inspection of the intercept matrix was required. We computed the square root of the sum of the squared differences for each pair of intercepts to identify which intercepts had the largest cross-field of knowledge discrepancies. These intercepts lay in two scales: Tolerance of Low Funding and the new Society Driven scale. This finding can be explained as follows. For Tolerance of Low Funding, it could relate to the widely varying availability of funding across the fields of knowledge, leading to different levels of risk tolerance (Lanahan, Graddy-Reed, & Feldman, 2016; Mejia & Kajikawa, 2018). Similarly, for the Society Driven scale, the finding could relate to the difference between basic and applied research, as basic research has lower levels of Society Driven research agenda characteristics than applied research (see Bentley, Gulbrandsen, & Kyvik, 2015).

Having identified the source of variance, we allowed these intercepts to vary freely across the fields of knowledge and proceeded with the analysis, as per the guidelines provided by Milfont and Fischer (2010). The new model met the threshold for

partial scalar invariance, with a ΔCFI of 0.008 (Model V), indicating scalar invariance for all of the scales except Tolerance of Low Funding and Society Driven. The next level of invariance is at the construct level. The next model constrained the construct variances and covariances, and tested hypotheses $H_{\Lambda,\Theta(jj)}$ and $H_{\Lambda,\Theta(jj')}$. The equivalence of construct variance and covariance was not demonstrated, with a ΔCFI of 0.011 (Model VI), indicating that the range of responses and relationships between the constructs were not identical across the groups. Finally, the last model tested for differences in the latent means (hypothesis $H_{\Lambda,\nu,\kappa}$), which were demonstrated with a ΔCFI of 0.000 (Model VII). As such, measurement invariance was demonstrated for the instrument, with full metric, scalar, and partial construct invariance for all of the scales except Tolerance of Low Funding and Society Driven, which nevertheless still possessed metric invariance. The results of the model comparison are summarized in Table 29. Finally, the descriptive statistics for each factor and for each field of knowledge are presented in Table 30.

Table 29: Comparison of unconstrained and constrained models

Model	*Hypothesis*	*Constraints*	*Level*	*CFI*	*ΔCFI*
I		Unconstrained	-	0.946	-
II	H_{λ}	Factor loadings	Metric	0.946	0.000
III	$H_{\Lambda,\Theta(\delta)}$	Residuals (co)variance	Metric	0.944	0.002
IV	$H_{\Lambda,\nu}$	Intercepts	Scalar	0.932	0.012
V	$H_{\Lambda,\nu}$	Intercepts (Partial)	Scalar	0.938	0.008
VI	$H_{\Lambda,\Theta(jj)}$ / $H_{\Lambda,\Theta(jj')}$	Construct (co)variance	Construct	0.935	0.011
VII	$H_{\Lambda,\nu,\kappa}$	Latent means	Construct	0.935	0.003

Notes: ΔCFI is calculated with reference to less constrained models using the guidelines in Cheung and Rensvold (2002). Although Cheung and Rensvold (2002) indicate equivalence of construct variance and equivalence of construct covariance as separate hypotheses, they were merged for this exercise. This is a technical limitation as the AMOS software package bundles these two constraints together.

Table 30: Descriptive statistics for all factors and sub-factors across fields of science

	N&A		*E&T*		*M&H*		*SS*		*H*	
Factor	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Scientific Ambition	5.017	0.945	5.007	0.953	5.068	0.916	5.071	0.993	5.054	0.956
Prestige	5.001	1.107	5.084	1.078	5.103	1.053	5.029	1.126	5.100	1.139
Drive to Publish	5.033	1.085	4.929	1.110	5.033	1.066	5.112	1.129	5.008	1.120
Divergence	5.002	0.934	5.195	0.858	5.060	0.849	4.971	0.959	5.054	0.958
Branching Out	4.858	1.010	5.025	0.959	4.730	1.026	4.834	1.062	4.953	1.046
Multidisciplinarity	5.147	1.163	5.365	1.050	5.391	1.043	5.108	1.169	5.155	1.167
Collaboration	5.133	0.824	5.040	0.768	5.289	0.779	5.144	0.868	4.861	1.043
Willing to Collab.	5.432	0.913	5.369	0.851	5.593	0.848	5.470	0.964	5.083	1.173
Invited to Collab.	4.833	1.012	4.711	0.963	4.985	0.960	4.818	1.091	4.638	1.167
Mentor Influence	2.847	1.373	3.134	1.420	3.085	1.384	2.879	1.439	2.701	1.411
TTLF	4.138	1.302	4.185	1.255	3.975	1.278	4.501	1.361	4.752	1.343
Discovery	5.010	0.927	5.080	0.864	4.971	0.894	5.026	0.952	5.113	0.934
Academia Driven	3.970	1.052	4.193	0.966	4.226	0.970	3.892	1.039	3.702	1.117
Field	3.982	1.163	4.199	1.088	4.269	1.116	3.963	1.171	3.819	1.270
Institution	3.959	1.326	4.186	1.234	4.184	1.224	3.822	1.304	3.585	1.349
Society Driven	3.658	1.187	4.204	0.975	4.208	0.989	4.373	1.063	4.170	1.125
Society	4.021	1.421	4.532	1.192	4.639	1.197	4.939	1.221	4.631	1.389
Non-Academics	3.296	1.244	3.876	1.149	3.777	1.165	3.807	1.260	3.709	1.206

Notes: N&A – Natural and Agricultural Sciences; E&T – Engineering and Technology; M&H – Medical and Health sciences; SS – Social Sciences; H – Humanities.

Discussion

In this section, the various scales and their scoring are interpreted. We first discuss the scales, and then focus on the scoring. To calculate composite scores for each scale, there are numerous options to choose from (DiStefano, Zhu, & Mindrila, 2009). As with the initial version of the MDRAI, simple summation is discouraged due to the unbalanced number of items across the factors. Although this was one of the goals of this revision, it was unfortunately not possible to do so and maintain the validity of the scale. Therefore, the score range varied across the scales, making direct comparison difficult. The simplest alternative way of computing the composite scores, and the approach we encourage for general use, is to calculate the mean score of the items in each scale. This yields a

composite non-discrete score ranging from 1 to 7. In addition, the mean for each item can be weighted using the factor loadings provided in Table 26. Scores can be computed either for the first-order factors or for the second-order factors, depending on the specific research purposes.

The Scientific Ambition dimension retained the same importance as it had in the MDRAI, including that of its sub-dimensions (Prestige and Drive to Publish), stressing the relevance of engaging in research agendas that can provide recognition for one's work from peers and help to achieve positions of intellectual and field authority in the knowledge communities of interest (Latour & Woolgar, 2013; Whitley, 2000). The Collaboration dimension and its sub-dimensions (Willing to Collaborate and Invited to Collaborate) also retained critical importance in the MDRAI-R, which demonstrates an understanding that collaborative agendas are necessary in all fields of knowledge, and that collaborating or not with peers is a key decision when embarking on new research agendas (Siciliano, Welch, & Feeney, 2018). Higher scores for the dimensions and the respective sub-dimensions mean that the relevance of these factors to the research agenda is more important for researchers, e.g. a higher score for Scientific Ambition means that researchers privilege this dimension when developing their research agendas.

The Tolerance of Low Funding and Mentor Influence dimensions also appear to be critical in influencing the research agendas of researchers, as they were in the MDRAI. Higher scores for Tolerance of Low Funding indicate that researchers are not discouraged by a lack of available funding from pursuing specific research agendas, meaning that they do not place an emphasis on research funding when deciding on a research agenda, while lower scores for this dimension indicate that researchers consider research funding to be a critical element when deciding on specific research agendas. We further argue that a median score in this dimension can indicate that in some cases researchers follow research funding when opting for specific research agendas, but not in others. This scoring could also indicate that researchers are willing to engage in exploratory research agendas that have little to no funding as a way to obtain initial findings that could allow them to then prepare research agendas of greater scope, ambition, and focus that might need research funding to come to fruition. A higher score for Mentor's Influence suggests that the PhD supervisor continues to have a say in or a degree of influence on a researcher's research

agenda, while the opposite means that the researcher embarks on research agendas without requesting their PhD supervisor's guidance or opinion. These scores can be a proxy for researcher independence, but can also be understood as a measure of a researcher's relationship with his or her PhD supervisor after completing a doctorate (Ooms et al., 2018).

The Discovery dimension in the MDRAI-R combines the MDRAI dimensions of Discovery and Conservative into a single dimension, as discussed in the main study section, thereby placing the previously independent dimensions on a continuum. The higher the score for the Discovery dimension, the more likely the researcher is to engage in research agendas that are riskier, and focus on emerging and unexplored themes that have greater potential for breakthroughs but also for failure. Santos and Horta (2018) characterize researchers with high Discovery score research agendas as trailblazers, and Foster et al. (2015) characterize these researchers as having innovative research strategies. A lower score in this dimension indicates a preference for low risk research agendas that are more focused on the gradual accumulation of knowledge in well-established themes, topics, and fields. Santos and Horta (2018) characterize researchers with low Discovery score research agendas as cohesive, and Foster et al. (2015) characterize them as having traditional research strategies. The Divergence dimension maintained the same structure as in the MDRAI, including its sub-dimensions (Branching out and Multidisciplinary), but similar to the Discovery dimension, it also combined the MDRAI dimensions of Divergence and Convergence into a one-dimension continuum. A higher score in the Divergence dimension means that researchers establish research agendas that link and involve knowledge from other fields of knowledge, and are attuned to the current needs of complex problems (Zuo & Zhao, 2018). Lower scores in this dimension indicate research agendas bounded by a single field of knowledge, and are associated with specialization, knowledge mastery, field identity, and a focus on one or few topics rather than diversification (Franzoni & Rossi-Lamastra, 2017).

The first new dimension of the MDRAI-R is Academia Driven, which refers to the extent to which a research agenda is influenced by holistic, valuative, and normative traits and dispositions related to the scholarly and academic environment and social structure with which the researcher identifies. The higher the score in this dimension, the

more the research agenda conforms to and is aligned with the questions, topics, and strategic focuses that the academic environment might regard as a priority. A lower score in this dimension indicates that a research agenda is more based on personal interests and is not as affected by the scholarly and academic environment. This dimension has two sub-dimensions. The Field sub-dimension refers to the extent to which the research agenda is influenced by scientific priorities that the field community determines by consensus (Becher & Trowler, 2001; Collins, 1994). A higher score for this sub-dimension means that the research agendas are more influenced by a community priority focus. The other sub-dimension, Institution, refers to the propensity of researchers to align their research agendas with the strategic research targets of their institutions. The higher the score for this sub-dimension, the greater this propensity will tend to be, while the lower the score, the greater the likelihood that the research agenda will be affected by institutional constraints. This propensity is expected to vary according to the sector in which the researcher is working (e.g., academia, industry, government, non-profit sector) and the career stage of the researcher, such that younger, untenured, and contract-based researchers will be more affected by institutional constraints (Giroux, 2015).

The second new dimension in the MDRAI-R is Society Driven, which measures the likelihood that a research agenda aims to solve challenges in society. The higher the score for this dimension, the greater the focus on such challenges, while the lower the score, the lesser the focus on such challenges. This dimension has two sub-dimensions. The first sub-dimension is Society, which refers to the incidence of society related challenges in a research agenda, while the second sub-dimension, Non-academics, measures the influence and participation of laymen and non-experts in the design of a research agenda. The higher the score for this sub-dimension, the greater the likelihood of engaging with non-research communities in an "action research community" or "participatory research" (Mendes et al., 2016; Wooltorton et al., 2015). These two sub-dimensions reflect the possibility of having a society-focused research agenda that does not involve collaboration with non-expert communities.

Conclusion

This study refines, extends, and optimizes the original MDRAI, which mostly focuses on the social sciences. Our revised MDRAI-R includes new dimensions and fewer items per dimension, and expands the scope and applicability of the inventory to all fields of knowledge. The new version exhibits good psychometric properties and satisfactory validity, reliability, and sensitivity. Furthermore, our measurement invariance analysis indicates that the model can be applied equally to all fields of knowledge, thus broadening its scope of application. The new dimensions (Academia Driven and Society Driven) provide new angles for assessing research agendas. This reinforces the usefulness of the instrument by allowing for cross-field studies while also identifying agendas with possible societal impact. Thus, in addition to being of interest to individual researchers, our instrument will be of value to policy makers, research funding agency strategists, and university and research organization leaders. In particular, the updated instrument will enable them to better characterize their research teams, and create incentives that can add value to their research. The final validated version is provided as an appendix to this study (Appendix G). The items are presented in no specific order and randomization is recommended before application to ensure that the gamification or fixed structuring of the questions does not result in biased responses.

This study has the following limitations. First, as with all perception-based measures, there is a risk of bias from the participants, and this possibility needs to be considered when reviewing the response data, especially with smaller samples. Second, the Academia Driven sub-scales are represented by only two items each. Although this is acceptable and not uncommon, it must be noted that this is the absolute minimum number of items possible per factor. Thus, care should be taken when using the sub-scales alone rather than the overall Academia Driven measure, especially when data are missing. An additional limitation is that we could not test the external validity with current data. This is something we plan to address in future studies. Finally, some minor issues were identified with the convergent validity of the Discovery scale, and with the reliability of the Divergence scale. Although these are only decimal and millesimal deviations

(respectively), they should still be noted, even though the practical impacts are likely to be negligible.

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Chapter 9
Conclusion

A summary of the findings thus far

In Chapter 2, we covered the development of a new instrument aimed at measuring various facets of research agendas. Understanding the process underlying research agenda setting is crucial given the role research has in the creation of knowledge (Pump, 2011). Preferences associated to research agenda setting by individual researchers is something which is mostly unexplored by the literature (Harris, 2001) and, to the best of our knowledge, no instrument of this kind existed prior to the current project. This also required the creation of an underlying framework. To this end, a great deal of fragmented literature had to be pieced together in order to create a meaningful framework that could both contribute to the literature and to provide policy and practical implications. The final framework and corresponding instrument are comprised of eight distinct dimensions. The first one, *Scientific ambition*, represents the drive to publish and attain recognition in one's field or beyond. The second, *Convergence*, reflects one's preference for single-discipline approaches, putting greater emphasis into the development of mastery in a single field. It stands in opposition to *Divergence*, which represents the preference for expansion towards other disciplinary fields and topics, including those of a multidisciplinary nature. The fourth dimension, *Discovery*, indicates a preference for research in riskier topics which also have the potential for greater breakthroughs, while the fifth dimension, *Conservative* – which stands in opposition to Discovery – represents a preference for more stable endeavors, likely in more mature topics. *Collaboration* is the sixth dimension and represents both availability and opportunity to engage in collaborate ventures with other researchers. Following this is *Mentor Influence*, which reflects the degree to which the individual's research is influenced by his or her mentor. Finally, *Tolerance to Low Funding* is a measure of risk propensity in what regards funding availability. This instrument and framework were employed in subsequent Chapters. The development of this instrument has uses beyond the scope of the current thesis. For academics, it will open new avenues of research in the fields of Science and Technology and Higher Education, by allowing old issues to be tackled from a new perspective (similarly to what was done in the following chapters of this thesis). Outside of academia, it can be useful for policy-makers, research managers, heads of research institutions, and

other individuals looking for new ways to either better understand or evaluate their research teams.

Chapter 3 focused on the development of another framework and instrument, but one which covered the organizational aspects of the research workplace. Although instruments to evaluate organizational aspects already existed, none were developed with academic settings in mind – and this is a reality which substantially differs from corporate settings, as researchers have to deal with issues such as securing research grant funding, balancing the teaching-research- nexus, supervise and teach students at graduate and undergraduate levels, and engage in service towards the civic community (Henkel, 2000; Horta, Dautel, & Veloso, 2012; Young, 2015). The lack of an instrument developed specifically for the reality of academic settings is something which has been noted in the literature (Blackburn & Lawrence, 1995; Tigelaar, Dolmans, Wolfhagen, & Van der Vleuten, 2004). Drawing inspiration from organizational studies (such as Avolio, Zhu, Koh, & Bhatia, 2004; Chiok Foong Loke, 2001; Dirani & Kuchinke, 2011; Meyer & Allen, 1991; Mowday, Steers, & Porter, 1979), it adapted several classical variables and concepts – such as organizational commitment, leadership, and satisfaction - to the realities of working in the academia. The first dimension contained in the instrument is *Organizational Commitment*, which is better defined by its constituent sub-dimensions – *Willingness to Stay*, reflecting the individual's desire to remain in his organization; *Belonging*, reflecting his sense of effectively belonging there; and *Satisfaction with the Leadership*, which reflects the degree to which he or she is satisfied with the decisions and behavior of the institutional leadership. The next top-level variable is *Funding/Resources*[11], which represents the individual's perception of available resources (mostly of a financial nature). Following this is *Social Satisfaction*, which is a measure of how the individual is satisfied with his or her interactions with peers and colleagues. The final two dimensions are perhaps the most important; *Autonomy* refers to the degree of autonomy the individual has in his or her work; and *Unconstraint*, which represents the lack of bureaucratic constraints on the pursuit of such work. Beyond the scope of this

[11] Both the terms "Funding" and "Resources" are used to describe this dimension and are used interchangeably in their published forms due to comments and requests from reviewers.

thesis, the development of this instrument allows researchers to expand their academic research into and beyond the organizational setting of universities (including those doing creative work and research in industrial and public laboratories), and is also useful for institutions to measure several key dimensions of their workplace setting.

In Chapter 4, we aimed to determine the existence of overarching archetypes or doctrines of research agendas, using the framework developed in Chapter 2. This study employed cluster analysis and determined the existence of two such doctrines. The first one, which we named "Trailblazing", represents individuals who are more oriented towards discovery-driven agendas, who have a higher tolerance to the lack of funding, have a higher independence from their mentors, higher levels of ambition, and prefer work of a more multidisciplinary and collaborative nature. The second doctrine, which we named "Cohesive", is comprised of individuals who pursue more stable agendas, gravitating towards established fields where funding is more available, and favor mastery in one field over branching out into many. They are also more influenced by their respective mentors, and less drawn to collaborative work. Interestingly, we noted that Trailblazers comprised roughly one third of the sample, with Cohesives accounting for the remaining two thirds. These findings somewhat resonate with Kuhn (2012)'s ideas on scientific revolution. An analogy could be traced between Cohesive agendas and the practitioners of "normal science", i.e., those who operate under the dominant paradigm, and between Trailblazing agendas and the practitioners of "extraordinary science", i.e., the conductors of scientific revolution towards the emergence of a new paradigm. Although this interpretation was further expanded in the relevant chapter, some remarks can be added here in post-script form. Notably, Kuhn considered the emergence of extraordinary science as the result of a crisis arising from anomalies which could no longer be explained under the current paradigm. As far as we know, in the field of Higher Education – from which the sample used was drawn – no crisis of such nature currently exists. Thus, this analogy – although useful for illustrating what these doctrines can theoretically be – might be somewhat limited in practical implementation, especially given that some critics of Kuhn's work consider his proposed process of scientific revolution to no longer apply to modern science, suggesting that it now follows a more

linear path of accumulation rather than disruption (Hacking, 2012). Let us consider how both opposing perspectives can apply to the interpretation of these findings.

If Kuhn (2012)'s perspective is correct, then – as mentioned before – cohesive agendas clearly align with the notion of normal science, and trailblazing agendas represent extraordinary science. A possible pitfall in this interpretation is that Kuhn considered that normal science does not "co-exist" with extraordinary science, except in certain bastions of stubbornness where scientists refuse to accept the emergence of a new paradigm – indeed, Kuhn considers that these individuals cease being scientists at this point (since they no longer operate within the agreed-upon fundamentals), and the new paradigm only completely takes hold when the older generation of scientists – including those who refuse to change their fundamentals – literally dies. As mentioned before, as far as we know this does not reflect the current reality of the field of Higher Education, but it can certainly apply in other fields. Nevertheless, adopting Kuhn's perspective to our findings means that, necessarily, normal science is co-existing with extraordinary science. This does lead to some credibility to Hacking (2012)'s argument of linearity over revolution; under this interpretation, what is occurring is that researchers following trailblazer agendas are pushing science forward, while researchers pursuing cohesive agendas are consolidating existing knowledge. There is an appeal to this simple interpretation, and it may make more sense in the social sciences and humanities; however, as we will demonstrate in the following paragraph, it falls apart if we focus on what is going on in the field of physics.

Incidentally, most of the practical examples given by Kuhn (2012) in his work concerned the field of physics, as that was his area of expertise. An example of a scientific revolution in Kuhn's view is the Copernican Revolution – although Copernicus created a cosmological model which competed with the Ptolemaic model, it was initially dismissed and only accepted as a new paradigm later on, following the works of Galileo and Newton. At this point, only the most stubborn of individuals would believe geocentrism over heliocentrism. If Hacking is correct, then revolutions of this sort would no longer occur in modern day science. However, this somewhat ignores the current state of affairs in physics, where competing, mutually exclusive models currently exist which are both correct given our current understanding of physics – which is, of course, a paradox – and

we argue that this would be the very definition of an anomaly under Kuhn's view. Currently, physics operates under two simultaneous paradigms – the quantum field theory, and by extension the Standard Model, which is the operating framework for three out of the four known fundamental forces in physics (notably, strong interactions, weak interactions, and electromagnetism) (Oerter, 2006); and general relativity, which describes how gravity – the fourth fundamental force - operates (Einstein, 1915). Individually, each model has been proven correct, but the mathematics of one have been found to be incompatible with the other – linking these models would lead to the creation of the Theory of Everything – arguably, the ultimate scientific revolution (Weinberg, 1994). Attempts at solving this paradox have led to the creation of alternative theories such as String Theory, which – although promising – have failed to solve the existing tension due to over-inflation in term of complexity, to the point where they can no longer be considered testable and falsifiable with current means; some critics question whether these remain scientific theories at this point (Woit, 2001).

Thus, it might be that in some fields of knowledge, science is now progressing linearly, while others are still in need of revolutions to advance. Or, as we proposed in Chapter 4, revolutions can still be occurring, albeit at a much smaller scale. If this is the case, then it further highlights the need of both cohesive and trailblazing agendas. Although we have done our best effort to outline interpretations for these doctrines from opposing perspectives, at this point we can only speculate if they emerge in the same manner in other fields, and this is something which warrants further research.

Chapter 5 delves into the realm of cognition and aims to relate it with research agendas. This is crucial because it covers the personal level in Bandura's triadic reciprocity framework (Bandura, 1986); cognition in particular is expected to hold some degree of influence over the individual's research agenda setting since this process is largely related to intellectual tasks. In this chapter, we used Sternberg (1986)'s model of thinking styles – which represent, broadly speaking, modes of thinking – to ascertain whether cognition has an impact on the choice of research agendas. The chapter was developed in close collaboration with Li-fang Zhang, who has further developed the thinking styles model created by Sternberg and is currently the utmost worldwide authority on the topic. We determined that Type 1 styles – typically associated with more creative endeavors

and multi-tasking – have a positive impact on the agendas of Divergence, Scientific Ambition, and Discovery, while having partially a negative impact on the agendas of Convergence, Conservative, and Mentor Influence. Further, Type 2 styles – which are typically considered to be a more rigid form of thinking – have a partial negative impact on the agendas of Divergence, Scientific Ambition, and Discovery, while having a positive impact on the agendas of Convergence, Conservative, and Mentor Influence. This indicates that cognition, at least under the form of thinking styles, does indeed play a part on the setting of research agendas. Linking this to the previous findings in Chapter 4, an argument could be made that Type 1 styles are more characteristic of Trailblazing doctrines, while Type 2 styles are the purview of Cohesive doctrines. These findings suggest that doctoral education, as well as supervisory best practices, can be designed in a way which encourages certain thinking styles which are deemed favorable – especially given that these are partly formed during formal education.

Chapter 6 explores the organizational dimension by employing both our research agendas framework and the organizational framework. This analysis is critical to determine the influence that the more managerial practices that are overtaking Higher Education systems (Jemielniak & Greenwood, 2015) can have on the direction that research takes at an individual level. The main finding was that autonomy is crucial for the development of ambitious and risk-taking agendas, something which is also true for social satisfaction. This further reinforces the idea that researchers require a great deal of freedom in order to pursue research agendas which can be considered "cutting edge". Organizational commitment, unexpectedly, was found to have the opposite effect, curtailing scientific ambition, discovery-driven research, collaboration, and divergence. We interpreted this as a result of researchers "falling in line" with the demands of the institution, which are often more oriented to the production of "safe" research, more likely to benefit performance metrics than riskier research where results are not guaranteed. Unconstraint - the lack of pressure to do non-research work - was also found to reduce collaboration scores as well as divergence; although not intuitive, we interpreted this as suggesting the need for researchers to also be engaged in non-research activities such as teaching. Finally, personality traits, which were included as controls, were also found to affect research agenda setting. This further reinforces the results of Chapter 5, by

suggesting that aspects intrinsic to the researcher also play a role in his choice of agendas. Overall, the findings of this chapter suggest that performance-based policies and managerial practices are having detrimental effects on the progression of science, mainly by privileging mass production of incremental or relatively conformist knowledge rather than fostering knowledge breakthroughs for the sake of career considerations and survival.

In Chapter 7, we endeavored to apply research agendas to shed new light on the topic of the gender gap in the academia. Research agendas are part of academic processes inherent to the academic workplace, in which a gender gap is manifested through various phenomena such as the *leaky pipeline* (Jensen, 2006) and the *old boys' network* (Van den Brink, 2010) – as such, determining how research agendas are influenced by these aspects can offer a new perspective on the gender gap. This was accomplished by means of a path analysis where the various organizational aspects were directed towards the differing research agendas, followed by a multi-group analysis where we observed the existence – or lack thereof – differences between men and women regarding these effects. First, men were found to have research agendas more focused on discovery than women, while the latter preferred to engage in more collaborative research agendas than men. Second, organizational characteristics were strongly associated with gendered research agenda choices. Autonomy was found to have positive impacts on Scientific Ambition, Collaboration, and Discovery exclusive to women academics. Further, Social Satisfaction was found to be a positive predictor of Discovery and Scientific Ambition, but only for men. The remaining variables had relatively homogenous effects across genders. Nevertheless, these findings highlight the impact of autonomy in women, as it is critical to allow them to develop more ambitious and ground-breaking agendas. The men-exclusive effect of Social Satisfaction is likely due to the existence of restricted male-dominated networks, a phenomenon known in the literature as the *old boys' network*. These findings open new strategies for tackling the gender gap, as suggested in the relevant chapter.

Finally, Chapter 8 re-visits the framework employed throughout the remainder of the thesis, and revises it based on the lessons learned thus far, as well as demonstrating measurement invariance across all fields of science – that is, the constructs are measured

in the same manner regardless of the field where the instrument is being applied (Byrne, Shavelson, & Muthén, 1989; Cheung & Rensvold, 2002; Kline, 2016). As part of the revision, the dimensions of Convergence and Conservative were removed; rather, they are now considered to be manifested as low scores in the Divergence and Discovery scales, respectively. Two new dimensions were also added – Academia Driven, which represents an orientation towards institutional and community-driven agendas, and Society Driven, which represents and orientation for tackling societal challenges, as well as considering the opinion of non-academics in the process of research agenda setting. Furthermore, throughout the process we demonstrated the measurement invariance of the instrument across all fields of science, indicating that the instrument can be universally used in all scientific areas. This final chapter paves the way for the continuation of research on the topic of research agendas, by creating the possibility for cross-field studies, which are certain to shed new light on the specificity of fields beyond Higher Education.

The following figure aims to provide a summarized schematic of all the findings made throughout this thesis; green lines indicate positive relationships, while red arrows indicate negative relationships:

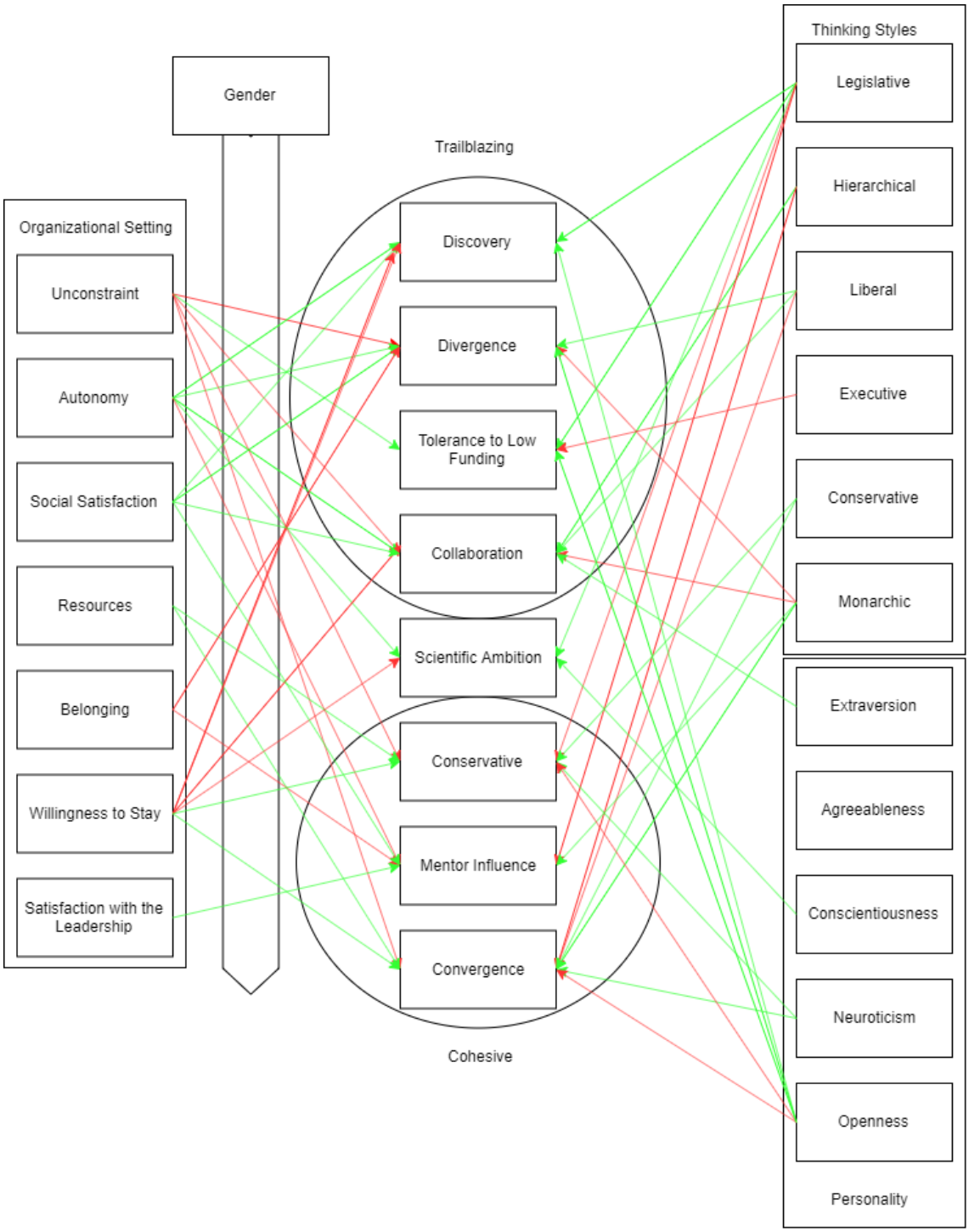

Figure 8: Summary of all findings

This concludes the overall summary of the various chapters of this thesis. We will now proceed with a discussion of its implications, limitations, and a roadmap for future research.

Implications

Implications for knowledge advancement and management

The main contribution of this thesis, in our perspective, is the development of a framework for the study of research agendas, which has opened new avenues of research which were limited or unavailable thus far. This framework has applications in diverse topics within the social study of science and higher education studies, as demonstrated throughout the various chapters, each with implications of its own. Further, its revision in the penultimate chapter demonstrates that it can be employed in all fields of science, while also providing new dimensions which remain yet to be explored. As we extensively described throughout the thesis, the existence of a framework on research agendas and an evaluation instrument opens new avenues of research through which old issues can be tackled from a new perspective, and likewise entirely new research can be developed.

Also of particular interest is the existence of doctrines concerning research agendas, to which we will give additional consideration in this conclusion. A noteworthy feature which was not fully explored in Chapter 4 is the distribution of researchers by research agenda clusters (two-thirds lean towards the cohesive research agenda and the remaining towards the trailblazing agenda). Although the characteristics of both research agenda clusters are of importance to research and communities, and the development of knowledge, there is a growing call for more multidisciplinary and disruptive agendas which are capable of tackling the complex issues of modern world (Martimianakis & Muzzin, 2015). Although acknowledging the extreme relevance of this line of argumentation, it is important to realize that fields of knowledge are social systems (Latour & Woolgar, 2013) and as such they require stability and a level of organization of values and norms that sustain them and which tend to be associated with a body of researchers that engages in more disciplinary-oriented and specialized research work. This means that fields of knowledge, such as the case of higher education research, requires researchers opting for cohesive research agendas and researchers leaning towards trailblazing research agendas. Similarly to the colonization process of new lands,

discoverers are required to find and explore new territory, but likewise, pioneers are also needed to build infrastructure and agriculture necessary to sustain new colonies.

The balance between agendas in a research community is critical. An example of this is the ongoing "crisis of replicability" in social psychology (see Pashler & Wagenmakers, 2012). This crisis was triggered by the publication of an article in a reputed journal claiming to show evidence of extrasensory perception (Bem, 2011). Following this publication, serious questions were raised regarding the legitimacy of much published work in the field that was being driven by a discovery-pressure associated to a publish-or-perish dynamic; this was further exacerbated by the fact that many accepted theories in that field were never subjected to replication attempts – in all psychology research published since 1900 in 100 journals, only 1.6% articles contained references to "replication" (Makel, Plucker, & Hegarty, 2012). This damaged the legitimacy of social psychology and serves as a cautionary tale for the field of higher education on the dangers of an overabundance of researchers leaning mostly towards trailblazing research agendas coupled with an absence of researchers leaning towards cohesive research agendas – just as excess of cohesive agendas can lead to a slower advance of new knowledge, excess of trailblazing research agendas can create a wealth of questionable findings.

Implications for academics

An interesting and additional consideration regarding these doctrines is that they were successfully cross-validated for both early and late career academics, indicating that cohesive and trailblazing agendas exist at both career stages. This has interesting implications since previous research suggested that research choices tended to shift focus over the career lifecycle, with convergence being usual at the PhD stage, divergence at the post-doc stage, and again convergence at late career (Horlings & Gurney, 2013). The relatively stable prevalence of cohesive and trailblazing agendas suggests that this is not always the case; thus, it can be that this shift in focus is only possible for researchers who have the opportunity to do so, and this can be influenced by a myriad of factors – for example, the various dimensions which are covered in the remaining chapters. Career paths are not linear, as mentioned earlier in the thesis (Horta & Yonezawa, 2013), and a

more holistic analysis must be conducted further ahead in order to determine the process underlying doctrine change over the career lifecycle.

Concerning intrinsic factors, as is the case of personality and thinking styles; as one of the cornerstones of this essay stated, the choice of an agenda should be a highly personal choice (Polanyi, 2000), and in some ways our findings show that it indeed is – the process of research agenda is influenced by not only the individual's thinking styles, but also his or her personality. It was previously known that personality traits influenced professional outcomes (Barrick & Mount, 1991), but the findings of this thesis suggest that they also influence the direction an individual takes his or her research into. The direct implication of this is that individuals with certain personality traits and thinking styles are more suited to certain lines of research than others. As this last statement can easily be twisted for perverse evaluation or selection purposes, it is of utmost importance to note here that our argument is not that certain individuals will perform better than others in some research topics, but rather that certain topics are more aligned with their own personal preferences and problem-solving strategies than others. Although personality is a relatively stable construct, unlikely to change substantially even over time (McCrae & Costa, 2003), thinking styles are susceptible to change since they are largely a result of the educational process and developed throughout the years, which suggests that changes at the PhD training level could potentially assist in the development of specific thinking styles which are considered desirable (Goodwin & Miller, 2013) . If it is the case, then fostering specific styles could be a useful strategy for aligning a specific individual with a specific research topic which favors a given style. With that said, this is largely speculative at this point and would require further research far beyond the scope of this thesis.

Implications for policymakers

In Chapter 6, we have shown how the research agenda of researchers is influenced by the organizational context. This is unsurprising; the publish-or-perish paradigm, coupled with the implementation of research evaluation frameworks (such as the REF – Research Excellence Framework – in the United Kingdom) which can be considered draconian by some and have led to strategies which maximize performance indicators

regardless of actual scientific contribution (Hicks, 2012; Martin, 2011); this is doubly concerning due to the fact that these indicators are very susceptible to manipulation and can be easily gamed, leading to institutional strategies of maximizing indicators for the sake of indicators alone (Grupp & Mogee, 2004) as part of neo-liberal policies which have largely overtaken Higher Education systems across the world (Jemielniak & Greenwood, 2015). Although some argue for the positive impact of the "battle for rankings", many of its effects are considered detrimental (Hazelkorn, 2009), as shown by the existence of incentives which can be considered perverse (Stephan, 2012). As we have shown, this is made manifest at a lower-level, as institutional policy – based on our interpretation of the aforementioned findings – seems to be encouraging conservative research which is likely to produce little scientific advancement, which is not surprising since funding is not so readily available for riskier research topics (Young, 2015). This is a phenomenon which has been explicitly documented in some fields of science, where researchers deliberately publish conservative research which does not contribute to the advancement of the field, due to career considerations (Rzhetsky, Foster, Foster, & Evans, 2015). Notwithstanding the importance of conservative studies – which, as mentioned above, are of great importance to the stabilization of knowledge – rigid policies which curtail ambitious and discovery-driven agendas, when taken to the extreme, risk causing a massive stagnation in terms of scientific progress. In this sense, it would seem that "publish or perish" is, in the end, causing discovery itself to perish even though more articles are published with every passing year (Johnson, Watkinson, & Mabe, 2018). This of course has serious implications for policy-makers; academic freedom is one of the most cherished facets of the profession, and adopting a corporate-like stance reduces individual agency and freedom (Oleksiyenko & Tierney, 2018). This will also curb collegiality and foster competition instead of cooperation between peers within the same department (Yokoyama, 2006). As we stated in the introduction chapter of this thesis, the academic workplace must necessarily be a creativity fostering environment (Csikszentmihalyi, 1999; Hemlin, Allwood, & Martin, 2008), something which is not achieved when researchers are falling in line in for the sake of their careers (Leišytė, 2016). In the end, policy-makers will have to opt between policies which lead to either scientific or indicator advancement.

Unsurprisingly, we also determined that this very same organizational context affects men and women differently, as shown in Chapter 7. Notably, women are more affected than men, especially in regard to autonomy, the lack of which directly affects their scientific ambition. In our view, this suggests that tackling the policy issues mentioned above might be a way of simultaneously addressing the gender gap in academia. If we are to assume that institutions constrain the research agendas of its researchers – as both the literature cited above (e.g., Rzhetsky et al., 2015; Young, 2015) and our own results seem to suggest – then this is directly causing a decrease in the ambition of women, which can be seen as one of the causes of the sharp drop-out rates in the academic profession for women (Clark Blickenstaff, 2005; Etzkowitz & Ranga, 2011). Thus, shifting policy into something which allows for personal academic freedom might have the potential to retain women in an otherwise unfriendly and chilly environment (Biggs, Hawley, & Biernat, 2018; Maranto & Griffin, 2011). Again, this links back to the overarching issue of excessive managerialism and performativity in academic settings, which we previously discussed, and presents yet another argument against the ongoing indicator craze (Young, 2015). Of course, this cannot simply be done at an institutional level – policy change needs to begin at the top – the governmental level – before institutions vying for extremely competitive funding can adapt.

Limitations

It is important to acknowledge that, despite our best efforts to keep them at a minimum, this project is not without limitations. The first one is that a qualitative analysis of research agendas was not conducted. This was initially planned but ended up not being implemented due to time and logistical limitations. This analysis would serve as either a basis for our research agendas framework, or as its validation. Even though the framework was developed nonetheless, and in part due to feedback from colleagues which is by definition qualitative in nature, it was largely substantiated by literature alone, and is likely missing some aspects of the research agenda setting process which would have

emerged in a content analysis exercise, for example. Future revisions of the framework would greatly benefit from such an exercise.

Another limitation is the fact that a great deal of the chapters in this thesis deal solely with the field of Higher Education, part of the disciplinary area of the social sciences. Although the cross-field data gathering exercise, which was planned from the onset, ended up being successfully concluded, only a single article making use of this dataset was produced within the time-frame of this thesis. Thus, most of the findings so far are constrained to a very specific field. This is however a momentary limitation, which is expected to be addressed as cross-field research is conducted on the new dataset.

It is also important to consider that our framework does not currently have a full suite of external validations. For example, we expect that individuals who score higher in Collaboration will have more co-authors, those with more Scientific Ambition will publish more, and so on. We have informally tested for this – and the results suggest that the various dimensions behave in relation to "real world" data as expected – but a full paper detailing these findings is yet to be produced. The reason why crossing the research agendas dimensions with bibliometric data was not yet done is for conceptual and methodological reasons; as this study was cross-sectional, we do not know if research agendas are stable over the career lifecycle, but they are likely to be time variant. If this is the case, it would make more sense to employ bibliometric data gathered in a short timespan following the response of the survey – for example, five years – rather than using career data, which is what we had available. Addressing this limitation will require longitudinal data to be collected in the near future, to determine how the research agendas dimensions influence the more immediate productivity and visibility indicators.

There are several other limitations which were noted throughout each specific chapter and will not be repeated here for the sake of parsimony, as is the case of most studies using largely perception-based data.

A research agenda for future studies on the topic of research agendas

Although this thesis shed some light on the process of knowledge creation by exploring individuals' research agendas, it raises even more questions which will have to be tackled in due time, some of which were foreshadowed in the previous section on limitations. As previously mentioned, qualitative studies should be conducted which are certain to add not only further robustness to the framework, but also potential new dimensions which were overlooked so far. Additionally, we now have the possibility to conduct cross-field studies; this is something which was heavily hinted at during Chapter 1, but sadly was unable to be implemented in time for the current thesis. Each field of science is likely to have differing agendas, and the findings thus far might not replicate exactly in all areas. Thus, replicating the studies so far, while comparing the findings for each of the different fields, will likely provide additional valuable insights on the disciplinary differences and how they influence the individual's research agenda.

Following the same logic, we now also have the data to conduct country comparisons, at least for the primary actors in the global scientific arena. This is an important analysis to conduct as it can shed some light into how national policy can influence research agendas at an individual level. Countries with more draconian research evaluation frameworks are likely to curb scientific progress for the sake of metrics alone, and we fully expect this to influence research agendas at an individual level – our findings in Chapter 6 strongly hint that this might be the case, and this is an avenue of research which should be pursued further.

Additionally, the two new dimensions – Society Driven and Academia Driven - in the revised version of the MDRAI are yet to be used in practice. These dimensions are of critical importance to measure both the degree of institutional pressure, but also the propensity to tackle societal challenges, which are of rising importance in the current research paradigm.

Finally, a more ambitious endeavor would be converting our current cross-field dataset into a longitudinal database. This is possible due to the fact that a) publications and citations are dated and b) the optional section of the survey – where employment and

education information was asked – was also dated. Further extraction of Scopus data at an article level can be used to augment the existing dataset by transforming it into panel data that contains datapoints for the entire career lifecycle of researchers. This of course has one unfortunate limitation which is the likely time variant nature of research agendas; however, it will allow us to determine how past events that shaped the life and career of the individual influenced his or her current research agenda. Such an analysis is likely to raise even further questions – but as mentioned at the beginning of this thesis, such is the nature of science.

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APPENDIX A – Multi-Dimensional Research Agendas Inventory

You will be asked a series of questions regarding your motivations and goals as an academic. To respond to this questionnaire, read each statement carefully and decide how much do you agree with each of them. For each statement, check one of the 7 boxes next to the corresponding item. If you don't know or a particular sentence does not apply to you, check the N/A box.

There are no right or wrong answers. Please read each statement and check the box which best applies to you.

How much do you agree with the following statements?

		Completely disagree	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Completely agree	N/A
A1	I aim to one day be one of the most respected experts in my field.								
A2	Being a highly regarded expert is one of my career goals.								
A3	I aim to be recognized by my peers.								
A4	Standing out from the rest of my peers is one of my goals.								
A5	I feel the need to constantly publish new and interesting papers.								
A6	I am constantly striving to publish new papers.								
C1	My expertise is focused on a single scientific area.								
C2	I believe that specialization in one area is preferable to diversification.								
C3	Shifting towards another field of science is not a part of my plans.								
C4	Studying subjects outside of my main field of work is pointless.								
C5	I have invested far too much in my current field to consider branching out into another.								
DI1	I find "cutting-edge" scientific areas more appealing than well-established ones.								
DI2	I would rather conduct revolutionary research with little chance of success than replicate research with a high chance of success.								

DI3	I prefer “cutting-edge” research to “safe” research, even when the odds of success are much lower.								
CN1	I prefer “safe” or “stable” fields of study.								
CN2	I prefer fields of study that are considered “safe” or “stable.”								
TL1	Limited funding does not constrain my choice of field.								
TL2	Highly limited funding does not constrain my choice of field.								
TL3	The availability of research funding for a certain topic does not influence me doing research on that topic.								
CO1	I enjoy collaborating with other authors in my scientific articles.								
CO2	My scientific articles are enhanced by collaboration with other authors.								
CO3	I see myself as a team player when it comes to research collaboration.								
CO4	I often seek peers with whom I can collaborate on scientific articles.								
CO5	My peers often seek my collaboration in their scientific articles.								
CO6	I am often invited to do collaborative work with my peers.								
M1	My PhD mentor’s opinion carries much weight in my research choices.								
M2	A part of my work is largely due to my PhD mentor.								
M3	My research choices are highly influenced by my PhD mentor’s opinion.								
M4	My PhD mentor is responsible for a large part of my work.								
M5	My PhD mentor still often works alongside me.								
M6	My PhD mentor largely determines my venues of research.								
D1	I look forward to diversifying into other areas.								
D2	I would be interested in pursuing research in other fields.								
D3	I enjoy multi-disciplinary research more than single-discipline research.								
D4	For me, multi-disciplinary research is more interesting than single-discipline research.								

APPENDIX B – Multi-Dimensional Research Workplace Inventory (MDRWI)

You will now be asked a series of questions regarding some aspects of your work, specifically your current department or Faculty. To respond to this questionnaire, read each statement carefully and decide how much do you agree with each of them. For each statement, check one of the 7 boxes next to the corresponding item. If you don't know or a particular sentence does not apply to you, check the N/A box.

There are no right or wrong answers. Please read each statement and check the box which best applies to you.

How much do you agree with the following statements?

		Completely disagree	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Completely agree	N/A
1.	The leadership of my department/Faculty is considerate towards the people who work in it.								
2.	The leadership of my department/Faculty understands my concerns.								
3.	The leadership of my department/Faculty treats its employees kindly.								
4	I feel like I am a part of my current department/Faculty.								
5.	I do not feel like I belong in this department/Faculty.								
6.	I consider my department/Faculty's success to be my own success.								
7.	I would be happy to spend the rest of my career in this department/Faculty.								
8.	I would not expect to spend the rest of my career in this department/Faculty.								
9.	Spending the rest of my career in this department/Faculty would be a good thing.								
10.	I have access to considerable amount of resources.								
11.	Obtaining research funding is not a problem for me.								
12.	I never had problems regarding research funding.								
13.	I have no shortage of research funding.								

14.	I do not have problems in obtaining research funding.								
15.	Research funding is not an issue for me.								
16.	I have good relations with my peers.								
17.	I recognize my peers to be highly competent.								
18.	I enjoy working with my peers.								
19.	My peers give me great research ideas.								
20.	I am on good terms with my peers.								
21.	Working with my peers is a pleasure.								
22.	I do not have much autonomy in my work.								
23.	I feel like I have a great deal of autonomy in my work.								
24.	I have a significant amount of autonomy in what I do.								
25.	My work is constrained by my department/Faculty's demands.								
26.	I spend a lot of time handling the bureaucratic aspects of my department/Faculty.								
27.	My department/Faculty's demands constrain my work.								

APPENDIX C – Six Thinking Styles in the Thinking Styles Inventory – Revised II

Style Type	Thinking Style	Key Characteristics
	Legislative	When faced with a problem, I use my own ideas and strategies to solve it.
I	Liberal	I like to take old problems and find new methods to solve them.
	Hierarchical	I like to set priorities for the things I need to do before I start doing them.
	Executive	I like to follow definite rules or directions when solving a problem or doing a task.
II	Monarchic	I tend to give full attention to one thing at a time.
	Conservative	I like tasks and problems that have fixed rules to follow in order to complete them.

APPENDIX D – Validation of the abridged version of the TSI-R2

TSI-R2 Reliability	
Sub-scale	Composite Reliability
Monarchic	0.873
Conservative	0.915
Hierarchical	0.767
Liberal	0.878
Executive	0.824
Legislative	0.833

TSI-R2 Validity		
Sub-scale	Item	Factorial loadings
Monarchic	When talking or writing about ideas, I prefer to focus on one idea at a time.	0.72
	I tend to give full attention to one thing at a time.	0.88
	If there are several important things to do, I focus on the one most important to me and disregard the rest.	0.58
	I like to concentrate on one task at a time.	0.91
	I have to finish one project before starting another one.	0.68
Legislative	When faced with a problem, I use my own ideas and strategies to solve it.	0.55
	I like to play with my ideas and see how far they go.	0.67
	I like problems where I can try my own way of solving them.	0.81
	When working on a task, I like to start with my own ideas.	0.62
	I like situations where I can use my own ideas and ways of doing things.	0.86
Executive	I like to figure out how to solve a problem following certain rules.	0.57
	I am careful to use the proper method to solve any problem.	0.53
	I enjoy working on things that I can do by following directions.	0.81
	I like projects that have a clear structure and a set plan and goal.	0.67
	I like to follow definite rules or directions when solving a problem or doing a task.	0.87
Liberal	I like to challenge old ideas or ways of doing things and to seek better ones.	0.79
	When faced with a problem, I prefer to try new strategies or methods to solve it.	0.87
	I like to do things in new ways not used by others in the past.	0.79
	I like to change routines in order to improve the way tasks are done.	0.67
	I like to take old problems and find new methods to solve them.	0.72
Conservative	I stick to standard rules or ways of doing things.	0.86

	When I'm in charge of something, I like to follow methods and ideas used in the past.	0.73
	I like situations where I can follow a set routine.	0.83
	I like tasks and problems that have fixed rules to follow in order to complete them.	0.89
	When faced with a problem, I like to solve it in a traditional way.	0.81
Hierarchical	I like to set priorities for the things I need to do before I start doing them.	0.64
	When working on a task, I can see how the parts relate to the overall goal of the task.	0.67
	When there are many things to do, I have a clear sense of the order in which to do them.	0.69
	In dealing with difficulties, I have a good sense of how important each of them is and in what order to tackle them.	0.56
	When starting something, I like to make a list of things to do and to order the things by importance.	0.59

APPENDIX E – Complete list of participant's countries

Country	Frequency	Percent
Argentina	1	0,10
Australia	114	15,50
Austria	2	0,30
Belgium	6	0,80
Botswana	1	0,10
Brazil	2	0,30
Canada	27	3,70
Chile	4	0,50
China	6	0,80
Cyprus	2	0,30
Denmark	4	0,50
Egypt	5	0,70
Estonia	1	0,10
Ethiopia	1	0,10
Fiji	1	0,10
Finland	18	2,40
France	5	0,70
Georgia	1	0,10
Germany	11	1,50
Greece	4	0,50
Hong Kong	12	1,60
Iceland	2	0,30
India	3	0,40
Indonesia	1	0,10
Iran	3	0,40
Ireland	7	1,00
Israel	5	0,70
Italy	9	1,20
Japan	2	0,30
Kenya	1	0,10
Korea, South	3	0,40
Latvia	1	0,10
Lebanon	3	0,40
Lithuania	1	0,10
Malaysia	8	1,10
Mexico	2	0,30
Netherlands	20	2,70
New Zealand	29	3,90
Nigeria	1	0,10

Norway	13	1,80
Oman	1	0,10
Pakistan	1	0,10
Philippines	1	0,10
Poland	3	0,40
Portugal	17	2,30
Puerto Rico	1	0,10
Russia	1	0,10
Singapore	2	0,30
Slovenia	5	0,70
South Africa	26	3,50
Spain	11	1,50
Sweden	15	2,00
Switzerland	5	0,70
Syria	1	0,10
Taiwan	8	1,10
Thailand	2	0,30
Turkey	3	0,40
Uganda	1	0,10
Ukraine	1	0,10
United Arab Emirates	2	0,30
United Kingdom	101	13,70
United States	183	24,90
Vietnam	1	0,10
Zimbabwe	1	0,10
Total	735	100,00

APPENDIX F – Geographical distribution of the sample

Country	N	%
Afghanistan	6	0.00
Albania	4	0.00
Algeria	20	0.20
Argentina	52	0.40
Armenia	5	0.00
Australia	454	3.70
Austria	106	0.90
Azerbaijan	4	0.00
Bahrain	3	0.00
Bangladesh	16	0.10
Belarus	5	0.00
Belgium	149	1.20
Benin	2	0.00
Bermuda	1	0.00
Bhutan	5	0.00
Bolivia	1	0.00
Bosnia and Herzegovina	11	0.10
Botswana	4	0.00
Brazil	514	4.20
Brunei	4	0.00
Bulgaria	24	0.20
Burkina Faso	2	0.00
Cambodia	1	0.00
Cameroon	6	0.00
Canada	460	3.80
Chile	59	0.50
China	223	1.80
Colombia	63	0.50
Congo, Democratic Republic of the	4	0.00
Congo, Republic of the	2	0.00
Costa Rica	8	0.10
Cote d'Ivoire	1	0.00
Croatia	76	0.60
Cuba	10	0.10
Cyprus	18	0.10
Czech Republic	71	0.60
Denmark	132	1.10
Djibouti	1	0.00
Ecuador	7	0.10

Country	N	%
Egypt	41	0.30
Estonia	23	0.20
Ethiopia	10	0.10
Faroe Islands	2	0.00
Fiji	1	0.00
Finland	132	1.10
France	548	4.50
Gabon	1	0.00
Gambia, The	2	0.00
Georgia	3	0.00
Germany	478	3.90
Ghana	10	0.10
Greece	171	1.40
Guadeloupe	1	0.00
Guam	2	0.00
Guatemala	1	0.00
Guinea	1	0.00
Haiti	1	0.00
Honduras	1	0.00
Hong Kong	51	0.40
Hungary	41	0.30
Iceland	8	0.10
India	419	3.40
Indonesia	37	0.30
Iran	101	0.80
Iraq	8	0.10
Ireland	53	0.40
Israel	60	0.50
Italy	806	6.60
Jamaica	4	0.00
Japan	153	1.30
Jordan	22	0.20
Kazakhstan	5	0.00
Kenya	11	0.10
Korea, South	35	0.30
Kosovo	2	0.00
Kuwait	7	0.10
Kyrgyzstan	1	0.00
Latvia	7	0.10
Lebanon	20	0.20
Libya	3	0.00
Lithuania	24	0.20

Country	N	%
Luxembourg	6	0.00
Macau	4	0.00
Macedonia	7	0.10
Madagascar	2	0.00
Malawi	1	0.00
Malaysia	135	1.10
Malta	2	0.00
Mauritius	2	0.00
Mexico	130	1.10
Moldova	4	0.00
Monaco	2	0.00
Montenegro	2	0.00
Morocco	13	0.10
Mozambique	6	0.00
Myanmar	2	0.00
Namibia	3	0.00
Nepal	2	0.00
Netherlands	247	2.00
New Caledonia	1	0.00
New Zealand	86	0.70
Nicaragua	2	0.00
Niger	1	0.00
Nigeria	60	0.50
Norway	111	0.90
Oman	9	0.10
Pakistan	37	0.30
Palestine	3	0.00
Panama	2	0.00
Peru	12	0.10
Philippines	14	0.10
Poland	156	1.30
Portugal	264	2.20
Puerto Rico	5	0.00
Qatar	7	0.10
Romania	149	1.20
Russia	169	1.40
Samoa	1	0.00
Saudi Arabia	42	0.30
Serbia	71	0.60
Seychelles	1	0.00
Sierra Leone	1	0.00
Singapore	42	0.30

Country	N	%
Sint Maarten	1	0.00
Slovakia	46	0.40
Slovenia	41	0.30
South Africa	109	0.90
Spain	554	4.50
Sri Lanka	7	0.10
Sudan	2	0.00
Swaziland	1	0.00
Sweden	244	2.00
Switzerland	155	1.30
Syria	3	0.00
Taiwan	75	0.60
Tajikistan	1	0.00
Tanzania	7	0.10
Thailand	47	0.40
Trinidad and Tobago	1	0.00
Tunisia	28	0.20
Turkey	107	0.90
Uganda	6	0.00
Ukraine	32	0.30
United Arab Emirates	15	0.10
United Kingdom	760	6.20
United States	2235	18.30
Uruguay	12	0.10
Uzbekistan	3	0.00
Venezuela	19	0.20
Vietnam	6	0.00
Virgin Islands	1	0.00
West Bank	1	0.00
Zambia	3	0.00
Zimbabwe	4	0.00

APPENDIX G – Multi-Dimensional Research Agendas Inventory – Revised (MDRAI-R)

You will be asked a series of questions regarding your motivations and goals as an academic. Please read and determine your level of agreement with each statement. Then, check one of the seven boxes next to the corresponding item. If you do not know or a particular sentence does not apply to you, check the N/A box.

Some questions will ask about your field, and others will ask about your research topics. Please consider "field" to be the main theme of your research (for example, "higher education"), and "research topic" as a specific subject within the main theme (e.g., "doctoral education" and "access to higher education" would be research topics in the "higher education" theme). "Field community" is also a term that you will encounter while you complete the survey. "Field community" is defined as the research/scholarly community(ies) with which you identify. Keep these definitions in mind when you respond to the questions.

There are no right or wrong answers. Please read each statement and check the box that best applies to you. How much do you agree with the following statements?

		Completely disagree	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Completely agree	N/A
A1	I aim to one day be one of the most respected experts in my field.								
A2	Being a highly regarded expert is one of my career goals.								
A3	I aim to be recognized by my peers.								
A5	I feel the need to constantly publish new and interesting papers.								
A6	I am constantly striving to publish new papers.								
A7	I am driven to publish papers.								
DV1	I look forward to diversifying into other fields.								
DV2	I would be interested in pursuing research in other fields.								
DV4	I would like to publish in different fields.								
DV5	I enjoy multi-disciplinary research more than single-disciplinary research.								

DV6	Multi-disciplinary research is more interesting than single-disciplinary research.								
DV8	I prefer to work with multi-disciplinary rather than single-disciplinary teams.								
COL2	My publications are enhanced by collaboration with other authors.								
COL4	I often seek peers with whom I can collaborate on publications.								
COL5	I enjoy conducting collaborative research with my peers.								
COL7	My peers often seek to collaborate with me in their publications.								
COL8	I am often invited to collaborate with my peers.								
COL12	I am frequently invited to participate in research collaborations due to my reputation.								
M2	Part of my work is largely due to my PhD mentor.								
M3	My research choices are highly influenced by my PhD mentor's opinion.								
M4	My PhD mentor is responsible for a large part of my work.								
M6	My PhD mentor largely determines my research topics.								
TTLF1	Limited funding does not constrain my choice of topic.								
TTLF2	Highly limited funding does not constrain my choice of topic.								
TTLF3	The availability of research funding for a certain topic does not influence my decision to conduct research on that topic.								
TTLF4	I am not discouraged by the lack of funding on a certain topic.								
D2	I would rather conduct revolutionary research with little chance of success than replicate research with a high probability of success.								
D3	I prefer "innovative" research to "safe" research, even when the odds of success are much lower.								
D4	I would rather engage in new research endeavors, even when success is unlikely, than safe research that contributes little to the field.								
D9	I am driven by innovative research.								
O1	My choice of topics is determined by my field community.								
O9	I often decide my research agenda in collaboration with my field community.								

O6	I adjust my research agenda based on my institution’s demands.								
O7	My research agenda is aligned with my institution's research strategies.								
S1	I decide my research topic based on societal challenges.								
S4	Societal challenges drive my research choices.								
S5	I often strive to engage in issues that address societal challenges.								
S2	I choose my research topics based on my interactions with my non-academic peers.								
S3	I consider my research topics myself, but this consideration often occurs after I hear what my non-academic peers have to say about these topics.								
S6	I consider the opinions of my non-academic peers when I choose my research topics.								