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Structural and Institutional Transformations in Doctoral Education

Social, Political and Student Expectations

Edited by
Sónia Cardoso · Orlanda Tavares
Cristina Sin · Teresa Carvalho

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Sónia Cardoso
Orlanda Tavares • Cristina Sin
Teresa Carvalho
Editors

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Editors
Sónia Cardoso
Agency for Assessment and Accreditation of Higher Education (A3ES)
Lisbon, Portugal

Centre for Research in Higher Education Policies (CIPES), Matosinhos, Portugal

Cristina Sin
Agency for Assessment and Accreditation of Higher Education (A3ES)
Lisbon, Portugal

Centre for Research in Higher Education Policies (CIPES), Matosinhos, Portugal

Orlanda Tavares
Agency for Assessment and Accreditation of Higher Education (A3ES)
Lisbon, Portugal

Centre for Research in Higher Education Policies (CIPES)
Matosinhos, Portugal

Teresa Carvalho
Department of Social, Political and Territorial Sciences, University of Aveiro
Aveiro, Portugal

Centre for Research in Higher Education Policies (CIPES)
Matosinhos, Portugal

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Praise for *Structural and Institutional Transformations in Doctoral Education*

"Despite tremendous national differences in doctoral education, there seem to be common, simultaneous, international pressures for both the expansion of Ph.D. graduates, and the re-visioning of the degree itself. The essays in this thoughtful collection raise a broad range of insightful issues and critical perspectives on both the shifting role of the doctorate, and the need for, and possibilities, of, reform."

—Glen A. Jones, *Professor of Higher Education and Dean, Ontario Institute for Studies in Education, University of Toronto, Canada*

Contents

Notes on Contributors

Alberto Amaral is a professor at the University of Porto, Portugal, and a researcher at Centre for Research in Higher Education Policies (CIPES). He was the rector of the University of Porto from 1985 to 1998 and former chair of Consortium of Higher Education Researchers (CHER). He is life-member of International Association of University Presidents (IAUP) and former member of the Board of Programme on Institutional Management in Higher Education/Organisation for Economic Co-operation and Development (IMHE/OECD). He is the chair of the administration council of the Portuguese Agency for Assessment and Accreditation of Higher Education (A3ES).

Corina Balaban is a research associate at the Manchester Institute of Innovation Research, The University of Manchester, UK. She has a background in Education Studies and wrote her PhD thesis on models of doctoral education in the EU and the US. Her doctorate was part of the Marie Curie project Universities in the Knowledge Economy (UNIKE), a four-year collaborative research initiative exploring the dynamic relationships between universities and knowledge economies in Europe and the Asia-Pacific Rim.

Lukas Baschung is Professor of Public Management and Dean of the Bachelor programme of Business Administration at the University of Applied Sciences Western Switzerland/Haute école de gestion Arc, Switzerland. His

PhD thesis focused on doctoral education's reform in Switzerland and Norway with an analytical approach in the field of public management. From 2010 to 2016, he worked for the government of the canton of Vaud, within the Board of Higher Education, lastly as operational director.

Sónia Cardoso is a researcher at Agency for Assessment and Accreditation (A3ES) and CIPES. Her main research interests are higher education policies; quality assurance; students and academics, especially their relation with quality assurance; doctoral education; internationalisation; and graduates' competences and employability. Her published work has appeared in higher education journals, and she has recently co-edited a book: *European Higher Education and the Internal Market: Tensions Between European Policy and National Sovereignty* (2018).

Teresa Carvalho is an associate professor at the University of Aveiro, Portugal, and a senior researcher at CIPES. Her main research interests are higher education policies and the professionals' roles in formulating and implementing public policies. Her published work has appeared in higher education journals. She has recently co-edited *Global Challenges, National Initiatives, and Institutional Responses: The transformation of Higher Education* (2016); and *Professionalism, Managerialism and Reform in Higher Education and the Health Services: The European Welfare State and the Rise of the Knowledge Society* (2015).

Rosemary Deem is a sociologist, Doctoral School Director, and Professor of Higher Education Management at Royal Holloway, University of London (UoL), Egham, UK. She has been a fellow at the UK Academy of Social Sciences since 2006. She has been the co-editor of Higher Education (Springer) since 2013. She was appointed Officer of the Order of the British Empire (OBE) for services to HE and social sciences in 2013. She is a member at the Peer Review College, European Science Foundation; and co-convenor at the Higher Education Network, European Educational Research Association. She has been chair at the UK Council for Graduate Education from 2015 to 2018. Her research interests include doctoral education, inequalities in HE, academic work, HE leadership, governance, management, and HE policy.

Hugo Horta is an assistant professor at the Faculty of Education, University of Hong Kong since September 2014. Before that, he worked in academia and as advisor to the Portuguese Secretary of State of the Ministry of Science, Technology, and Higher Education. He also served as the Portuguese National delegate to the European Research Area Steering Committee on Human Resources and Mobility until 2014. He is the coordinating editor of *Higher Education*, a leading journal of higher education studies, and sits in the editorial boards of several journals. His research focuses on academic research workforce development and knowledge production.

Barbara M. Kehm is a fellow at the Leibniz Research Center for Science and Society, University of Hannover, Germany. She was Professor of Higher Education Research at the University of Glasgow, UK; and from 2003 until 2011 Professor of Higher Education Research and Director of the International Centre for Higher Education Research (INCHER) at the University of Kassel, Germany. Her published work includes more than 30 books and almost 300 journal articles and book chapters on a variety of higher education-related topics. Her areas of expertise are internationalisation, governance, and reforms of doctoral education.

Lynn McAlpine is Professor Emerita at the University of Oxford, UK, and McGill University, Canada. She is internationally recognised for her research conducted in Canada and Europe which examines how early career researchers engage in and learn to do research—further, how they navigate their careers both in and outside the academy. She receives frequent international invitations to do keynotes, presentations, and workshops that explore the implications of her research both for policy and for pedagogy.

Vera Miguéis is an assistant professor in the Department of Industrial Engineering and Management at the Faculty of Engineering (MIEGI), University of Porto, Portugal. She has taught courses in operations research, data mining, statistics, and operations management. She is the external relations manager of MIEGI. She is also a researcher at Institute for Systems and Computer Engineering, Technology and Science (INESC TEC), and her research interests include data analytics and quantitative methods to support the decision process. She has been mainly working on analytical customer relationship management and data mining. Her published papers have appeared in several international journals in Computer Science.

Maresi Nerad is the founding director of the Center for Innovation and Research in Graduate Education (CIRGE) and Professor Emerita for Higher Education, University of Washington, Seattle, USA. She received her doctorate from the University of California, Berkeley; and directed research on doctoral education at the Graduate Division of Berkeley, as Dean in Residence at the Council of Graduate Schools, D.C., and as Associate Dean of the UW central Graduate School. She serves on national and international review committees and advisory boards, holds international appointments and award, and has written and edited five books. Her numerous articles on doctoral education have been published.

Ruth Neumann is an honorary fellow at Macquarie University, Australia, where she was previously Associate Professor of Higher Education and Management. She has been a higher education researcher for over 35 years with a specific focus on higher education policy, management, and doctoral education with extensive publications in these areas. Early academic appointments were at the University of Oxford and the University of Technology, Sydney. For several years she was Principal Advisor, Education and Training, with the Malaysian government.

Maria J. Rosa is an assistant professor at the Department of Economics, Management, Industrial Engineering, and Tourism at the University of Aveiro, Portugal, a senior researcher at CIPES, and a collaborator researcher at Research Unit on Governance, Competitiveness and Public Policies (GOVCOPP). Her main research topic is quality management, with a special focus on higher education systems and institutions. She has several publications on the subject, namely in different journals, and she has co-edited different books on the theme. She is a member of Consortium of Higher Education Researchers (CHER) and European Higher Eduaction Society (EAIR) (where she has been a member of the executive committee).

Cristina Sin is a researcher at the Portuguese Agency for Assessment and Accreditation (A3ES) and at CIPES. Her research interests are European higher education policies, the Bologna Process, and quality assurance/enhancement. She is a co-author of the book *European Policy Implementation and Higher Education: Analysing the Bologna Process* (2016). She has co-edited *European Higher Education and the Internal Market: Tensions Between European Policy and National Sovereignty* (2018).

Diana Soares holds a PhD in Educational Sciences. She is a professor at the Faculty of Education and Psychology, Universidade Católica Portuguesa, and a researcher in the Centre for Research in Higher Education Policies in Portugal. She also carries out research activities at the Centre for Studies in Human Development. She has participated in several research projects on policies and practices in higher and non-higher education, working as an expert consultant in the field of education. Her research interests include curriculum design and development, competency-based education, and pedagogical innovation. She is the author and co-author of several national and international publications.

Orlanda Tavares is a researcher at Agency for Assessment and Accreditation (A3ES) and CIPES. Her main interest areas are higher education policies, quality assurance/enhancement, and the student experience. Her published work has appeared in higher education journals, and she has co-edited two recent books: *European Higher Education and the Internal Market: Tensions Between European Policy and National Sovereignty* (2016) and *Cross-Border Higher Education and Quality Assurance: Commerce, the Services Directive and Governing Higher Education* (2015).

Abbreviations

A3ES	Agency for Assessment and Accreditation of Higher Education
AAQ	Swiss Agency for Accreditation and Quality Assurance
ACAF	Academy of Finland
ANVUR	Agenzia Nazionale di Valutazione del Sistema Universitario e della Ricerca
AQ	Agency for Quality Assurance and Accreditation in Higher Education, Austria
ARDE	Accountable Research Environments for Doctoral Education survey
ARWU	Academic Ranking of World Universities
ASEAN	Association of Southeast Asian Nations
BIC	Bayesian Inference Criterion
BIGSSS	Bremen International Graduate School of Social Sciences
CIRGE	Centre for Innovation and Research in Graduate Education
COSEMPUP	Committee on Science, Engineering, Medicine, and Public Policy
CRUS	Rectors' Conference of the Swiss Universities
CUSO	Conférence Universitaire de Suisse Occidentale
DAAD	German Academic Exchange Service
DC	Doctoral Committee
DDOGS	Deans and Directors of Graduate Studies
DVCR	Deputy Vice-Chancellor-Research
EC	European Commission

ECR	Early career researchers
ECTS	European Credit Transfer System
EFA	Exploratory Factor Analysis
EHEA	European Higher Education Area
EID	European Industrial Doctorate
ENQA	European Association for Quality Assurance in Higher Education
EQF	European Qualifications Framework
ERA	European Research Area
ERC	European Research Council
ESF	European Science Foundation
ESG	European Standards and Guidelines
ESU	European Students' Union
EUA	European University Association
EUA-CDE	Council for Doctoral Education of the European University Association
FCT	Foundation for Science and Technology
FG	Focus groups
FINEEC	Finnish Education Evaluation Centre
FWF	The Austrian Science Fund
Hcéres	High Council for Evaluation of Research and Higher Education, France
HE	Higher Education
HEIs	Higher Education Institutions
HKU	University of Hong Kong
IGERT	Integrated Graduate Education Research Training aka Integrative Graduate Education Research Traineeship
ITN	Innovative Training Network(s)
KNAW	Royal Netherlands Academy of Arts and Sciences, the Netherlands
LERU	League of European Research Universities
MARPs	Multi-actor Research Projects
MIUR	Ministero dell'Istruzione dell'Università e della Ricerca
MOU	Memorandums of understanding
NCCR	National Centres of Competence in Research
NOKUT	Norwegian Agency for Quality Assurance in Education
NPM	New Public Management
NQF	National qualifications frameworks

NRT	National Science Foundation Research Traineeship aka National Research Traineeship
NSF	National Science Foundation
NUS	National University of Singapore
NVAO	Accreditation Organisation of the Netherlands and Flanders
NWO	Netherlands Organisation for Scientific Research
OECD	Organisation for Economic Co-operation and Development
PhD	Doctor of Philosophy
PLACE	Proprietary, Local, Authoritarian, Commissioned, and Expert
PREQ	Postgraduate research experience questionnaire
QA	Quality Assurance
QAA	Quality Assurance Agency for Higher Education in the UK
QF–EHEA	Qualifications frameworks in the European Higher Education Area
QS	Quacquarelli Symonds World University Rankings
SEP	Standard Evaluation Protocol, in Netherlands
SFI	Swiss Finance Institute
SNF	Swiss National Science Foundation
SNU	Seoul National University
STEM	Science, Technology, Engineering, and Mathematics
THE	Times Higher Education World University Rankings
VSNU	Association of Universities in the Netherlands
UAS	Universities of Applied Sciences
UD	University Dean
UKÄ	Higher Education Authority in Sweden
UTE	Universities of Teacher Education
ZEvA	Central Evaluation and Accreditation Agency in Lower Saxony, Germany

List of Figures

List of Graphs

How Effective Are Doctoral Schools? Organisational Characteristics and Related Objectives

List of Tables

Leadership and Institutional Change in Doctoral Education in a Neoliberal Policy Context

Views on the Usefulness of the PhD Outside Academia: What Do We Know and Need to Know?

PhD Students' Self-Perception of Skills Acquired During Their PhD and Plans for Their Postdoctoral Careers: A Joint Analysis of Doctoral Students at Three Flagship Universities in Asia

Diversifying the Missions and Expectations of Doctoral Education: Are We Losing the Distinctive 'Added Value' of the PhD?

Building Bridges Between Industry and Academia: What Is the Profile of an Industrial Doctorate Student?

Introduction

Cristina Sin and Orlanda Tavares

This book is the result of the Douro seminar which was organised by Centre for Research in Higher Education Policies (CIPES) and The Portuguese Agency for Assessment and Accreditation of Higher Education (A3ES) in October 2018. Several researchers from around the world came together to discuss the recent developments, challenges and ways forward in doctoral education. As a result of new demands and expectations regarding the role higher education should play in the knowledge society and economy, doctoral education, too, has been affected by structural and institutional transformations in recent decades. The book analyses these transformations and the extent to which they are able to respond to policy-makers' and students' expectations of this qualification

C. Sin (✉) • O. Tavares
Agency for Assessment and Accreditation of Higher Education (A3ES), Lisbon, Portugal

Centre for Research in Higher Education Policies (CIPES), Matosinhos, Portugal
e-mail: cristina.sin@a3es.pt; orlanda.tavares@a3es.pt

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level. It is also a critical reflection on the direction doctoral education is currently following, whether it is desirable and should continue to be encouraged. Whereas it is obvious that policy reforms and discourses, anchored in the knowledge economy, are the main drivers of the reshaping of doctoral education, it is less clear if this reconfiguration achieves the policy objectives and if this is aligned with doctoral candidates' expectations and to what extent the labour market needs to justify these changes (considering the claims of skills mismatches). The book brings forward institutional and student perspectives in order to study this alignment, drawing on experiences from across the world—including European, Asian, Australian and American realities—and on specific national contexts.

Higher education has gone through deep changes driven by the massification and the diversification of the student body, the rise of neoliberal policies often accompanied by the reduction in public funding, the emergence of the knowledge society and economy, or the growing demands for accountability. As a result, new missions have been attributed to higher education, more outward-looking, related to its contribution to the society and the economy. These developments have also affected doctoral education, which has increasingly become the target of policies and reform initiatives promoted at supra-national, national and institutional level (Bartelse & Huisman, 2008; Kehm, 2006, 2011; Nerad, 2014). The urge for countries to reinforce their research and knowledge capacity as a way to respond to the requirements of the knowledge society (Bao, Kehm, & Ma, 2018; Bartelse & Huisman, 2008; Bernstein et al., 2014; Bitusikova et al., 2010; Nerad & Trzyna, 2008) was one important reform driver. The other was the perceived need to deal with the 'alleged' problems affecting the doctorate: long duration and high dropout; lack of transparency in recruitment, selection and admission; difficulties related with regulation and funding (EUA, 2005); the quality of doctoral education and its assurance; or the mismatch between doctoral candidates' skills and the demands of non-academic careers (Bartelse & Huisman, 2008; Bernstein et al., 2014; Clarke & Lunt, 2014; Huisman, de Weert, & Bartelse, 2002; Kehm, 2007; Park, 2005). According to Kehm (2007, p. 314), doctoral education is nowadays deemed too important to be 'left in the hands of professors and departments'.

Thus, although once conceived as a crucial component of university research and a 'gateway' to the academic career, doctoral education—its conceptualisation, organisation and provision—has been in the past few decades, in almost all western societies, in a process of deep transformation (Huisman et al., 2002; Kehm, 2007; Park, 2005). This is reflected in several developments. First, further to the massification and diversification of the student body (Bernstein et al., 2014; Evans et al., 2014; Kehm, 2006, 2007; Nerad, 2014), the purposes and modes of delivery of doctorates have also become more varied (Bao et al., 2018; Bartelse & Huisman, 2008; Kehm, 2007, 2011). Moreover, new ways of structuring and organising doctoral education have emerged (Bitusikova et al., 2010; Byrne, Jørgensen, & Loukkola, 2013; Clarke & Lunt, 2014). The development of skills and the transition to the labour market in order for students to pursue potential employment opportunities outside academia are currently also of paramount importance (Bao et al., 2018; Byrne et al., 2013; Clarke & Lunt, 2014; Kehm, 2011). Consequently, policymakers, researchers, academics, institutional leaders and managers, students, or even the general public have shown a growing interest in the transformations of doctoral education.

The book offers a comprehensive perspective on several topics which are pertinent to doctoral education nowadays, drawing on international and national realities: (1) the main structural transformations in doctoral education; (2) readjustments and changes within higher education institutions regarding doctoral education management and organisation; and (3) doctoral candidates' experience of these transformations and changes, specifically their perceptions and expectations regarding the degree, its focus and future careers. These topics structure the book at three main levels, reflected in the three parts of the book: the macro level, the meso level and the micro level. The first part (the first four chapters) addresses the macro level, namely the current developments and future challenges of doctoral education worldwide; the way in which the changing environment and purposes of higher education institutions shape doctoral education and affect doctoral candidates' work and well-being; the diversification of types of doctorates; and the current situation as well as the possible future developments in external assurance of doctoral education quality. In the second part (the three middle chapters), the meso level is explored through the institutional readjustments induced by the previous structural transformations. This sheds light on the way in which higher education institutions structure and organise doctoral education through the establishment of doctoral schools, as well as how they manage doctoral education, by paying special attention to the role and influence of senior leadership. The third part of the book (the last four chapters) deals with the micro level reflected in doctoral candidates' experiences, motivations and expectations regarding the doctoral degree. Several aspects are discussed: the 'value' candidates ascribe to the doctorate and how they define future career paths, within and outside academia; how the competences they perceive to be developing during doctoral education influence future career plans; and, for doctoral candidates enrolled in programmes designed to boost employability beyond academia, their motivations, expectations and satisfaction with the perceived match between such programmes and their career ambitions.

Part I starts with Rosemary Deem's chapter, which sets the scene by bringing together several topics not typically perceived as integral to the analysis of doctoral education, such as the cultures of contemporary performance-managed academic work in the context of corporate regimes, new managerialism ideologies about the supremacy of managers over academics, the rise of 'boardism' through increased powers of external stakeholders on university governing bodies and conflicting agendas of finance and fund-raising, institutional reputation and external rankings, and the pursuit of social transformation. She argues that this climate, in which doctoral students conduct their research, may be troubling for students and may lead to poor mental health. She suggests that activities which can contribute to the public good (e.g. becoming public intellectuals or helping develop public understanding of science, social science and arts/humanities) could significantly improve the well-being of doctoral students.

The chapter by Nerad addresses the connections between governmental innovation policies and changes in doctoral education at the level of national and regional higher education systems (macro level) as well as at the individual doctoral programme (micro level) worldwide in its local university context (meso level). She argues that the predominant models of doctoral education reforms used by governments are monetary incentives in the form of direct funding to universities for desired outcomes and competitive funding schemes for doctoral programmes with specified characteristics. New reform models and funding schemes are analysed in their intended and unintended consequences, and the question of whether doctoral programme structures worldwide are converging is investigated. The chapter highlights some useful lessons learned from recent reforms with examples from countries around the world and pinpoints key observations of new tensions that have emerged following recent changes in doctoral education.

Barbara Kehm's chapter starts by discussing the driving factors of the reforms of doctoral education in Europe, arguing that doctoral education has become a strategic resource in knowledge societies and is no longer an exclusively academic affair. This is demonstrated by showing how doctoral education has become an object of institutional management as well as national and supra-national policy making. The chapter then considers the diversification of types of doctorates to cater for the increasing numbers of doctoral students and the growing heterogeneity of motivations among the doctoral student body. A typology which comprises nine different types of doctorates is proposed and the arguments of both critics and supporters of the proliferation of types of doctorates are presented. She argues that the wider employment prospects of doctorate holders, especially outside academia, also require a broader set of skills.

Sónia Cardoso, Maria J. Rosa and Vera Miguéis, in their chapter, explore current trends in the quality assurance of doctoral education, which has become an issue of increasing public concern following its expansion and transformation. Higher education institutions now have to demonstrate that doctoral education is properly managed, efficient and transparent, fit for purpose and provide the highest-quality research education, under the scrutiny of both external and internal quality assurance. The chapter provides an overview on the dynamics inherent to the quality assurance of doctoral education at the European, national and institutional levels. Focusing specifically on the national level, the external quality assurance requirements and guidelines addressing doctoral education in various European countries are presented. Acknowledging the special nature of doctoral education, the chapter argues that it is necessary to develop tailored external quality assurance procedures at this level, while suggesting some proposals for future developments.

Part II reveals to the reader some readjustments within higher education institutions triggered by the structural transformations discussed in Part I, particularly focusing on the organisation and management of doctoral education. The chapter by Amaral and Carvalho presents a reflection on current changes in doctoral education, through a historical perspective on the nature and evolution of the doctoral degree and its purposes. The chapter describes how the traditional model has been progressively losing centrality in favour of more structured models, using the case of the organisation of doctoral education in schools and other similar structures. The authors analyse the variety of doctoral/graduate schools existent in different European countries and identify different ideal-types. Finally, they propose a critical discussion on the emergence of these new organisational structures aiming to institutionalise the new discourses about doctoral education in the context of the knowledge economy.

Still related to doctoral schools, Lukas Baschung's chapter analyses factors which affect the effectiveness of doctoral schools, such as organisational characteristics and objectives. The chapter identifies the objectives underlying the reforms of doctoral education in Switzerland and analyses their relationship with the organisational structure of doctoral schools based on public management literature and data dealing with Swiss higher education. The author suggests that exogenous factors, like the form of the network collaboration, type of inception and developmental stage, seem to have a certain impact on the doctoral schools' effectiveness, although not completely predetermining. He argues that endogenous factors like resource availability and especially common purposes also play an important role for the effectiveness of doctoral schools.

Ruth Neumann's chapter looks into the role and influence of leadership at the most senior university levels in generating institutional change at doctoral and research levels in a well-established research university. The neoliberal context in which universities operate has implications for university managers and leaders. This chapter studies leadership in action, by examining the challenges for senior university managers and leaders to operate, change and adapt in a highly competitive, tightly funded and corporatised environment to make their university nationally competitive and globally attractive for doctoral study. The case study is considered within the organisational change and culture literature generally and quite specifically in the higher education literature on university organisation, structure, leadership and change. Neumann offers insights into university leadership, institutional doctoral education practices and the impact of national education investment policies at a time when managerialism in the international public university sector is becoming increasingly pervasive.

Part III addresses the doctoral candidates' experiences of the doctoral degree, their motivations and their expectations of the degree during and after the research training. Lynn McAlpine, based on a long experience as an academic and on a ten-year longitudinal study, explores the changes in the PhD labour market and the extent to which the degree is useful outside academia. She argues that understanding the nature and quality of post-PhD careers outside academia is a pressing issue given more than half of PhD graduates work there. The chapter synthesises what we know and what we don't know about the perceived usefulness of the PhD through the following aspects: the influence of the PhD on post-PhD outcomes; PhD graduates' perceptions of the value of the PhD and non-academic employers' views as to PhD work-preparedness. The author identifies gaps in our knowledge of the non-academic labour market for PhD graduates and argues for a more fine-grained systematic research agenda in this area.

The remaining chapters address some of the gaps identified by the previous chapter, particularly related to the labour market preferences of doctorate holders in different countries and continents. Hugo Horta's chapter takes us to three flagship universities in South-East Asia, where he examines the association between PhD students' self-perception of the skills they acquire during the PhD and their career plans after the degree. The chapter assesses students' career plans from a theory of planned behaviour perspective, using five distinct alternatives to an academic career: research-related and non-research-related work in the business sector, research-related and non-research-related work in the government sector, and self-employment. Considering the 'skill-push' policies promoted by governments and institutions, the analysis questions the assumption that a broader skillset ensures that PhD students are open to a broader set of employment choices. The author argues that the motivations for starting a PhD strongly predict career choices after graduation and also highlights differences between STEM and non-STEM PhD students.

The issue of a broader skillset is also problematised in Corina Balaban's chapter. She investigates whether or not broadening the scope of the training offered at doctoral education level may have unintended negative effects on the distinctive added value of the PhD. Drawing on the specific case of two 'flagship' models of doctoral education—the Innovative Training Network (ITN) in the EU and the Integrative Graduate Education Research Traineeship (IGERT) in the US—the chapter criticises their ambitions to achieve many things at the same time: create great researchers, and also great entrepreneurs; create experts able to work across many different disciplines; create the in-depth knowledge of a research degree; and also develop a breadth of generic 'transferable' skills. This chapter argues that by trying to do so much within a very limited time frame, this new kind of PhD runs the risk of spreading itself too thin and of not exceling in any of its objectives. Balaban suggests that such approaches, meant to act as examples to be followed more widely, may threat what she assumes to be the distinctiveness of the PhD, that is, training specialised 'experts' in a given field.

The last chapter, by Orlanda Tavares, Cristina Sin and Diana Soares, brings a different perspective on a relatively new type of doctoral degree—the industrial doctorate—which, similar to the doctoral programmes discussed by Corina Balaban, also deviates from the traditional research doctorate. These authors focus on the self-perceptions of students enrolled in Portuguese industrial doctorates regarding their profile: motivations and expectations behind their enrolment, the personality traits perceived to be in tune with the demands of industrial doctorates and the skills and competences acquired during the programme. Starting from the premise that students in industrial doctorates are at the centre of the relationship between industry and academia, the chapter analyses whether students' profile reflects the dual culture. The authors suggest that the profile of Portuguese industrial doctorate students has a great potential to bridge two apparently distant worlds, academia and industry, and also point to the emergence of a different professional identity than the one typically associated with PhD holders.

It is hoped that the book contributes to the political and academic debate on doctoral education and encourages reflection about its direction nowadays.

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Part I

The Macro Level: Structural Transformations in Doctoral Education

Rethinking Doctoral Education: University Purposes, Academic Cultures, Mental Health and the Public Good

Rosemary Deem

Introduction

In this chapter I explore, using a sociological perspective, possible connections between debates about university purposes, changing academic cultures and a high incidence of doctoral researcher mental health. Following on from this and drawing upon Locatelli's work about education *for* the public good and Burawoy's work on public sociology (Burawoy, 2005; Locatelli, 2017), the chapter makes some suggestions about activities which doctoral researchers could use to

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R. Deem (✉)
School of Business and Management, Royal Holloway, University of London, Egham, UK
e-mail: R.Deem@rhul.ac.uk

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develop interactions within civil society but which also utilize their academic expertise. The discussion about connections of different things currently happening in the academy involves considering the effects of higher education's global contexts, debates about the purposes of higher education (HE) and contemporary academic cultures, on the wellbeing of those studying for a doctorate. Then, after looking at the broader positioning of higher education institutions (HEIs), including the rise of (largely right-wing) political movements critical of 'experts' and how twenty-first-century purposes of universities are conceived, as well as shifts in predominant academic cultures, I go on to examine the issue of the poor mental health of large numbers of doctoral candidates. The current period is seen as one in which the incidence of mental illness amongst doctoral students in many countries, particularly clinically certified anxiety and depression, is rising fast (Flaherty, 2018). Yet few explanations of this phenomenon take a broad social science approach (Levecquea, Anseela, De Beuckelaerd, Van der Heyden, & Gislef, 2017), with the dominant discipline being psychology. Although remedies are being put forward to improve wellbeing (Metcalfe, Wilson, & Levecquea, 2018), most interventions focus only on individuals, not the broader context of higher education or the actual skills that doctoral students acquire during their studies. I suggest how it might be possible, by focusing on doctoral education as a force *for* public good rather than doctoral education *as* a public good (Locatelli, 2017), to support wellbeing amongst doctoral candidates, using an approach somewhat along the lines of what is termed 'public sociology' (Burawoy, 2005). The latter concentrates on the use of academic knowledge to engage academics and members of the general public in dialogue about a range of issues, including topical controversial matters and community-focused lifelong learning. Using such an approach could also question the predominant mode of operation of many universities in the early twenty-first century.

The Global Context of Universities and Doctoral Education

Many universities worldwide are in intense competition with each other, for prestige, international staff and students (including doctoral researchers) and research reputation, based on outputs and citations. The growth of university international league tables and rankings (Hazelkorn, 2011) has exacerbated this competition, as has the gradual emergence of the concept of the world-class university (Deem, Mok, & Lucas, 2007; Mok, 2005). Recent work on world-class universities has either focused on the development of world-class universities in countries outside the global north (Song, 2018) or on how higher education institutions are now taking social and ethical responsibility for serving both their own locality and society, as well as the global common good (de Maret & Salmi, 2018). The latter is at a time when the relevance of academic or other experts and the role of universities in the world are increasingly being questioned by far right political grouping and movements. There are, of course, many researchers, including doctoral students, whose research encompasses such concerns as local and national social priorities, the global south or a global common good. However, we have to set against this, the many research projects in universities across the globe funded by organizations whose work has destructive consequences both for individuals (e.g. the tobacco industry) and the environment (e.g. multinational oil companies). The backdrop to universities' attempts to engage in more social responsibility and sustainability sits alongside (albeit not comfortably) a recent political shift to the extreme right in both Europe and North America (Lazaridis, Campani, & Benveniste, 2016; Norris & Inglehart, 2019) as well as in Brazil (Giroux, 2018). This shift includes not only political parties but also grassroots movements such as the 'Gilets Jaunes' who have been active on the streets in France and Belgium in 2018–2019. The extreme right do not seem to like universities and tend to attack both 'experts' as well as some specific fields such as climate change research and gender studies. The latter is seen as an ideology, not an academic discipline (e.g. in Hungary gender studies degrees can no longer be validated, hence the Central European

University's move to Vienna), despite the evident hard work and grant-winning capacities of gender studies scholars (Pereira, 2017). Such political developments make life uncomfortable for higher education institutional leaders but also for academics and students, including doctoral researchers.

There are also some other shared features of the broad HE landscape, though national cultures, economic prosperity or indebtedness and the nature of particular HE systems still make a difference. The common features include competitiveness, quality auditing of teaching and research (Cruickshank, 2016) and massification of the undergraduate intake (Giannakis & Bullivant, 2014; Mok & Jiang, 2018). The latter has taken the spotlight off postgraduate education and arguably starved it of resources. Doctoral education too has been massified, though to a much lesser extent than undergraduate education, particularly in relation to international students and professional doctorates where these exist (Jones, 2018), though recruitment is often still predominantly from higher social groups (Wakeling & Hampden-Thompson, 2013; Wakeling & Laurison, 2017). However, doctoral education is still free in a few countries, including Finland. In many countries, whether HE is fee-paying or not, there are active debates about the costs of HE and who should pay those (governments, students, employers?). In countries like South Africa, strong opinions about university fees, alongside concerns about colonial curricula and attainment gaps between white and black and minority ethnic groups students in HE, have turned into violent protests on university campuses (Keet, Nel, & Sattarzadeh, 2017). An enduring 2018 UK pensions strike, which began as a dispute about academics' pension benefits, ended with both staff and students questioning the idea of corporate universities as well as holding teach-outs and 'Why is my curriculum white?' debates. In France school students have protested about exams needed for university entrance being made harder and excluding less well-off students. Of course, doctoral researchers are not always engaged in such struggles (although a good many undertake poorly paid teaching of undergraduates) but they are certainly aware of them.

There is also a significant turbulent element in many HE systems. It is not just about fees, as even in countries with low or no fees, universities have still become more like businesses (Bok, 2004), permeated not only by new managerialist ideologies and practices which favour manager-academics over academics (Deem, 2017; Deem, Hillyard, & Reed, 2007; Magalhães, Veiga, & Videira, 2017) but also by 'boardism', which places emphasis on the power of university lay governing body members rather than collegial governance by academic staff (Veiga, Magalhães, & Amaral, 2015). Increasingly, research, teaching and supervision are driven by their usefulness for the economy, not by their social and cultural relevance (Gumport, 2000). The employability of former undergraduates becomes paramount, despite the problematic nature of the concept of graduate employability (Boden & Nedeva, 2010). Students themselves are becoming increasingly instrumental in their approach to higher education (Budd, 2016), though as Budd's comparison of undergraduates in England and Germany shows marketized systems encourage a consumerist approach to a greater extent than quasi- or non-marketized systems. Doctoral researchers may be less obviously instrumental than undergraduates but faced with decreasing doctoral degree funding and job vacancies in HE in decline in many countries, with at best part-time insecure jobs as teachers or researcher, many must now look outside academe for a job. Future employment has become a major issue for doctoral researchers in the current decade (Bernstein et al., 2014; Lunt & Clarke, 2014; McAlpine & Emmioğlu, 2015). In this climate, doctoral students may also be more inclined to complain about poor supervision and adverse doctoral degree outcomes than in the past.

Globalized higher education is now massified and highly competitive, which positions academics in the spotlight, as it is they who must deliver competitive research, teaching and supervision and who are increasingly performance-managed to do so. In turn, this puts pressure on early stage researchers too, many of whom are also doctoral candidates, to perform at a high level. For international students, the fact that an employer or sponsor has paid for them to study for a doctorate may add to the pressures they experience during their studies. Stress itself is not abnormal in academic work and can sometimes have a positive effect on doctoral researchers in learning to cope with challenging situations. By contrast, if stress then leads to suffering from extreme anxiety, lack of self-worth and severe depression, the result is usually multiple interruptions to study and poor or no degree outcomes. The perennial discussions about financing higher education continue and the very real budgetary problems of both public and private higher education institutions are reducing the numbers of academic staff being recruited in many countries and leading to more precarious academic jobs (Allmer, 2018; Courtois & O'Keefe, 2015, 2019). Whilst doctoral graduates can and do work in many other sectors than higher education, these are not always the first choice destination. In addition, the increased focus in recent decades on discussing the challenges of doctoral education and the value and relevance of the doctoral degree tend to make doctoral candidates want to submit a brilliant thesis (rather than just an examinable one) on time, both to show they can compete with the best in the field and in order to strengthen the chances of acquiring a job on graduation. So indirectly, the increased globalization of higher education and the job insecurity endemic to many twenty-first-century HE systems can make the lives of doctoral candidates (and that of their supervisors) much more difficult than might otherwise be the case (Gopaul, 2015; Pedersen, 2014).

The Purposes of Universities

The pace of change in universities in recent decades has led to a good deal of questioning about what the contemporary purposes of universities are (Collini, 2012; Swartz, Ivancheva, Czerniewicz, & Morris, 2019). Doctoral education is located right at the heart of these purposes debates (in terms of what doctoral candidates are doing, who supervises them and their employment prospects), even though the protagonists in the purposes debate tend to concentrate more on the roles of academics and undergraduate student teaching than doctoral candidates. Much of the purposes debate is about how to steer universities away from what seems to some a total pre-occupation with money and league table rankings. This state of affairs can be to the detriment of any other considerations about students *qua* students (as contrasted with 'students as consumers'), acquisition of knowledge, learning or the contribution of higher education to society and is often accompanied by a desire to concentrate on 'useful' subjects; the latter may exclude both the arts/humanities and social sciences (Gumport, 2000).

Commentaries on the purposes of universities come both from those who have researched universities for decades to more polemical interventions from those whose own academic careers and lives have been affected by the instrumental turn in university politics and policies (Collini, 2012; Docherty, 2011) or from journalists concerned about whether marketized university systems with high fees may be duping young people (Charkabortty, 2018). Delanty's work, which more closely aligns with the former approach, examined not only how universities reflect national cultures but also how the university operates as a key institution in contemporary societies, thus enabling knowledge, culture and society to feed into each other (Delanty, 2001). The modern university is frequently alleged to be in crisis but Delanty, after considering some of the aspects underpinning this assertion, including forces of globalization, the nation-state, academic capitalism, the politics of culture and a changing dynamic between research and teaching, suggests that in the context of the knowledge economy, the modern university could and should have a key role in providing public space for debate and also enable reflexive communication of ideas and knowledge and developing notions of citizenship in democratic societies. However, there is a big gap between what should and what does happen in universities.

The debate about mode 1 and mode 2 knowledge (Gibbons et al., 1994), though much critiqued, and later revised somewhat (Nowotny, Scott, & Gibbons, 2001), is also a reference point for debates on university purposes, as the analysis exposes some of the tensions between different kinds of knowledge created in universities. Whereas mode 1 is the pursuit of abstract knowledge in traditional and mono-disciplinary way by academics, mode 2 knowledge is often interdisciplinary, has contributions from those outside as well as inside academe and the focus is on its application, not on knowledge for knowledge's sake. Both the 1994 and the 2001 volume pose some of the dilemmas faced by doctoral candidates choosing a research topic as well as their subsequent search for employment. Collini's (2012) work on the contemporary university is more polemical than Delanty's carefully crafted analysis but his perspective is particularly informed by how the humanities are faring in a context where constantly reformed and overly managerial universities can appear as little more than glorified training institutions for young people (Collini, 2012). The HE institutional ethos often pays more attention to consumerism than to learning and the value of research can be reduced to an assessment of its non-academic impact, bibliometrics or journal 'impact' factors. The latter are part of the publishing industry's attempt to ensure that they continue to obtain new knowledge free of charge from universities and then sell it back to them for vast sums of money. This is demonstrated by some of the recent disagreements between a number of European countries and the publishing corporation Elsevier and other publishers over the high cost of journal licences for HE (Schiermeier, 2018).

Doctoral candidates are very close to experiencing the effects of the purposes of universities. They may also experience less frequent and diligent supervision as a result of their supervisors being engaged in ensuring the satisfaction levels of consumerist undergraduate students. The research cultures of universities may not all prove equally permeable to early stage researchers, especially those working in a second language. For example, the UK Postgraduate Research Experience Survey has consistently shown over many years, the extent of doctoral candidate dissatisfaction with their lack of integration into departmental research cultures (Advance HE, 2018).

Being concerned about purposes of universities is not just a theoretical debate. An example of how those who run universities are also caught up in the debate is from a recent paper where South African university leaders from different types of university as well as HE policy makers, were interviewed about their ideas on what constitute the 'core business' of universities (Swartz et al., 2019). Swartz et al. show that there is wide confusion and uncertainty amongst South African university leaders on this topic and that what is at the core of universities is historically grounded, not just a response to recent student protests about colonial curricula and university fees. Three main arenas of activity at the heart of university *raison d'être* are raised in Swartz and her colleagues' discussion—financial matters and imperatives to raise money (both through research and third stream income but also online teaching programmes and recruiting more international students);

maintaining university status and reputation, which includes paying attention to league tables and rankings and finally dealing with matters of social justice and reparation. Whilst for historical reasons related to apartheid, social justice is somewhat more prominent and also somewhat differently framed in the South African context, the list of core purposes could otherwise be repeated in many other countries. As the authors note, the three foci are in constant competition and conflict with each other, directly affecting teaching and research. Often the financial imperative overrides the other two. Whilst doctoral candidates may not be fully aware of these competing concerns, some aspects are likely to directly affect all those enrolled on university programmes. The message that money and reputation are what counts the most may be particularly sobering for doctoral students anticipating an academic career—the message suggests an unsupportive, performance and metrics-driven approach to academic work and also indicates the likelihood of cutting back on academic labour force costs, which reduces the possibility of non-precarious or indeed any jobs being available. Furthermore, the notion that social justice may sometimes be bottom of the pile for prioritization may also not be welcome news to women students, those who are from economically disadvantaged or ethnic minority groups or those with a disability.

I want to suggest that the overall shape and cultures of higher education across the world, which make academic work more demanding and less enjoyable and impose instrumentalism and consumerism, rather than enhance learner/teacher relationships, may be part of the reason why more and more HE systems are reporting increased incidence of poor mental health amongst all students. The latter is especially found amongst those studying for a doctorate (Bothwell, 2017; Levecquea et al., 2017; Thomas, 2015). Doctoral students are positioned at the heart of the many tensions and contradictions that are now an integral part of higher education institutions' daily struggle with what constitute the purposes of higher education. It is perhaps no surprise that these tensions and the cultures within which they are embedded in HE may be at least partially responsible for doctoral researchers' decreased sense of wellbeing.

Academic Cultures

Academic work itself is in a period of rapid change. More and more is expected of academics in respect of teaching, research, administration and third mission work (Kyvic, 2013) but they are also increasingly subject to a level of scrutiny and performance management unheard of 30 years ago. Academic labour is not only becoming more casualized but increasingly specialized, with some staff concentrating on research, others on teaching or following management careers. Academic work is also being speeded-up (Ylijoki, 2011), with academic responses to this varying from total commitment to paid work, through setting a clear boundary between 'real' paid work and other work, to establishing a solid boundary between paid work and life itself. As Ylijoki observes, the necessity of academics *having* to react to speed-up says much about the changing nature of academic work. But HE systems and academic work are not yet fully homogenous. A study of 13 countries on the working time and conditions of academics shows some variation remaining in each of those HE systems (Bentley & Kyvik, 2012). There is also a significant degree of collectivization occurring in academe (Nyhagen & Baschung, 2013), though this tends to be more evident in activities like graduate schools than in research centres which retain more autonomy.

Academics themselves feeling alienated from their workplace and suffering mental health challenges is not a new research finding (Wells, 1996). However, in the past two decades or so, a number of changes have occurred that have made academic work rather more likely to lead to poor mental health than previously (Kinman, Jones, & Kinman, 2005). These changes include much more emphasis on performativity, a greater focus on how academics' outputs influence academic rankings and contribute to 'impact', additional responsibilities for the student experience, job insecurity and the growth of more and more casual labour. Tight has argued that academic workloads per se have not increased dramatically but rather the problem is related to the balance of work tasks, with a big recent increase in administrative roles (Tight, 2010). Kyvic, on the other hand, explores how the responsibilities of researchers have multiplied, with undertaking research and publishing joined by social media promotion of outputs, a growing burden of evaluating the papers and research grants of others, seeking new research collaborators and so on (Kyvik, 2013). Research on work and anxiety suggests that not having a permanent job adds massively to incidence of mental illness, with permanent employees less subject to severe anxiety than those on temporary contracts (Fontinha, Van Laar, & Easton, 2018). Other writers suggest that individual resilience and ability to cope make a lot of difference (Darabi, Macaskill, & Reidy, 2017) and research from Portugal argues that women's continuingly heavy workloads mean they experience a much less optimum work-life balance than do male colleagues (Santos, 2015). A comparative study of academics working in 19 different HE systems found that anxiety levels were greatest in countries with highly marketized higher education systems (Shin & Jung, 2014) and much of this was attributed to the existence and continued performance management of new public management regimes. One Belgian university, Ghent, has recently announced that it is trying to move to a less overt emphasis on rankings and other ultra-competitive measures amongst its academic staff in order to improve their working conditions and give back some autonomy (Redden, 2019). But this is an atypical response.

The reader interested in doctoral education may say, yes but what has all this to do with doctoral candidates and their supervisors? Firstly, as already noted, the content of academic workloads is rising and academics have much less time to devote to postgraduates as undergraduate classes get bigger, marking loads increase and all research production is closely monitored. Secondly, academic work is also becoming a less attractive job in itself, less 'special' (Musselin, 2013) and more mundane, which affects both the aspirations of many doctoral candidates and the motivation and commitment of their supervisors. Finally, the financial pressures facing modern universities run as businesses mean insecure academic jobs are the order of the day, so the academic career prospects of doctoral graduates are much lower than they once were and many institutions neither value nor provide adequate preparation for, roles outside HE. Spending time with overworked and exhausted academic supervisors may lead to their doctoral researchers wanting to flee academe (Hunter & Devine, 2016). The focus now turns to the question of declining wellbeing and rising incidence of poor mental health amongst doctoral candidates itself.

Doctoral Student Mental Health

A recent US-initiated international survey of PhD candidates from a range of disciplines suggested that they are around six times more likely than the general public to experience clinically validated symptoms of poor mental health (Flaherty, 2018). Of course, the general public may not be the best comparator group for a highly educated sample. Another recent study about the incidence of poor mental health involving 3659 PhD students in Flanders, Belgium (Levecquea et al., 2017), suggested that a third of the sample have or are at high risk of developing some kind of mental health disorder, typically depression. The study also compared doctoral candidates with other highly educated sample groups and found that the doctoral researchers had a greater incidence of poor mental health. According to the same study, Flanders has seen recent significant rises in the numbers of doctoral candidates relative to other European countries but all candidates surveyed were full-time, many holding a well-paid employment contract and having good working conditions. The authors note several reasons why universities and society at large should care about the state of doctoral students' wellbeing and mental health. Firstly, the doctoral dissertation is a major source of scientific knowledge development and is an important pre-requisite for academic posts; poor mental health may affect the supply of new academic knowledge and thesis submission rates. Secondly, in STEM areas in particular, doctoral candidates are an important part of scientific teams and any problems they experience will affect the outputs and impact of the work done by those research teams. Finally, mental health problems can affect the supply of labour to research-based companies and organizations if candidates are slow to finish or drop out. The Flanders authors say that previous studies of doctoral students and mental health are thin on the ground. However, those undertaken prior to the Flanders study suggest that problems with learning, financial difficulty, insecurity about unwritten rules of doctoral education, the extent or absence of regular evaluation of work such as experimental results and chapters, a competitive ethos, poor quality of supervision, lack of good relationships with academic staff and other students, a heavy workload, work/life imbalance and the absence of a collegial culture may all be factors leading to poor mental health (Appel & Dahlgren, 2003; Kurtz-Costes, Helmke, & Ulku-Steiner, 2006; Stubb, Pyhältö, & Lonka, 2011, 2012). Appel and Dahlgren also point to women doctoral candidates being more likely to suffer from stress and mental fatigue than male candidates. However, the latter is also likely to be linked to other factors, such as sex discrimination and sexual harassment (Danowitz, 2016). Furthermore, as Acker and Haque have noted in a Canadian interview-based study, the pervasive but outdated idea that all research students form part of an elite and privileged group can mask the everyday economic and social conditions, pressures and tensions within which many doctoral students actually live (Acker & Haque, 2014). This typically includes international students, not a new situation (Deem & Brehony, 2000) but sadly not getting better.

The Flanders authors outline the key elements in their findings, indicating that poor mental health such as depression typically arose from work/family conflict, job demands, lack of inspirational leadership, family/work tensions, absence of work/job control and closed (non-consultative) decision making. They note that inspirational supervisors with enough time to supervise, increase good career prospects for doctoral graduates because they tighten the psychological ties of students to their research group (the recent increase in Flanders' doctoral student numbers whilst keeping static academic staffing, did not augur well for future academic posts) and offer better protection from and monitoring of mental health amongst staff and students. These approaches, could all help improve matters. They also make some recommendations for universities:

> Our analyses suggest that universities will benefit in terms of PhD students' mental health when they facilitate management of work-family balance and workload, design open decision-making procedures, and help PhD supervisors to adopt leadership styles that lead to satisfactory and constructive work relations. Our findings also suggest that universities might benefit from offering PhD students clear and full information on job expectations and career prospects, both in and outside academia. (Levecquea et al., 2017, p. 878)

A recent literature review on doctoral student wellbeing also points to a number of similar important factors but unlike the Flanders study, makes much more of the point that experiences of doctoral students may vary by discipline (Schmidt & Hansson, 2018). The authors found a plethora of definitions and measurements of wellbeing in the articles reviewed as well as a wide variety of theoretical frameworks and methods. The literature, however, does have some recurring findings. These include the significance of role conflict in relation to self-concepts and identities of doctoral candidates (those who exhibited low self-care and poor life-work balance also had a higher incidence of poor wellbeing). Other factors include the kind of meanings candidates attach to their studies (those over-emphasizing academic growth at the expense of emotional and personal development are more likely to experience mental ill-health), the incidence of serial interruptions of study, an intention to leave academe on thesis completion and not being part of a research team. Students who were introverted and students with a low capacity to cope with difficult situations by problem-solving, reaching out to friends and colleagues or asking for specialist support, experienced higher incidence of poor mental health. Structural factors such as organizational support and social networks were important too. Trigger factors for mental health included clustering of deadlines, lack of money, difficulties in time management, family problems and less than optimal relationships with supervisors (Schmidt & Hansson, 2018).

What is interesting in most existing studies of doctoral researchers and mental health is that the focus is generally on the individual student and/or the supervisor, with relatively little emphasis placed on the organizational climate of higher education systems and universities, the wider turbulent societal and international context, or on the highly competitive long-hours cultures of many academic workplaces. Bad habits of workaholic academics are not only passed onto research students but also emphasized as essential to future success as an academic. Yet only the Flanders study really mentions any significant organizational factors affecting wellbeing. Although most papers on mental health refer to supervisors, this is often done without mentioning the climate within which those supervisors conduct their supervision, alongside many other duties. Indeed the problems of modern academic life such as anxiety about over-production of research outputs (Pereira, 2017) are so taken-for-granted that no one notices any more, never mind considers that continued pressures to perform academically at high levels may be counter-productive. I recently took part in a UK-based summer school on peer review processes aimed at PhD researchers and postdocs, where a senior male academic said to an audience largely composed of young women that it was not possible to be a successful academic unless you were prepared to work at least 70 hours a week. The audience was clearly not at all impressed with this, seeing it as an attempt to discourage anyone with family responsibilities from trying to be an academic.

Reflecting on the points already made in the previous section about the broader context of higher education surrounding doctoral education, which includes massification and an increasingly diverse array of doctoral candidates, the ambiguity and angst experienced even by senior university leaders over the purposes of universities, the pace of change in many HE systems and the extent of intrusive audit and performance measures for teaching and research, it is somewhat disturbing that a good proportion of the relevant mental health literature places at least some responsibility on the individual doctoral candidates and sometimes even attempts to medicalize the issue. Of course, we need to nurture wellbeing, support those doctoral researchers who experience severe mental health problems to get professional help, make sure all supervision is of high quality and train supervisors in spotting potential mental health problems so help can be sought. We should also ensure new candidates are aware that PhD study involves significant challenges and that it is helpful if they can acquire some coping strategies early on in their studies. Universities could arrange for early stage doctoral candidates to have access to student mentors in other years of doctoral study and make specialist mental health support available for those who need it. Nevertheless, the elephant in the mental health room is the state of contemporary universities and academic work. There is a common thread running through the current global political situation, the debates on the purposes of universities and the conditions of contemporary academic life (precarity, multiple responsibilities, work overload, measurement by metrics) which together could make anyone working on a doctorate reflect deeply on what they are doing and question their own self confidence and capacity. It is not surprising that in an era of close surveillance of academic work and an ever-widening selection of metrics by which to measure academic performance, more and more pressure is applied to everyone working in higher education teaching and research, from early stage researchers to senior professors. In the final section of the chapter, I suggest how the concept of public good might be adapted in such a way that we start to change some elements of whom we teach doctoral candidates to become and acknowledge the extent of the task that lies ahead in reshaping higher education systems and institutions.

The Public Good—A Route to Good Citizenship in and Beyond Doctoral Education

In this section I consider how we may be able to develop a healthier and more societally oriented base for doctoral education by connecting doctoral researchers to local communities, providing skills of use in civil society and at the same time possibly starting to develop an alternative future for higher education. Doctoral candidates in many countries are now not just working with supervisors and research teams but are also the (sometimes reluctant) recipients of taught units and workshops, ranging from research methods to how to talk to the media about your research. Those workshops, often called generic skills or researcher development, though extremely valuable to doctoral candidates' research and their future careers, do not necessarily always significantly contribute to the subsequent citizenship of doctoral graduates or their societal contribution *as* citizens, an aspect of contemporary university life which Delanty (2001), among others, advocates as an important element of what universities can still achieve. Earlier in the chapter it was suggested that the stance taken on doctoral education and improving mental health here would be a sociological rather than psychological one, echoing some of Burawoy's (2005) idea of 'public sociology' by finding a path to utilizing academic research and knowledge in a manner which brings in the wider public in a fully participative way:

> Public sociology … strikes up a dialogic relation between sociologist and public in which the agenda of each is brought to the table, in which each adjusts to the other. In public sociology, discussion often involves values or goals that are not automatically shared by both sides so that reciprocity, or as Habermas (1984) calls it 'communicative action,' is often hard to sustain. Still, it is the goal of public sociology to develop such a conversation. (Burawoy, 2005, p. 267)

'Public sociology' is seen by Burawoy as different from professional, critical and policy sociologies in that it focuses on applying social science knowledge in the public arena for public debate and benefit in civil society. It is *not* suggested here that only social science doctoral researchers are able to engage in such public sphere activities, since the wider engagement of both doctoral researchers (and subsequently, doctoral graduates) in making academic knowledge accessible in order to facilitate debating broad societal concerns, values and goals and/or offering co-created lifelong learning opportunities, could be applied to almost any discipline and could constitute a new phase of doctoral education. It would also revitalize lifelong learning in the community, moving away from recent restrictive forms of adult education emphasizing teacher-led curricula, credentialism and over-assessment rather than a more fluid and learner-centred approach such as that advocated by a recent critical study of what is now meant by lifelong learning in contemporary Europe (Mayo, 2019).

Working *for* the public good can be interpreted in a variety of ways, from volunteering in the public or charity sectors to getting engaged in contributing to society in the wider community or being an activist operating in the field of social justice. Though there is now quite an extensive debate about higher education and the public good (Calhoun, 2006; Leibowitz, 2012; Marginson, 2018; Nixon, 2011; Walker, Dison, McClean, & Vaughan, 2010), almost none of it relates to doctoral students, with a few exceptions (Cloete, 2015; Cloete, Mouton, & Sheppard, 2015). Some of the generic work on public good and HE looks at how universities can become a public space where matters of public concern can be debated but much of the rest refers to marketized higher education systems and whether a degree is a private or public good (Deem & McCowan, 2018g). However, the need for a public space/dialogue about academic knowledge is more relevant to doctoral education and is exactly the kind of activity to which Burawoy's public sociology refers.

Locatelli makes a useful distinction between education *as* a public good (which might relate to the degrees that students get and who benefits from them) and education *for* the public good (which could be outreach work to communities not traditionally engaged in higher education or contributing to public understanding of science), highlighting in turn both its intrinsic and instrumental value (Locatelli, 2017). I want to focus here mainly on education *for* the public good, although there is still an issue in many countries, and not just in the global south, about who gets recruited to do a doctorate (Cloete, 2015; Wakeling & Hampden-Thompson, 2013; Wakeling & Laurison, 2017). Selecting those who have already had the best educational opportunities for doctoral study may miss out those who have not performed to their full potential at first degree level, for reasons related to a range of factors known to impede optimum academic performance such as gender, 'race' and ethnicity or disability. Furthermore not everyone accepts the argument that only the 'top' institutions should be allowed to recruit doctoral researchers and publish research papers (Altbach & De Wit, 2018). Beyond that though, there are a series of things that could be done to make doctoral candidates and graduates aware of how to use their new skills and expertise for the benefit of others. This goes well beyond what are often seen as the attributes of doctoral candidates. In 2017 David Bogle from University College London, speaking at a UK Council event on doctoral education in Stratford on Avon, England, said:

> Universities' goal, … must be to create doctoral graduates who are 'creative, critical, autonomous intellectual risk-takers' and could act as 'drivers of their professional development'. With skills development now 'the cornerstone of the modern doctorate', institutions should start thinking of the candidate as the central 'product' and the thesis as just an important piece of supporting evidence. (Reisz, 2017)

This is fine as a starting point but much more could be done. Public good activities might start with more experienced doctoral candidates mentoring other earlier stage doctoral researchers, which would help with wellbeing as mentees could be reassured that they will sometimes feel down but that based on the mentors once having felt the same, those feelings will become easier to manage and deal with. Public good related activities outside the university could include early stage researchers undertaking voluntary work in their local communities, choosing something which uses their academic expertise. For example, in the UK there is a scheme called the Brilliant Club enabling doctoral candidates to work with school students. There are two routes, one a Scholars Programme which allows doctoral and postdoctoral researchers to provide academic enrichment sessions, trips and tutorials to pupils from 10–18 years old and the other a Researchers in Schools programme which offers a special route for PhD graduates to qualify as school teachers. We could encourage doctoral candidates to see this work not as just their private job-related or voluntary activity but also as part of a process of co-creation and co-production of knowledge for wider societal use. Other possibilities are to engage doctoral researchers not just in teaching but also in undertaking pedagogic research on aspects of academics' teaching that require investigation, as a long standing National Science Foundation scheme involving 40 US universities does (see www.cirtl.net). Although this scheme is aimed ostensibly at improving undergraduate science teaching, a similar scheme could also provide skills and understanding of pedagogy which could be applied in the public sphere (e.g. in relation to public understanding of academic disciplines or in community-based lifelong learning). The University of British Columbia has introduced a real-life problem-solving approach to the doctoral thesis, whereby the findings have to involve end-users of the findings and also talking or presenting to the public about the study (Porter, 2019).

Although some researcher development programmes include workshops on translating doctoral research into something lay people can grasp or on preparing CVs for non-academic jobs, detailed support for developing the capacity to contribute to public understanding of science, social science and arts/humanities is thin on the ground in such programmes. Nor do researcher development programmes usually provide help for those who would like a future role as public intellectuals or what Gramsci called organic intellectuals (Gramsci, 1971), that is, actively seeking to use their academic knowledge and experience in everyday life, not just inside academe. Finally, creating spaces for debating current issues like education for and with the public, would be a good initiatives too, along the broad lines suggested by some of the commentators on the university and public good (Calhoun, 2006; Nixon, 2011; Walker et al., 2010). Introducing or extending these activities and encouraging supervisors to support participation at them, as that is often an issue for doctoral and postdoctoral researchers (Soubes, 2017), would help to focus doctoral candidates' attention on something much more productive than just becoming ultra-competitive towards peers and working a 70-hour week, whilst also contributing to the public good. It might also mean more early stage researchers and their supervisors would start to question the marketization, financialization and overly performative emphasis on bibliometrics and rankings that preoccupy many universities around the world.

Concluding Thoughts

The intention of the chapter was to explore, from a sociological perspective, the possible links between the contemporary external and institutional contexts of doctoral education, contested debates about the purposes of universities in the twenty-first century, shifts in academic cultures away from collegial self-governance towards new managerialist management and 'boardist' (external stakeholder dominated) governance regimes and rising rates of poor mental health amongst early stage researchers. A second intention was to utilize Locatelli's (2017) notion of education for the public good and Burawoy's (2005) idea of a public sociology, by encouraging doctoral researchers and doctoral graduates to engage in public space dialogue on a variety of issues and also participate in learner focused lifelong learning, thus using their academic expertise and skills for the public good, regardless of what career they are pursuing. This could reduce doctoral researchers' depression and anxiety arising from a sense of being worthless or lacking academic capacity and give them a new sense of purpose as well as utilizing their academic expertise. Mental health and wellbeing are crucially important for doctoral researchers and wellbeing could be promoted beyond the scope of psychological and medical approaches or by encouraging individuals to take up hobbies in their free time. Instead, working for the public good would encourage social and cultural approaches involving the development of skills useful in civil society that would aid the public good *and* assist the wellbeing of doctoral candidates. Some examples have been provided but there could be many other initiatives beyond those.

The chapter began by looking at what it means for doctoral education to be globalized beyond merely competing for early stage researcher recruitment and some shared characteristics of doctoral programmes and thesis supervision. Next, an exploration of what constitutes the 'core business' and purposes of contemporary public universities revealed that even university leaders are uncertain whether they should focus on fund raising, protecting their reputation and league table position, employability or campaigning for the rights of students to an education which is not prohibitively expensive. Unfortunately, in the twenty-first century, universities' purposes seem to be moving inexorably away from cultural and social functions towards the economic end of the spectrum, leaving behind concerns such as citizenship. At the same time, a sharp rightward turn in global politics towards extreme forms of right-wing politics and social movements has unleashed a stream of criticism directed at universities, from disparaging remarks about the discredited role of 'experts' to condemnation of whole areas of the curriculum because they are considered to be purely ideological. The consequences of universities' organizational moves towards the power of manager-academics and external stakeholder members of university governing boards and universities conceived as businesses were also considered. Academics themselves are working long hours with ever more complex duties and responsibilities, losing the sense of academic labour as 'special' (Musselin, 2013) and finding their teaching and research constantly monitored and evaluated. Small wonder then that many doctoral candidates, all of whom work closely with academics, are experiencing, not just stress which is normal and can on occasions be beneficial but also symptoms of poor mental health such as depression and extreme anxiety. Doctoral students are right at the critical point between academic staff dissatisfied with their jobs and university managers overdetermining everything. The state of academic work and the capacity of academics to supervise their doctoral researchers and care for their wellbeing is being severely tested and even for those doctoral education participants who want to become academics, the role is increasingly seen as less attractive and as offering mainly precarious, badly paid, employment as part-time teachers or research assistants which may further depress wellbeing.

There are ways forward. Applicants for doctoral degrees need hard facts on employment prospects from the universities and departments/disciplines they are applying to but also require alerting to things like the growth of hybrid part-academic, part-administrative jobs in HE in areas like research impact and research management and the vast range of third and private sector jobs they could also apply for. Instead of HEIs teaching doctoral candidates to be ultra-competitive people with no time for work/life balance (both are contra-indications for good mental health), universities could offer as part of researcher development, applied activities which focus on postdoctoral life as a force for public good, using elements of the work undertaken for the thesis as well as developing new skills and looking outwards to local communities, so that doctoral researchers become a powerful means of university regional outreach. Doctoral researchers could help set up these activities and ensure their peers engage with whatever is designed. Activities could be developed via voluntary work, helping school students or adult learners from disadvantaged backgrounds to achieve their educational aspirations or learning how to be involved in public understanding of science, social science and arts/humanities and becoming public intellectuals. Some people have expressed doubt that all higher education systems could support activities of this kind but the point is that the exact nature of the activities needs to be related to the cultural and social context; the suggestions presented here are illustrative rather than prescriptive. Universities doing this would be taking a small step in addressing the decline of the contemporary university into a kind of underfunded training organization whose leaders are pre-occupied by fund raising and league tables but it is an important one. Those same universities might also care to re-examine the tendency to over-manage academic work itself, much as Ghent University in Belgium has begun to do (Redden, 2019) and to question why they are so driven by metrics and league tables. Several goals could then be achieved at the same time—greater academic autonomy over research foci and other aspects of academic work, a new sense of public good purpose for universities and a better sense of wellbeing amongst doctoral researchers.

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Governmental Innovation Policies, Globalisation, and Change in Doctoral Education Worldwide: Are Doctoral Programmes Converging? Trends and Tensions

Maresi Nerad

Introduction

During the past 25 years, doctoral education around the world has received heightened attention by national and supranational policy makers; national funding agencies; and subsequently, social science researchers (Gokhberg, Meissner, Shmatko, & Auriol, 2016; Nerad, 1997; Shin, Kehm, & Jones, 2018; Walker, Golde, Jones, Bueschel, & Hutchings, 2008). Motivated by the belief that more PhDs will increase a country's innovation potential and in turn lead to economic growth, national governments and their research funding agencies have established special funding models and introduced quality assurance schemes to ascertain that their countries not only increase the numbers of PhDs produced but

M. Nerad (✉)
University of Washington, Seattle, WA, USA
e-mail: mnerad@uw.edu

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also produce quality training (Fortes, Kehm, & Mayekiso, 2014). Supranational organisations (e.g., the European Union, the Organisation for Economic Co-operation and Development [OECD], Association of Southeast Asian Nations [ASEAN, ten countries whose ministers of education/higher education meet regularly], and the World Bank) have made postgraduate education a target for policy attention and intervention (Nerad & Evans, 2014; Nerad & Heggelund, 2008). Comparison and ranking of higher education institutions worldwide (e.g., the Times Higher Education World *University Rankings* [THE], Quacquarelli Symonds [QS] World University Rankings, and *Academic Ranking* of *World Universities* [ARWU]) have also been a notable driving force in doctoral education changes and reforms, not only in countries of the Global North (e.g., the United States, Germany, and the United Kingdom) but also in emerging economies (e.g., China, Chile, Brazil, and India). In times of globalisation—defined as 'the intensified movement of goods, money, technology, information, people, ideas, and cultural practice across political and cultural boundaries' (Holtman, 2005, p. 14)—and in light of these rankings, universities now aspire to be of world-class research quality, and doctoral education plays an essential part in this aspiration.

Since the 1990s, an enormous increase in PhD production has occurred in countries as small as Iceland and as large as China; in countries, such as Germany, with a long tradition of doctoral education; and in others with much more recently established doctoral programmes (e.g., Malaysia, Saudi Arabia, South Korea, and Chile). For example, in the United Kingdom and in the United States, the number of doctoral degrees awarded doubled or tripled in the 25 years from 1991 to 2014 (United Kingdom from 8000 to 25,000; United States from 37,000 to 67,000),[1] while the number skyrocketed in China from 2000 to 54,000. At the same time, doctoral education systems have become part of an international context in which policy makers are aware of and responding to developments in higher education outside their national borders. The predominant models of reform in doctoral education used by governments are (a) monetary incentives in the form of direct funding to universities for desired outcomes, (b) competitive research-funding schemes for doctoral programmes with specified characteristics, offered by national research councils, and (c) individual scholarships and awards given directly to professors and doctoral candidates.

I have previously argued (Nerad, 2010) that globalisation has brought various 'converging practices' to graduate education worldwide, and that these practices have had different effects on different regions, past structures, and different academic cultures. I further argued that due to globalisation, universities must fulfil a dual mission: building a nation's infrastructure by preparing the next generation of professionals and scholars for the local and national labour market, inside and outside academia, and preparing their domestic and international students for a global labour market and an international scholarly community. I have noted that 'this dual mission has been often experienced as a tension, because universities in many ways operate under a sole national lens' (Nerad, 2010, p. 2).

Today, I notice additional trends resulting from more recent changes or longer experiences within doctoral education and the adverse impacts of globalisation on higher education, as well as from subsequent governmental innovation strategies aimed at improving a country's economic performance and finding solutions to national challenges that arise (Edler & Fagerberg, 2017; Goding, 2009). These trends are driven by simplified 'policy borrowing' from one nation's programmes to another nation and by simplistic, efficiency-driven assessment criteria that stifle creative research learning (e.g., overly short times to doctoral degrees) and often work against quality in doctoral education. The arguments and evidence presented in this chapter are a synthesis of the international research workshops and conferences undertaken by the Centre for Innovation and Research (CIRGE) over a period of 15 years, including publications on the impact of globalisation on doctoral education (Nerad, 2010; Nerad & Evans, 2014; Nerad & Heggelund, 2008).

Specifically, in this chapter, I explore the effects of globalisation and of national innovation strategies and national policies on doctoral education at the higher education system (macro) level and the subsequent reforms and changes in doctoral education at the department and programme (micro) level. These include reforms that have occurred in countries that have a central regulatory agency (i.e., ministry) that sets policy, as well as changes that have occurred in countries that have no major federal or state policies or national research council but rather that rely on initiatives by the universities themselves. This chapter will address four main questions:

1. What is the connection between globalisation, governmental innovation strategies and policies, and doctoral education?
2. What are the effects of governmental innovation policy and globalisation on national and regional higher education systems (macro level) and on individual doctoral programmes (micro level) within a local university context?
3. Are doctoral programmes converging?
4. What are the intended or unintended consequences of the recent changes in doctoral education?

The chapter will conclude by pointing to tensions that follow from the macro- and micro-level changes, including changes in funding, structure, and forms of doctoral education and training. The chapter makes the plea that forward-looking doctoral education needs to include learning at many levels, both inside and outside a university, and that doctoral education should commit itself to the social justice principles of inclusion, equity, and diversity and should be responsive to the social context in which doctoral research takes place.

The Connection Between Globalisation, Governmental Innovation Policies, and Doctoral Education

During the last three decades, just as in the decades before, universities and departments with postgraduate education had to respond to demands from external forces as well as to internal demands and to dynamics within their own universities. Up to approximately the 1990s, the *external* forces on doctoral education were the national labour market; national federal and state research funding; student financial support and aid policies; and the demographic and social developments of a country, including, of course, the particular historical development of the country's higher education system. Internal forces were the advancement in knowledge by individual departments, the size and composition of the student body, the local funding of students, the internal infrastructure to support doctoral education and research training on campus, and (mainly in the United States) intra-institutional competitive pressure through comparing and benchmarking with US peer institutions.

Today, globalisation and national ranking schemes have become major external and internal forces. The national pride gained by having at least one world-class university in their country and the desire for prestige by universities themselves to be ranked high among research universities in the world are further external forces and extrinsic motivations that prompt governments and universities to invest in the quantity and quality of doctoral education. Furthermore, international ranking schemes, such as the THE, include not only the total number of PhDs awarded as an indicator of quality but also the number of international doctoral students. The rational is that in today's globalised world, doctoral students can choose any university in any country, as long as they are admitted to study for a doctorate.

Globalisation has exerted a steady, substantial external pressure on doctoral education through various national governmental policies designed to promote innovation in response to globalisation pressures and competition. According to Edler and Fagerberg (2017), 'Innovation is understood as the introduction of new solutions in response to problems, challenges, or opportunities that arise in the social and/or economic environment' (p. 2). At the beginning of the 1990s, the terms *innovation strategies* and *innovation policies* became popular with policy makers. Innovation strategies are plans to achieve innovation objectives; innovation policies are a set of principles, rules, and regulations intended to implement the innovation strategies.

In a global marketplace, natural resources are no longer the key means for economic growth. Rather, innovation and technical changes have become the principal means of growing the economy and sustaining international competitiveness. In this new outlook, human capital—the knowledge, skills, and experience of a person and his or her ability to create new combinations of existing knowledge, capabilities, and resources—is regarded as the major source of change in all social and economy activities (Dill & van Vught, 2010). In addition, what matters economically and societally is 'not only the idea itself, but its exploitation in the economic and social system' (Edler & Fagerberg, 2017, p. 4). In other words, new knowledge and ideas need to be distributed and translated into knowledge-intensive products and services.

Since the advent of economic globalisation, which followed from the acceptance of the neoliberal economic model[2] and its concept of innovation and technological advances, governments everywhere have viewed knowledge as a critical national resource for economic growth, innovation, prosperity, and international competitiveness. In this model, universities are seen as significant knowledge producers and as agents for economic growth. This applies particularly to the natural sciences, engineering, health, and business fields. Starting around 1990, governments have provided substantial funding for efforts to build national capacities in research and development for the knowledge economy. Government started to incentivise the increased production of highly skilled knowledge professionals and the development of professional skills for doctoral and postdoctoral researchers. As a result of national innovation strategies to find new solutions in response to problems and to create opportunities for improved social and economic activities, around 2000, national funding agencies devised competitive funding schemes for the development of master's and doctoral programmes to train students for employment in multiple sectors, while increasing students' mobility; directing them towards problem-solving approaches in learning and research; and connecting them to industry, business, and local communities during their research.

For example, in Germany, the Graduiertenkollegs (theme-oriented, structured doctoral programs, starting in 2001) and the Excellence Initiative (starting in 2011) represent a new funding model geared towards postgraduate education and research training. The latter included in its concept the establishment of 'graduate schools'. In Japan, between 2002 and 2007, the Japanese Ministry of Education provided money for Centres for Excellence in which doctoral students worked alongside their professors; between 2011 and 2019, Japanese universities could apply for major grants to establish 'leading graduate schools'. In 2007, Malaysia develop the Tenth Malaysian Higher Education Action Plan, which subsequently asked through its MyBrain15 (2015) programme for an increase in doctoral education, to reach a target of 60,000 PhD holders by 2020 (Ministry of Higher Education Malaysia, 2007). This programme provided full financial support to PhD candidates. In 2018, MyBrainSc scholarships became available to Malaysian citizens who were currently pursuing or wanted to pursue undergraduate and postgraduate studies full time in the pure science fields (e.g., physics, chemistry, biology, and mathematics) at public universities (IPTA), private universities (IPTS), or leading overseas universities. Between 1999 and 2013, China established the National Doctoral Dissertation Project, which provided extra money and national recognition for the top 5% of completed dissertations. In 2013, the Chinese Ministry of Education, National Development and Reform Commission, and Ministry of Finance developed a strategic plan called Deepening of Postgraduate Education Reform that explicitly asked for the development of innovative abilities during the training of master's and doctoral students. India's Department of Science and Technology (DST, 2008) established an innovative programme named Innovation in Science Pursuit for Inspired Research (INSPIRE) to attract talents early, provide scholarships for higher education, and assure opportunities for research careers. Between 2010 and 2018, the Brazilian government developed and funded the Science without Border Program to promote the consolidation, expansion, and internationalisation of science, technology, and innovation and to improve Brazilian competitiveness through the exchange and international mobility (Stallivieri, 2015). New Zealand has taken an approach that is somewhat different from those just mentioned. Because of the country's small domestic workforce, New Zealand decided to allow international students to pay domestic fees, and in 2010, the government provided completion funding to universities for every master's and PhD degree completed (see the OECD Reviews of Innovation Policy [OECD, 2019]).

Thus we see that governments (and their relevant agencies) around the world view knowledge as a critical national resource for economic growth, innovation, prosperity, and international competitiveness. Not all policies are monetary; governments and universities alike have learned that if innovations and economic growth are to emerge from new knowledge, that knowledge must be disseminated effectively through publications, patents, and practical applications in society. Publications and patents are created mostly in connection with doctoral education and postdoc training. Increasingly, the translation from research to application in start-up companies is supported by grants from federal research funding agencies and involves doctoral candidates and postdoctoral fellows. It also involves funding for professional development workshops for doctoral and postdoctoral fellows, such as working effectively in teams, giving clear presentation, and developing budgets.

However, although these efforts have increased the number of doctoral recipients worldwide, not all countries have developed the next step, which involves providing the necessary infrastructure to absorb the newly minted doctorates who were to create innovation in public and private sectors. In light of the swift increase in doctorates and the interconnectedness of labour markets, finding adequate employment after the completion of a doctorate has become a new global concern for the individual doctorates and their professors. Not only have more PhDs been produced worldwide, but many postdoc positions have been established via competitive research grants all over Europe and in many Asian countries, where the completed PhDs move into quasi-holding positions before more permanent employment is found. Thus, the issue of employment for PhDs has shifted to the postdoc level in many countries, but not all.

The Impact of Governmental Innovation Policies Worldwide on Doctoral Education

The macro and micro impacts of innovation strategies to train innovators and highly skilled professionals for the knowledge economy are presented here and analysed for doctoral education at both the national and regional higher education (i.e., macro) level and the department and local university (i.e., micro) level.

Macro-Level Impacts: Growth, Reform, and Accountability

The macro-level impacts of national innovation strategies and their subsequent policies on the national higher education and research systems levels are felt in

- the increased proliferation of doctoral programmes and the diversity of their student bodies;
- a change in the mode of research that is produced, which emphasises workforce preparedness, the importance of working in multidisciplinary teams, and the importance of translational research and skills;
- the development and allocation of governmental grant funds for competitive funding schemes in order to foster human capital development;
- a quest for greater accountability and increased collection of output data through accreditation schemes;
- increased global communication and the creation of international networks; and
- governmental support for returning expatriates with a visible research profile.

Degree Production and Diversity of Students

The most visible macro-level effect of governmental attention to and intervention in doctoral and master's education has been the sheer growth in the number of master's and doctoral degrees earned all over the world, particularly in Asia (Table 1).

Some countries (e.g., Malaysia, China, and Japan) have set targets for the increase of PhDs. In China, for example, growth in master's degrees was more than tenfold from 1991 to 2014 (Fig. 1), with growth in doctoral

Table 1 Increase in PhD production 1991–2014

Country	1991	2004	2008	2012	2014
Australia	N/A	5000	6500	6547	8400
Brazil	N/A	N/A	10,700	13,912	16,745
China	2000	23,400	43,800	51,713	53,653
Germany	22,000	23,100	25,600	26,807	28,147
India	N/A	17,850	18,700	21,544*	21,830
Japan	10,000	16,900	17,300	15,911*	15,045
Russia**	N/A	29,850	27,700	34,403	36,533
South Korea	1000	7950	9400	12,243	12,931
United Kingdom	8000	15,300	16,600	20,438	25,020
United States	37,000	48,500	61,730	62,071	67,591

Source NSF Science Indicators 2016 and 2018, chapter 2, Appendix Table 2–37
*The values for India and Japan correspond to 2011
**The numbers for Russia are ABD numbers, i.e. indicate the numbers of people who completed doctoral studies, but not the PhD dissertation

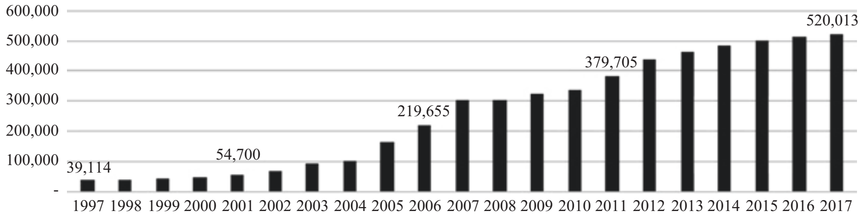

Fig. 1 Increase in master's degrees in China (1997–2017). (*Source* Minister of Higher Education of China, *Data Digest 2019*)

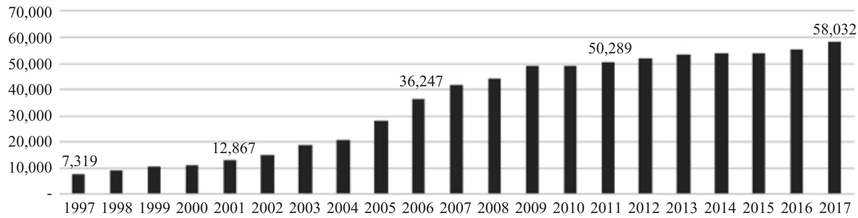

Fig. 2 Increase in doctoral degrees in China (1997–2017). (*Source* Minister of Higher Education of China, *Data Digest 2019*)

degrees more than fivefold for the same period (Fig. 2). For growth in doctoral degrees earned worldwide between 1991 and 2014, see the National Science Board (2012, 2014, 2016, 2018) and Organisation for Economic Co-operation and Development (2016), and the World Economic Forum (Gray, 2017).

The proliferation in master's and doctoral programmes has created a more diverse student body in universities around the world. When the data are disaggregated by gender, the extent to which women's participation in PhD programmes has increased in many countries becomes visible. For example, the percentage of women among PhD recipients increased in Australia from 41% in 2000 to 50% in 2015, in Japan from 19% to 31%, in the United Kingdom from 38% to 50%, in the United States from 44% to 50%, in Germany from 34% to 45%, and in Portugal from 49% to 54% (OECD, 2016). The percentage of older students has also increased, coupled with an increase of part-time PhD students (Gardner & Gopaul, 2012). After having worked for some time, devoting time to raising children, or both, older students return to advance their education and acquire expert professional knowledge.

Professional doctorates have also increased in the fields of public health; nursing; business; social work; and more recently, in fields such as physical therapy and audiology, at least in the United Kingdom, the United States, and Australia. In the United States, for example, professional doctoral programmes in newly professional doctoral fields skyrocketed 'from near 0 in 2000 to about 650 programmes by 2015, with more than 12,000 degrees awarded in 2014' (Zusman, 2017, p. 33).

In addition, the flow of international doctoral students has increased for several reasons (OECD, 2018, pp. 228–229; Nerad, 2010). Because post-industrial societies need knowledge workers for the knowledge economy, international students are recruited, especially when sufficient numbers of highly trained domestic young people are not readily available. Countries with low birth rates or shrinking populations (e.g., the United Kingdom, Germany, the Scandinavian countries, Japan, and Australia) have sought to attract highly skilled professionals for postgraduate education, particularly programmes in science, engineering, mathematics, and agriculture, with the hope that these qualified international students will join the host countries' workforces (see OECD, 2018, p. 229, 2019). Furthermore, the economic crisis of 2008 drove many universities in the Global North to make up for shortfalls in governmental funding by recruiting more international students. Even in the United States, where active recruitment of international doctoral students has been rare, efforts are now being made to recruit international students, especially into professional master's programmes at public universities.

Emerging nations with flourishing economies (e.g., China, India, South Korea, Malaysia, and Indonesia) also need highly trained professionals for their growing economies. To fill this need, these countries have established national fellowships for their own people to participate in doctoral education abroad, while simultaneously increasing PhD production at home. One such new type of fellowship to keep more students at home is exemplified by the India Prime Minister Research Fellowship of 2019, designed to attract students to stay at home in one of India's premier higher education institutions.

Until recent political circumstances (e.g., Brexit in the United Kingdom and the Trump administration in the United States), the flow of international students from the Global South to the Global North (i.e., mainly to the United Kingdom, Central Europe, the United States, Australia, and New Zealand) occurred as a result of governments in emerging nations creating competitive fellowships for their best students to study fully or partially abroad. In some countries, students on such a fellowship had to be accepted to one of the top 150 'world-class' universities, with the condition they return home and contribute their new advanced knowledge by working in their home country's internal labour force. Until 2016, this was the case in Brazil's Science Without Borders Program,[3] and it is still the case in Mexico, Chile, China, Thailand, and Columbia. Students in these countries are provided fellowships for the entire duration of their doctoral studies, or (as is the case in China) for one or two years of study. These students return to their home countries with a degree in hand; however, these countries do not always have provisions to absorb the new PhDs in academia or in industry or business (Chiappa & Perez Mejias, 2019).

Another reason for the increase in PhDs is that more students are completing their doctoral studies, in part due to the role played by government accountability schemes. In the United States, for example, a group of top research universities (Nerad & Cerny, 1991; Nerad & Miller, 1996) and the US Council of Graduate Schools (CGS, 2010) drove the efforts to decrease doctoral attrition and undertook research to shed light on how to increase doctoral completion. In some countries (e.g., Australia, New Zealand, and South Africa), the government provides money to universities for each completed PhD. While this top-down monetary incentive works in some cases, it also can work against the quality of degrees, as I will discuss later.

Mode of Knowledge Production: Multidisciplinary Teams and Translational Research

Governmental innovation policies focus on linking universities closer to society. This has been occurring mainly in natural sciences and engineering, but is increasingly occurring in other fields, as well. The production of knowledge has changed to what is called in sociological and higher education terms a shift to mode 2 knowledge production (Gibbons et al., 1994). This approach contrasts with the traditional knowledge production known as mode 1, in which learning takes place with one master scholar within one discipline. Universities and doctoral programmes are now linking more closely to the larger society and have moved away from mode 1 production. In mode 2, doctoral education and its research training are increasingly organised around a problem-solving approach that uses multidisciplinary teams and includes participants from industry, business, and government, often across multiple countries. Mode 2 knowledge production emphasises the theory-practice relationship and translational research, whereby basic findings are given practical societal applications, assuring knowledge transfer. The new mode of research production does not stop at basic research findings but translates them into applications that address societal and business needs. Examples are universities working with industry in research hubs, such as in the US Silicon Valley and in the Food Valley at Wageningen, between the university of Wageningen and the agri-business of the Netherlands.

In support of this trend, many national research councils have established separate funding tracks for university-based start-ups. In turn, universities have established technology transfer centres, sometimes called centres for commercialisation (e.g., at the University of Washington, Seattle, now called CoMotion). These offices support the process of knowledge transfer from the university to industry and business sectors, with the hope that products will derive from university-created knowledge. Some universities establish their own incubator companies and hope to reap profits from their innovations and to create new income sources. In this process, these centres hire local staff for administration, accounting, and legal services. These on-campus incubators also function like small local economic engines.

Specifically, change in the mode thorough which research is produced has had what is perhaps one of the most significant impacts on the micro level of doctoral education. As will be discussed in the section on micro-level changes, the new research mode 2 has contributed to a situation where more than solely academic skills and knowledge is asked of today's doctoral candidates.

Governmental Funding Schemes, Flagship Programmes: Policy Borrowing

To elevate a nation's status and to signal national preparedness for innovation in the employment sector, governments strive to establish and sustain a world-class status within their universities. A university's attainment of world-class ranking, and thus its ability to attract excellent students and academic staff, is not only a matter of pride and prestige but is linked to the hope of attracting substantial business and industrial investments in a particular region or nation.[4] Being able to move up to a world-class university ranking requires postgraduate programmes of the highest quality. Governments have addressed this requirement with substantial initiatives that seek to reform and elevate the quality of graduate education, increase the number of doctoral students and completed doctoral degrees, improve facilities and build new research centres, sponsor international conferences, and fund study abroad initiatives. An example of such initiatives is Japan's Centres of Excellence Program (2002–2007) and its Program for Leading Graduate Schools (2011–2019). Other examples of past initiatives include the German Excellence Initiative, Malaysia's Accelerated Program for Excellence of 2007 (the APEX program), and China's Project 985 as well as its latest reform policy of Double First-Class Rate of 2015 (i.e., world-class university and first-rate discipline).

Governments and their funding agencies often borrow policies across national boundaries. The Malaysian government invited the German Wissenschaftrat to advise them on their excellence initiative, which resulted in Malaysia's model called the Apex University competition. Gita Steoner Khamsi's (2016) empirical research studies have found that policy borrowing[5] helps to mobilise financial resources, 'especially when it is preceded by political talk of falling behind some international standards or best practices' (p. 382).

One area where policy borrowing has taken place across national boundaries is the creation and funding of grant programmes. National and regional research councils have implemented well-funded, competitive grant programmes that solicit innovative, collaborative, multidisciplinary, and often multinational models of doctoral education, with the goal of training a globally engaged workforce. These very selective national flagship programmes are more common in the science, technology, and engineering, and mathematics (STEM) fields than in the humanities or the arts. Although they primarily fund students and programme expenses rather than academic staff, they are intended as a catalyst for cultural change at the micro level, targeted at the education and training of students, professors, and institutions alike. Examples include the European Commission's Erasmus Mundus programmes at the master's level and the Innovative Training Networks (ITN) at the doctoral level; the National Science Foundation's Research Traineeship programme (NRT) in the United States (an earlier iteration of this programme was the Integrative Graduate Education and Research Traineeship Program); the Cooperative Research Centres Programme in Australia; and the German Excellence Graduate Schools and earlier forms of this country's research training group programmes (Graduiertenkolleg). With the aim of better preparing versatile, highly trained professionals to address large-scale problems of industrial societies that cannot be solved through a single disciplinary focus or by a single researcher, these multidisciplinary programmes emphasise skill building, the learning environment, international collaboration, visits by students to other universities, and the geographical and intersectoral mobility represented by internships in non-academic settings. These new doctoral programmes focus mostly on real-world problems, such as environmental issues (e.g., climate change), data security, and nanotechnology, to name a few.

These new regional or national funding schemes are intended to play a catalytic role on campuses and at the doctoral programme level by enticing other departments and their faculty to emulate their novel structures. Governments often forget that other programmes have neither the finances nor the necessary staff to offer such elaborate programmes. For example, many of these programmes require research stays in another university outside the country, so that doctoral students will not only acquire specialised research skills and have access to instrumentation and new methods not available at their own programme but also will learn intercultural communication competencies. These truly important features for today's globalised world and labour market require trained administrative staff, mostly included in the funding of flagship programmes but missing at many universities and programmes. The spread of doctoral programmes with novel structures often stops due to the lack of local administrative staff who are professionally trained and understand the intricacies of international travel arrangements, such as visa requirements, currency restrictions, and foreign language skills.

Accountability and Data Collection

In light of the rapid expansion of doctoral education and the increased mobility of doctoral candidates, governments and private agencies invested in higher education have established standards and schemes to guarantee the quality of higher education, including doctoral education. These measures are intended to uphold comparable standards among doctoral programmes and doctoral theses by defining those standards externally and then determining whether particular programmes and dissertation research comply with them. For example, such comparable quality standards are important for multinational consortia to agree to exchanges at the doctoral level. Also, academic and non-academic employers of doctoral degree holders want assurance of university-quality training. Quality assurance measures also legitimise differences between programmes so that action can be taken regarding resource allocation and even the permission to run a doctoral programme.

Furthermore, quality assurance has become instrumental in diminishing the migration of talented graduate students because it aims to provide those students with higher quality education at home, and it promotes the establishment of standards for dealing with the rapid expansion of for-profit graduate programmes (Fortes et al., 2014). It also is a means to attract quality international doctoral students. In the United States, the National Research Council assesses the quality of doctoral programmes every ten years, most recently in 2010. Australia and New Zealand implemented various quality assurance exercises in the 1990s; since then, the European University Association's Council for Doctoral Education[6] has also developed assessment mechanisms. Trends for adopting quality assurance schemes also are visible in newly established accreditation agencies in Europe (see the chapter by Cardoso, Rosa & Miguéis) Japan, India, and most recently by the Research Funding Council (FNR) of

Luxembourg (2017).[7] These requirements are followed by the collection and reporting of substantial national data to the national government and to these national quality assurance and assessment agencies. The proportion of quantitative data assessment to qualitative programme assessment varies from country to country. In the section on micro-level effects, I will describe university and programme quality assurance criteria in detail.

When quantitative doctoral education data (e.g., the number of doctoral degrees produced and the number of academic journal articles published) are the main criteria rewarded with additional governmental funding, the quality of doctoral training often suffers a negative impact, as the programme may focus on the quantity rather than quality of the degree produced. Examples of the adverse impact of governmental policies on funding incentives can be found in South Africa and China, where universities put pressure on doctoral programmes to increase the output of degrees, with little attention to the quality of the research and dissertations produced.

Communication and International Networks

Increased global communication is driven by technological innovation. The new computing information systems make communication across vast spaces easier, faster, and more widespread. As a result, scholarly networks have formed rapidly that are actively and explicitly supported by the European Union, international foundations, and governmental agencies (e.g., the German Academic Exchange Service [DAAD], the National Science Foundation and National Institute of Health in the United States, the Association of Southeast Asian Nations [ASEAN], Mercosur[8] countries, and African countries).

Governments and regional organisations are encouraging and funding international collaborations in research and degree offerings. Universities are actively pursuing these activities, which are now financially supported. For example, universities have established various joint or dual graduate and doctoral degrees. Research universities are keen to get the best possible students to their campuses. They also connect internationally with other universities to use facilities and instrumentation they lack (Nerad & Evans, 2014). For example, the European Union and the United States have established international summer schools and special funding for time abroad in another laboratory or for the opportunity to work with another research group. These various international networks and collaborations prepare researchers to function globally. Currently, most research universities have many memorandums of understanding (MOU), established in the first rush of excitement about international collaborations by individual faculty members, without a coherent campus strategy; many are now dormant or 'dead', as the faculty members have retired or moved on to other research areas. After this early rapid, often spontaneous start, many universities are developing more coherent, university-wide internationalisation plans that include models for the international experiences of their master's and doctoral students (Mitchell, Besterfiled-Sacre, Bhandari, & Jesiek, 2019).

Support for the Returning Expatriate

In a relatively new worldwide trend, some governments seek to interest their expatriate doctoral recipients in returning home. France, Portugal, and Germany, for example, sponsor get-togethers in the United States and other countries, where native doctoral students or postdocs living abroad are informed about employment opportunities in the students' home countries. China grants returning doctorates the status of local residents in major cities (a status that is difficult to attain), as well as tax and monetary incentives to start their own businesses and funds to reside in China temporarily, while lecturing and sharing knowledge or setting up research groups in Chinese universities. Since 2016, India has developed a few lucrative fellowships and incentives for expatriate scientists and engineer at all career levels to bring knowledge home through yearlong visits or returning permanently. These new fellowships are the Ramanujan Fellowship for young scientists and engineers by the Indian Ministry of Science and Technology, and the Ramalingaswamy Re-entry Fellowship for highly skilled researchers up to age 45 in various fields of biotechnology and life sciences.

Unfortunately, most of these governmental funding schemes and special additional financial allocations are focused on STEM fields. The social sciences, and particularly the humanities and arts, are only marginally included or are total excluded from the various national funding schemes. In the United States and in most of Asia, preference is given to STEM fields. Increasingly in Europe, the National Research Council's budgets are weighted towards the STEM fields. This imbalance between major fields of study with respect to funding for doctoral education programmes and research grants is painfully felt at the micro level all around the world. In the next section, I shift to discussion of the micro-level impacts of the macro-level reforms, as they are felt at the nation's universities and individual departments and doctoral programmes.

Micro-Level Impacts: Commonalities and Competencies

Most macro-level reforms have been developed expressly for their potential impact at the individual doctoral programme level (i.e., the micro level). In fact, the reforms just discussed have brought both major and minor changes to the structure and operation of doctoral education and training in many countries. Countries have various starting points and different histories and local structures; therefore, doctoral programmes worldwide can be expected to vary. However, common structures and requirements are increasingly found. Specifically, the micro-level impacts of governmental innovation policies on national higher education and research systems can be classified as the following:

- Macro-level changes and reforms demand more competencies from the next generation of doctoral candidates than in the past. More structured doctoral programmes can ensure that students not only finish in a reasonable time but also receive current professional development training.
- In many universities and doctoral programmes, doctoral supervision has shifted from a single doctoral supervisor[9] to two or a committee of supervisors. This change is a paradigm shift from the master-apprentice model to a multi-level advising and mentoring model.

- Doctoral programmes' quality assurance schemes are increasingly observed at the programme and university levels. These follow the input, throughput, and output quality assurance model commonly used in business.
- The use of the English language in doctoral education is prevalent worldwide.
- More defined admission criteria and selection mechanisms have been established, and many doctoral programmes offer three years of funding.
- Attention is paid to the length of doctoral degree programmes worldwide.
- Career planning during doctoral education, more and more, has become an accepted responsibility of doctoral programmes and campus career centres.
- Greater diversification in the forms of dissertations and of doctoral degrees is now accepted.
- A central campus graduate school or graduate division, as is found in US research universities, or a central organisational unit that supports early career researchers (ECR) has been established in some countries.
- An input, throughput, and output quality assurance model is increasingly being used to set up new programmes and assess existing doctoral programmes.
- National doctoral flagship programmes combine many of these micro-level changes into well-structured doctoral programmes.

More Is Being Asked of the Next Generation of Researchers

The competencies that are demanded from changed workplaces inside and outside academia encompass academic, professional, and cultural competencies and skills. The traditional academic knowledge, skills, and competencies include critical thinking, analytical skills, writing, synthesis, research integrity, and ethical conduct of research. These competencies are customarily considered central in doctoral education, such as in-depth knowledge of one's field, knowledge of the development of conceptual frameworks and research designs, knowledge of the application of appropriate research methods, and skills in writing and publishing research findings. These competencies were called 'PhD-completion skills' by Rudd, Nerad, Emory, and Picciano (2008). They are developed in the normal course of mastering specialised knowledge and contribute to original research.

Ethics training, or training in responsible research conduct, is increasingly required from doctoral candidates as part of undertaking research. Cases of dissertation plagiarism by politicians in several European countries (e.g., Germany, Portugal) brought attention to ethics in research in Europe. In the United States, ethics training has been standard in all fields of research that involve people or animals. The use of software to check for plagiarism has become the norm in many universities in Europe, the United States, and Australasia.

Professional competencies,[10] also called *generic skills* in the United Kingdom and Australia, were not traditional by-products of completing a doctorate. They include knowing how to teach and design a course syllabus; communicating complex research findings to diverse audiences; working in multi-, trans, or interdisciplinary teams; writing grants; applying knowledge in commercially viable and socially responsible ways; managing people and budgets; and taking on leadership roles in complex organisations. Universities in the United Kingdom, central Europe, Australia, New Zealand, and the United States offer these competencies and skills in special workshops (Nerad, 2015).

Lastly, cultural competencies are pertinent to effective collaboration in international teams, including working with people of different backgrounds, races, ethnicities, cultures, and religions, and with people who hold different perspectives from one's own. As competent writers, speakers, and team members, today's doctoral candidates are expected to communicate their research results effectively inside and outside of the university.

It can take considerable time for doctoral candidates to meet all these new expectations—which are requirements in some countries (e.g., the United Kingdom) in form of workshop participation—either in practice or in true life situations. However, many government efficiency measures have adhered to the Bologna Agreement specified in the Berlin meeting of the European ministers in 2003, which defined a model for a three-year undergraduate degree, a two-year master's degree, and a three-year doctoral degree. When more is asked from the current doctoral student, and yet the time to complete a degree is limited to three years, tensions can arise. While the focus on professional skills is widely acknowledged as useful and welcome, critique and concerns about the quality of the research and the breadth of the education and training have increasingly been voiced. In the section on shortening the time to degree, I will discuss the ramifications of an increase in competencies with a simultaneous increase in pressure to shorten time to degree.

A Paradigm Shift in Supervision

In the past, traditional doctoral programmes under an apprenticeship model depended on one master professor being the sole person to whom a doctoral candidate could turn and from whom he or she learned how to conduct research. This Humboldtian concept of one master/one student did not include taking a course. It was and often still is focused solely on undertaking a research project presented in a dissertation. This fact, plus the situation in which people undertake their dissertation research while working at the university as employees without student status, led to terminology that distinguished doctoral training from doctoral education. Doctoral training has mostly been used in Europe and in countries employing the Humboldtian concept of one master/one student (e.g., in Japan).

Given the heightened emphasis on increasing the number of doctoral degrees and on securing quality research education, funding agencies proposed a shift away from a single supervisor to a team of two supervisors or a dissertation committee. This paradigm shift away from the traditional apprenticeship model tries, among other things, to reduce the doctoral candidate's dependence on a single person and broadens input to multiple sources (Nerad, 2012). For example, the German government-funded Excellence Initiative required an advising scheme of at least two professors and a structured doctoral programme. Attention in doctoral education is moving towards acknowledging not just the dissertation as a singular outcome but also the importance of the process and the learning environment (Manathunga, 2014).

Recent empirical research (Flores & Nerad, 2012) indicated that apprenticeship as the sole learning model is too narrow an approach for students to acquire the competencies needed today. However, the practice of joint supervision of a dissertation committee, with each member having equal power and with one main advisor expected to provide substantial professional training, has existed in the United States for decades. This model, together with a more structured learning process and a predetermined number of classes to be taken (e.g., in research methodology), has proven to create more academic freedom and diverse guidance for the doctoral candidate on his or her way to becoming a junior scholar. This type of supervision has been emulated by many doctoral programmes around the world, but certainly not by all. Such a paradigm shift is a slow process. It involves an attitudinal shift by professors who are no longer esteemed as the single best scholarly authority. Notably, doctoral programmes without external funding are slow to change.

In addition to these substantial changes at the programme level, other modifications for postgraduate students and professors have occurred, often with significant impact. One is the use of English as a medium of instruction; others include transparent admission criteria, more career planning during one's studies, and the acceptance of various dissertation formats.

The Prevalence of English

The governmental goal of increasing the number of doctoral students and the universities' search for increased revenues have made recruiting international doctoral students attractive. Countries with languages not widely spoken began switching to English in their instruction at the doctoral level. For example, South Korea included English in university teaching, and especially in graduate courses in their national internationalisation strategy for South Korean universities. Around the world, English has become the lingua franca of doctoral education, and many scholarly journals are published in the English language. The use of a common language allows students greater mobility and provides greater visibility for their research when they are also able to publish in English journals.

At the same time, the use of English as doctoral education's common language gives an advantage to students from English-speaking countries as well as to those who have had access to English-language schooling before entering their graduate programmes. Lately, nationalistic movements around the world have attacked universities for the widespread use of English in their classes. Because one of a university's key roles is to pass on societal knowledge, including the national cultural heritage and literature, teaching in English at the doctoral level has been criticised by certain governments. Specifically, governments in countries with endangered languages are raising concerns about losing their literature and language heritage, and about not passing this heritage on to the next generation. The most recent occurrences have been reported from Denmark (personal e-mail with a graduate dean in Denmark, Sept. 2018; *University World News*, 2019).

Admission Practices and Funding Packages

Admitting more doctoral students and more international doctoral students has led to an admission process that has become more defined, more transparent, and more competitive. However, in many countries, mixed models still exist whereby the faculty in an entire department makes the admission decision; in others, individual faculty still make the decision. In Europe, some universities have used the *European Code of Conduct for the Recruitment of Researchers* by the European Commission EURAXESS[11] as a basis for the application requirements and doctoral admission processes. After application packages are screened, the most promising applicants, including international students, are personally interviewed or otherwise invited to Skype interviews. More countries (e.g., Mexico, India, and Germany) now allow fast-track access to doctoral programmes, whereby applicants are admitted after the completion of a bachelor's degree, without having to earn a master's degree first.

The new worldwide competition among doctoral students has pressured many doctoral programmes to offer three years of funding to outstanding applicants, with benchmarks and timelines towards degree completion. In some countries, student funding comes directly from the government (e.g., Denmark, China, and Luxembourg). In others, funding is indirect; in the United States, for example, funding comes from the federal government through research grants, from state governments through teaching assistantships, or from private foundations. Increasingly, universities and academic departments are approaching private donors to raise funds for doctoral fellowships, especially in the social sciences and humanities. While funding for innovation is expected in the science and technology fields, most governments today provide less grant funding and fewer scholarships to humanities and social science students; hence, universities have increased fundraising efforts with private donors for these fields.

The Length of Doctoral Studies

Time to doctoral degree has increasingly become a concern for doctoral funding agencies, such as national research councils, private foundations, and accreditation agencies. Accordingly, universities and doctoral programmes have made time to degree a matter of attention. For doctoral degrees, time to completion differs. In Europe, under the Bologna Agreement, the expected time to completion is three years; in the United States it is five years, a period that may include completion of the master's degree as well. Time to degree is an efficiency measure. It conveys little about quality. Flagship programmes with ample funding try to adhere to their funder's specified time to degree.

Until recently, Germany, for example, was not able to determine the average time to doctoral degree completion because candidates only registered officially until they were ready to set their final examination date. However, to receive funding from governmental funding schemes, such as the European Marie Curie doctoral programme or an excellence graduate school, such doctoral candidates are required to register their doctoral study status from the beginning of their doctoral studies. Candidates therefore often enter such doctoral programmes when considerable portions of their dissertation research have already been undertaken, and thus a time of three years can be expected. Alternatively, students accept a given well-defined research project that reflects little of their own initiative with respect to finding a research topic and expect to complete that project in three years.

The effects of needing to complete their doctoral studies in three years creates additional stress on doctoral students because they are also asked to acquire professional competencies, as was discussed in an earlier section. Some funders and some doctoral programmes cut off financial support if the required time is exceeded. Attention to a more efficient time to degree completion is reasonable when doctoral students take 9 to 12 years to complete their degrees. Time to degree also varies by field of study. However, making three years the optimal time to complete doctoral studies forces the student's sole focus to be on the dissertation, without allowing time to master the breadth of various research methods and array of theories in that student's field.

Career Planning During Doctoral Education

Workforce preparedness has become the slogan for any kind of education, doctoral education included. An increasing number of doctoral programmes, in concert with their campus career placement centres or with newly established campus-wide Early Career Training centres (as in Germany, Austria, and Switzerland), provide career development and job application workshops. Many individual doctoral programmes have adopted the UK tradition of a career plan that doctoral candidates develop and that is annually reviewed by their supervisor or supervisory team and then updated by the candidates themselves. The idea behind this career plan is that it may lead to reflection and self-evaluation, resulting in purposeful steps towards learning additional competencies, earlier research publications, and more support for students completing their degrees. Such pedagogical thinking is well meaning. However, whether a career plan is already useful at the beginning of doctoral study, as is the case in some programmes, when the doctoral students are not sure whether to pursue an academic or non-academic career, is questionable.

Diversification of Degrees and Dissertation Formats

At the doctoral level, the most common degree remains the traditional research doctorate, or PhD. Agreement persists worldwide that holders of this degree will have obtained substantial knowledge in their relevant area of study and will have contributed to that knowledge through original research. The hope that the doctoral candidate has also undergone training in professional competencies (Bernstein et al., 2014) is more prevalent in national flagship programmes in the United Kingdom, Australia, and the United States, and within any of the European Commission-funded doctoral programmes. In the United Kingdom, Australia, and the United States, professional and practice-based doctoral programmes are growing (see the chapter by Kehm), with more weight placed on coursework than on training in research methods, and more emphasis on applied rather than original research (Zusman, 2017).

In some countries and disciplines, doctoral candidates may be able to choose between writing a traditional dissertation or submitting several peer-reviewed articles based on their own research that have been published or are likely to be accepted for publication. In the United States, this type of dissertation format is most common in economics, the biological sciences, and lately in fields such as public policy and higher education. The argument is that in these fields (i.e., economics and biological sciences), the most common academic discourse happens through academic journals and not through books. Therefore, while writing their dissertations, doctoral students should learn the most relevant form of presenting their research findings. In many doctoral programmes, the form in which the dissertation research is presented is still up to the main supervisor or dissertation committee.

Centralised Organised Unit for Doctoral and Postdoctoral Education

A central organisational unit that has existed for decades in the United States is the graduate school (or 'graduate division', as it is also called there). It grants the official degrees, collects dissertations, approves new doctoral degree programmes, determines financial support, and develops mechanisms for quality assurance. A US centralised university graduate school is headed by an academic graduate dean. The graduate school plays additional important roles on campus, including establishing basic policies regarding master's and doctoral education, as well as minimum requirements for admissions and doctoral degree completion. Each doctoral programme in a department has the freedom to set higher requirements. US graduate schools are advocates for the academic staff in their roles as advisors and also support the intellectual development of doctoral students, with a focus on student retention, time to degree, career development, and doctoral job placement (Nerad, 2008).

More recently, such centralised graduate schools have become established on university campuses in the United Kingdom, Australia, New Zealand, and China. In these countries (except China), graduate schools serve as advocates for graduate education with top university administrators. They develop guidelines for the overall process of graduate education, provide training in professional competencies, and offer incentives for excellence in academic mentoring. They also solicit students' evaluations regarding programme quality and the quality of professors' advising, and they have increasingly begun to track the careers of their graduates to collect outcome information (Council of Graduate Schools, 2015). In addition, a graduate school may establish procedures for earning a dual degree or a joint degree with another university.

A centralised unit in universities that supports doctoral education is a new phenomenon in Europe, Africa, some Asian countries, and Latin America. In Europe in recent years, we find two types of units in service of doctoral candidates: graduate schools (also called research schools or doctoral schools) and graduate academies (also called early career researcher centres). Graduate schools are hubs of multi- or interdisciplinary doctoral programmes in a major field of study. Many also serve postdoctoral fellows. For example, the Graduate School in Material Sciences at Gutenberg University in Mainz, Germany, includes chemistry, biology, and some engineering and the Bremen International Graduate School of Social Sciences (BIGSSS) in Germany, which focuses on the umbrella theme of 'changing patterns of social and political integration' is founded upon the core disciplines of political science, sociology, and psychology. These graduate schools offer academic, professional, and cultural competencies within their fields of study. The other type (graduate academies) are central units that offer support services related to professional and academic development as well as some financial assistance for all doctoral candidates and postdocs, regardless of field of study.[12]

Quality Assurance of Doctoral Programmes Locally

Increased accountability requests by governments, accreditation agencies, and funders have translated into a more explicit assessment of doctoral education in its various phases. Coupled with a better understanding of how people learn, more attention has been placed on the structure and learning environment of doctoral education (Maki & Borkowski, 2006). The new emphasis on learning sciences, human development, brain functions, and educational psychology research has found application in the way doctoral education is structured. Doctoral education is conceptualised in at least three distinct parts: getting started, getting through, and getting finished and getting a job. More and more, we find that structured programmes—and accordingly, the quality of doctoral education—is assessed using an input, throughput, and output model (Fig. 3).

Input measures assess the entrance score of doctoral admits, the status of the professors, and the campus infrastructure (e.g., library holdings and the quality of laboratories). *Throughput* measures include assessment of coursework (in systems where courses existed), assessment of doctoral

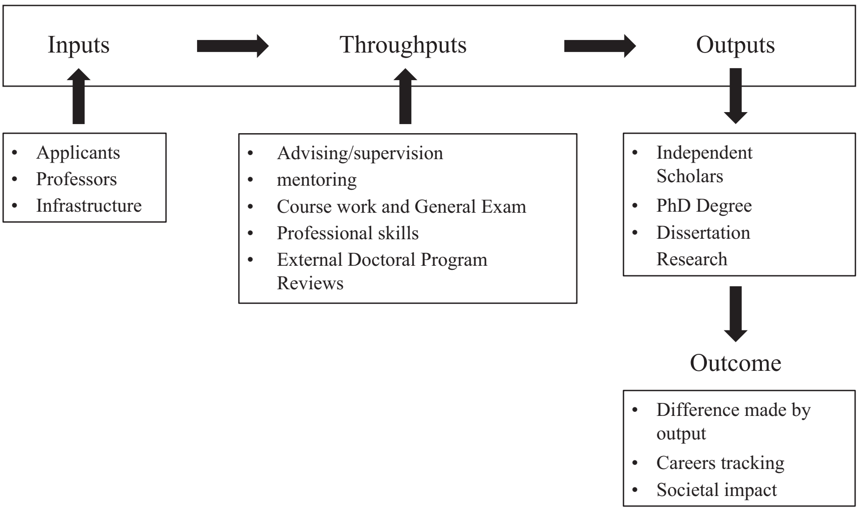

Fig. 3 Common quality assurance model in doctoral education

supervisors by advisees, external programme reviews and, increasingly, the existence of professional competencies workshops. *Output* measures are time to degree, doctoral-completion rates, employment of graduates, and, increasingly, contributions to identified research agendas (Nerad, 2014).

Governments, national funders, and regional consortiums that fund doctoral programmes require increased data collection. These days, at a minimum this includes data on time to doctoral degree; if possible, the percentage of doctoral completion; and if available, the first employment after degree completion.

Flagship Doctoral Programmes

National, well-funded, competitive flagship programmes have in their grant certain specifications, including many of the micro-level changes just described. These national or Europe-wide flagship programmes allow studying under ideal situations: in a well-funded, well-structured setting, with a small number of committed professors attending to a well-selected cohort of doctoral students. These programmes not only provide each doctoral student with extra research allowances but also pay attention to the theory that learning is a social act, and that social interaction boosts research as well. Once a year, new doctoral students are admitted as a group, and this new group, or cohort, of generally 12 students stays together throughout the structured part of the programme. In the process, they become peers and often work together and support each other. Such peer learning has proved to be an extremely important moral support mechanism for doctoral candidates (Flores & Nerad, 2012).

To better understand the many changes in doctoral education and training that have occurred, three examples of flagship programmes are presented in Table 2, along with their core characteristics and structure: the European Commission's flagship Innovative Training Networks (ITN) programme, the German Excellence Graduate School programme, and the US National Science Foundation's Research Traineeship (NRT; formerly the Integrated Graduate Education Research Training program [IGERT]). The ITN was chosen because it is one of the best-known current doctoral funding schemes in Europe. Professors from universities in all European Commission countries may apply for a three-year competitive

Table 2 Comparison of three flagship doctoral programmes

Features	European ITN	German GS	US NRT
Full funding of fellows (three years)	Yes	Yes	3–5 years
Interdisciplinary and theme-based	Yes	Yes	Yes
Structured programme with a 'road-plan plan'	Yes	Yes	Yes
Collective applicants' selection by academic staff	Yes	Yes	Yes
Organised in cohort	Yes	Yes	Yes
Explicit connection to non-academic world, secondments, internship	Yes	Recommended	Yes
English medium	Yes	Yes	Yes
Professional development activities	Yes	Yes	Yes
Each student has own research allowances			
International components	Yes	Yes	Yes

grant. The second example was part of the last two Germany Excellence Initiatives. An Excellence Initiative graduate school award has been the most outstanding academic sign of excellence for a doctoral programme during the last ten years in Germany. This competitive government-funding scheme included all the micro-level characteristics described here. Unfortunately, the 2019 German Excellence Initiative did not include any more the funding of graduate schools. The third example is the NRT programme in the United States, which is one of the most prestigious national doctoral education grant programmes.

Most characteristics of these three programmes are the same; however, the European ITN requires an international component and often an internship. Most German Excellence Initiative graduate schools and the US NTR also include an international research stay for doctoral students, although the grant programme does not necessarily require it. All three of these funding schemes have a focus on workforce preparedness, with explicit connections to other academic settings and the world outside academia.

Are Doctoral Programmes Converging?

On the macro level, we have seen a common trend whereby much governmental financial support comes in the form of competitive grants that target professors or groups of professors, doctoral students, and postdoctoral fellows directly, rather than instigating top-down reforms for all universities. This 'backdoor' reform focuses on human capital development embedded in research grants. The hope is that grants entice professors, doctoral students, and entire universities to show initiative in trying out changes in doctoral education and training. Funders also hope these well-funded doctoral programmes will have a spill-over effect on all of the doctoral education at a university.

I am arguing that the most elite forms of doctoral education, but not all doctoral programmes, are converging. The grant-funding schemes for national and supranational flagship doctoral programmes have resulted in a two-tier system. The first tier is a small group of well-funded, well-designed doctoral programmes with international components, often at already well-recognised universities and programmes. These mostly flagship programmes look alike. Indeed, these programmes are converging. The second tier includes many ordinary programmes that are less well funded but are carrying the mass of doctoral education. This bifurcation can exist within the same department of a university, as well as within departments at universities in the same country. This converging trend among flagship programmes has resulted in the intensified stratification of doctoral education training. Stratification has always existed between universities and between departments, but not within a department or in such extreme forms.

The new governmental grant-funding schemes for flagship doctoral programmes are often project focused.[13] However, since the grant funding's timing is limited (e.g., to a three-year or five-year grant, as seen in the German Excellence Initiative and US NRT funding), these doctoral programmes have resulted in 'ruins of innovation' in places where projects could not be continued after external funding ran out. The attempt to improve institutional structures through three-to-five-year funding, while universities in general remain underfunded, has become problematic and has increasingly created tensions.

One such tension is the new governmental monetary allocation in some countries that is given to universities for desired outcomes and that uses only quantitative indicators (e.g., increased numbers of completed doctoral degrees or of peer-reviewed publications). While these allocations have brought many positive changes in terms of degree completion rates and times to completion, the converging top-down, outcome-oriented incentive funding policy strategies have also resulted in institutional compliance behaviour rather than an improvement of the quality of doctoral education, as seen in South Africa and China (personal correspondence).

The world's doctoral programmes are converging around the value of educating and training creative and innovative researchers. However, a doctoral programme's goal of educating the next generation of researchers to be creative and innovative—with all the false starts and learning from the experience that this goal entails—along with funders' demands for the shortest possible time to degree completion have created a contradiction. Learning from mistakes is not allowed in a system that focuses solely on effectivity. Yet studies have shown that many innovations were created from false starts (Zuckerman, 1996).

While we find that some elements of doctoral programmes are becoming similar and that the structure and characteristics of national or supranational flagship programmes are converging, many doctoral programmes are still bound by their local, historical development, university conditions, and overall economic/political situation of their country. Yet, it is important to note that since the 1990s, doctoral education has been changing in a fast pace, compared with the pace in the decades after World War II and until 1990 (Kerr, 1994). Globalisation and governmental innovation policies accelerated these changes, both nationally and at the doctoral programme level.

Conclusion: Tensions and a Move Forward

In this chapter, I set out to inquire about recent governmental innovation policies and national frameworks that have targeted doctoral education. In most countries, these policies and their subsequent funding schemes were intended to be catalysts for doctoral education changes, including changes in the quality of doctoral education. We can indeed conclude that governmental innovation policies and their frameworks, national research councils, and regional and national funding agencies have been stimuli and initiators changing doctoral education. Whether these policies have always improved the quality of doctoral education is, however, questionable. It could be demonstrated that an increase in the number of doctoral recipients has occurred worldwide. While some changes certainly have improved the quality of doctoral programmes, especially in national flagship programmes, tensions at the doctoral programme level have become apparent. In conclusion, I offer a few observations about these current tensions.

First, the grant-funding schemes for national and supranational flagship doctoral programmes have resulted in a two-tier system and a new stratification in doctoral education training, beyond that defined by the so-called top universities and doctoral granting departments and by the majority of universities and departments. The first tier is a small group of well-funded, well-designed doctoral programmes with international components, with a very select group of doctoral students, often at already well-recognised universities. The second tier includes many regular programmes that are funded at lower levels but carry the mass of doctoral education. This bifurcation can exist within the same department, in universities within one country, and in universities across the globe. This new stratification sits on top of the already existing one. Both sets of stratification result in a situation where the value of a PhD awarded in one of the top 150 world-class universities counts more to academic employers than does a PhD awarded in one's own country.

Second, the new governmental monetary allocations to universities for desired outcomes (e.g., money for every new PhD produced or for every peer-reviewed publication) have resulted in institutional compliance behaviour in some places to receive extra funding, rather than in an improvement of the quality of doctoral education.

Third, tensions are arising between a doctoral programme's goal of educating the next generation of researchers to be creative and innovative—with all the false starts and learning from experience this goal entails—and funders' demands for the shortest possible time to degree completion.

Fourth, a notably negative effect of governmental innovation policies is their focus on the STEM and health fields, with the humanities, the arts, and the social sciences (with the exception of business administration) receiving less governmental funding. Doctoral programmes in the STEM disciplines and the biomedical fields are perceived to offer the strongest local and regional economic impact and are the first programmes to be supported financially and in other ways (e.g., with more space and better location on campus). As a result, the status and influence of doctoral programmes in the humanities and arts have diminished within their own institutions. Not only in the United States and in China, but increasingly in other countries (e.g., Slovenia, Czech Republic), these programmes are losing prominence and financial support on their own campuses.

Fifth, a university's goal of attaining world-class status creates tension between the university's and the doctoral programme's commitment to equity in terms of access of domestic groups who traditionally had little chance of pursuing a doctoral degree. With the goal of attaining top world-class status, doctoral programmes tend to admit risk-free doctoral students from top-ranked institutions, whose success is likely, rather than admitting promising first-generation domestic doctoral students from lower ranked universities who will require perhaps more of faculty's efforts and departmental resources to be highly successful (Perez Mejias, Chiappa, & Guzman-Valenzuela, 2018; Posselt, 2016).

Sixth, while changes at the system, institutional, and programme levels have increased the number of doctoral recipients worldwide, not all countries have developed the next steps to provide the necessary infrastructure to absorb the newly minted doctorates, who were expected to create innovation in public and private sectors. In light of the swift increase in doctorates worldwide, and the interconnectedness of labour markets, finding adequate employment after the completion of a doctorate has become a global concern for individual doctoral students and their professors. Not only have more PhDs been produced worldwide, but many postdoc positions have been created via competitive research grants, resulting in the movement of completed PhDs into quasi-holding positions as postdocs until more permanent employment can be found. The increase in PhD production worldwide—along with the simultaneous decrease in governmental funding for universities, the minimal increase in professorial positions, and the increase in expected competencies (academic, professional, and cultural)—makes career seeking for PhD candidates more complex and more intimidating, especially for those in second-tier doctoral programmes. In the eyes of many professors, and thus also of their PhDs, a career outside academia is still seen as an alternative career and viewed as a less desirable career path. Anxiety over finding a job is not common, however, in emerging nations with an expanding system of research universities that in the past employed instructors without doctorates. Often these instructors pursue a PhD in order to keep their academic position, as has been observed in South Africa, India, Malaysia, Indonesia, and Chile (Academy of Science of South Africa, 2010; Bawa, 2008; Chiappa, 2019; Department of Science and Technology, 2008; Jayaram, 2008; Nerad, Scholz, & Hashim, 2010). For these new doctorate holders, a career after degree completion is secured.

Finally, the rise of nationalism around the world, especially as it concerns the widespread use of English in doctoral education, is one of the most recent tensions. With the most educated people in many countries now being taught in a foreign language, universities have been attacked for their contributions to the younger generation's loss or abandonment of their native language and literature (de Groot, 2019). It remains to be seen how and how much the new nationalist movements will affect doctoral students' mobility and interfere with vibrant international collaborations at the doctoral level. Van der Wende (2017) wrote: 'Indeed, walls are being built up, borders are being closed down and global citizenship has been denounced by Prime Minister Theresa May: "If you believe you are a citizen of the world, you're a citizen of nowhere"' (p. 29).

Moving Forward

Overall, we can conclude that the number of positive changes that have occurred in doctoral education outnumber the negative changes. Now is the time to expand on good practices from the flagship programmes and to work to create a spill-over effect from these doctoral programmes to the many others that have to educate and train doctoral candidates under less optimal conditions.

For the individual doctoral candidate to become a researcher who possesses the necessary competencies (traditional academic, professional, cultural), we have learned that universities must provide opportunities for contextual learning at multiple levels. Quality preparation of a doctoral candidate requires coordinated efforts at many levels in the university, between universities, between national and international funding agencies, and across various learning communities throughout the duration of that candidate's doctoral education. It is important not only to increase funding and the quality of doctoral programmes for all doctorate holders but also to commit to questioning the norms and values that cause inequality and exclusion in society at the local, national, and global levels. Doctoral education is the most advanced level of education individuals can achieve and is one of the arenas in which different types of knowledge are discovered, passed from one generation of scholars to the next, and reinterpreted in the process. These functions give doctoral education unique access to individuals and institutions in positions of authority in different nations, and consequently also create an extra responsibility for them to work towards democracy, inclusion, diversity, and equity; in short, to commit to social justice. The convergence of doctoral programmes cannot be a desired goal per se; rather, universities must educate future scholars for civil democratic societies that respect and defend human rights through academic and research freedom, regardless of the structure and forms of their doctoral education. We can share practices that seem to work, but we need to convey within them the context and conditions under which they were successful; if we fail to do so, those 'best practices' can result in unintended negative consequences.

Notes

1. The numbers have been rounded up in the text; the exact numbers are presented in Table 1.
2. *Neoliberalism* is an ideology and a policy model that emphasises the value of free market competition. The roots go back to the classical liberalism of the nineteenth century, which championed economic laissez-faire and the freedom of individuals against the excessive power of government.
3. Science Without Borders was a large-scale, nationwide scholarship programme offered by Brazil's Ministry of Education (MEC) and Ministry of Science and Technology (MCT) through their respective funding agencies (CAPES and CNP). The programme sought to strengthen and expand the initiatives of science and technology, innovation, and com-

petitiveness through the international mobility of undergraduate and graduate students and researchers. Its primary goal was to qualify 100,000 Brazilian students and researchers in top universities worldwide through 2018. Due to federal spending cuts in higher education, this very successful programmes ended in 2016.

4. A recent example is the search for Amazon's second headquarters in the United States, during which Amazon specified, among other criteria, closeness to an excellent university and training of high-quality professionals.
5. The key element of policy borrowing is the conscious adoption of a policy from one context to another, led by the belief that foreign educational policies and models might solve existing or emerging problems (see G. Steiner-Khansi, 2016, p. 382).
6. The European Council of Doctoral Education (EU-CDE) is a subunit of the European University Association.
7. The FNR required an assessment of the implementation status in 2017–2018 of the Luxembourg National Quality Framework for Doctoral Training.
8. Mercosur is an economic and political bloc comprising Argentina, Brazil, Paraguay, Uruguay, and Venezuela.
9. *Doctoral supervisor* is synonym for the US term *doctoral student's adviser*.
10. *Professional competencies* are a cluster of related abilities, commitments, knowledge, and skills that enable a person to act effectively in a job or situation. Competencies acquired can only be demonstrated in context. This term is often used synonymously with *generic skills*, which are used to carry out complex activities or job functions involving cognitive, technical, and/or interpersonal skills.
11. The code of conduct for the recruitment of researchers consists of a set of general principles and requirements that should be followed by employers and/or funders when appointing or recruiting researchers. These principles and requirements should ensure observance of values such as transparency of the recruitment process and equal treatment of all applicants, in particular with regard to the development of an attractive, open, and sustainable European labour market for researchers, and are complementary to those outlined in the European Charter for Researchers (see https://euraxess.ec.europa.eu/jobs/charter/code).
12. See, for example, the Goethe University in Frankfurt, GRADE, and the Graduate Academy at the University of Heidelberg.
13. An interesting critique of project-funding is presented by Torka (2018).

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Reforms of Doctoral Education in Europe and Diversification of Types

Barbara M. Kehm

Introduction

In recent years, the need to reform doctoral education and training has been high on the policy agenda in many countries around the world. The goal to increase the production of doctoral degrees is closely related to ambitions of becoming a knowledge society and economy or gaining a competitive advantage in the global knowledge economy. Accordingly, national governments and the European Commission have encouraged universities to increase the number of doctoral degrees awarded, recruit best talent internationally for research training, and structure this phase of qualification in such a way that doctoral degree holders have the necessary competencies and skills to work in academic as well as non-academic labour markets. This has led to a diversification of types of doctoral degrees and models of training. Furthermore, in Europe more

B. M. Kehm (✉)
Leibniz Center for Science and Society, University of Hannover,
Kassel, Germany

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differentiated approaches to reform doctoral education and training can be observed. In the following the driving factors for the initiation of such reforms will be identified and related to the extended policy field. Main examples are the European Bologna Process and new forms of institutional governance in universities. Then there will be a section discussing European trends in terms of a multiplication of purposes and types of doctoral education before coming to some conclusions. Altogether nine different types have been identified, creating more diverse pathways to a doctoral degree. In the last section, supporters' and opponents' opinions about these developments will be discussed and the concluding argument developed, taking into account that the vast majority of doctoral degree holders will not remain in academia.

Driving Factors for the Initiation of Reforms

Increasingly the production of new knowledge, often a task and an aspiration of doctoral candidates, is no longer regarded as a purely academic affair but as a strategic resource in emerging knowledge societies. With this shift doctoral education and training has become an object of institutional management, of national policy and related funding programmes, and of supra-national incentives, regulations and measures for better integration into the existing knowledge and innovation systems. Furthermore, an increasingly international competition for best talent has begun (Kehm, 2006, p. 67).

At the same time public criticism of doctoral education and training has become louder: too long, too many drop-outs, too specialised, questionable quality of supervision, lack of competences for non-academic labour markets. The continental European answer to such criticism was "structured doctoral education", that is, the integration of this qualification phase into programmes, centres, schools or colleges, and so on, and the addition of systematic curricular provisions to offer theoretical, methodological and labour market related competences to the research work on the dissertation. This development currently has three observable consequences: first, the master-apprentice model which was dominant in the continental European countries for a long time is regarded as a phasing-out model; second, the focus on a point in the framework of a rite of passage (i.e., defence and award of title) with an emphasis on the product "dissertation" is shifting to a focus on the process of doctoral education and training (its structures, content, quality); third, access to doctoral education and the process of getting a doctorate are increasingly embedded in a dense layer of regulations, criteria, defined rights and obligations, procedures of evaluation and control of success (Kehm, 2006, p. 73).

In the framework of the European Bologna Process the phase of getting a doctoral degree also has become a much discussed topic. The reform initiators (ministers for higher education from 27, later 46 European countries) conceptualised doctoral education as a third cycle of studies, in the framework of which seminars had to be taken and credit points earned. However, this conceptualisation as a third cycle of studies met with resistance from a number of (mostly continental) European countries. Such a concept was only valid in those European countries in which doctoral candidates were traditionally regarded as students and had to pay fees for supervision and seminars or in countries in which graduate studies follow a bachelor's degree. Such a concept did not fit at all in those European countries (Germany among them) in which eligibility for doctoral education is only achieved after a master's degree and in which doctoral education and training takes place predominantly in the framework of employment contracts as research assistants or junior academics and is understood as a first phase of an academic or research career (e.g., in Sweden). Typical for Germany is the multitude of pathways towards a doctoral degree (see Burkhardt, 2008) whereby the status of the candidates depends on their form of funding: doctoral candidates are employees of the university when getting their degree in the framework of a research assistant position, they are scholarship holders when they receive financial support from one of the many foundations, or they are externals when they have a regular job on the non-academic labour market and fund themselves through their salaries. In the two latter cases doctoral candidates have a professorial supervisor but no status vis-à-vis the university (Burkhardt, 2008).

However, in the meantime the structuring of doctoral degrees has found many supporters in Germany as well as in other European countries which traditionally followed the master-apprentice model with individual supervision. Despite the fact that the organisational forms as well as the terminology (e.g., graduate college, graduate centre, graduate school, doctoral programme) continue to proliferate, it is hoped, in principle, that structuring the doctoral phase will solve a number of problems (Kehm, 2006).

In the framework of the European Bologna Process new aspects have entered into the discussion. First among these is the better preparation of doctoral candidates for non-academic labour markets, because a high proportion of doctoral degree holders will not remain within a higher education institution or an extra-university research institute (around 80 per cent).

A second issue is that professors are increasingly made responsible for the success of the doctoral candidates they supervise. In some European countries (e.g., in the UK and in Spain) regulations have been introduced which define who can act as a supervisor (no longer every professor) and what kinds of formal qualifications and further criteria must be obtained and fulfilled in order to have the right to supervise doctoral candidates (e.g., some kind of further professional qualification in supervision or a minimum number of research projects and publications) (Halse & Malfroy, 2010; Lee, 2007). This trend has an impact on the degree of selectivity in terms of access and admission of doctoral candidates.

Thirdly, there are issues pertaining to the meaning of "critical mass" in the framework of ongoing discussions about efficiency and effectiveness. This means that in quite a number of European universities criteria are established to determine (a) how many professors a university should have in a given field or discipline in order to offer optimal conditions for doctoral candidates, and (b) how many doctoral candidates a given doctoral programme, doctoral school or doctoral college should have ideally (or minimum and maximum numbers). These numbers can differ from subject to subject but we can observe concentration processes with consequences for smaller subjects which might be closed at some universities to create a critical mass at others (Kehm, 2004, 2005, 2006, 2007).

The Extended Policy Field

As mentioned before, doctoral education and training is no longer exclusively an academic affair but has become an object of institutional management as well as national and supra-national policy making.

Supra-national level: The inclusion, in 2003, of doctoral education as a third cycle of a tiered structure of studies and degrees in the framework of the Bologna Process was, among other things, a consequence of the European Council's and Parliament's strategy in the year 2000 to create a common European Research Area (Lisbon Summit, 2000). This strategy was supposed to develop Europe into the most dynamic knowledge-based economy in the world in order to be globally competitive. To achieve this, the number of doctoral degree holders was to be increased and doctoral candidates were supposed to become better prepared for non-academic labour markets. The descriptors for the doctoral level of the European Qualifications Framework clearly reflect this.

National level: In most European higher education systems we can observe an increasing number of initiatives and support programmes at the national level to establish a structure for doctoral education and training. The number of doctoral degrees awarded has become part of indicator and performance based funding and budgeting in negotiations between universities and the state about the overall budget as well as in intra-institutional budget allocations. German universities produce about 35 per cent of doctoral degrees in the European Union, that is, almost 30,000 in 2016 (Destatis, 2017, p. 11). The German Excellence Initiative supports the establishment of graduate schools and the German non-academic labour market is relatively open for job seekers with a doctoral degree. This also implies that the unemployment rate among doctoral degree holders in Germany is the lowest compared to all other levels of education and training. National policy by and large is in favour of increasing even further the number of doctoral degree holders because it is believed that a high number of people with high qualifications provide a competitive advantage for the economy on a global scale.

Institutional level: The institutional policy field has also changed with regard to the indicator "doctoral degrees". Almost all universities encourage their professors as well as faculties and departments to increase the number of doctoral degrees awarded and to reduce the time to degree. The number of doctoral degrees awarded is an important indicator when measuring research output, in the context of establishing a profile and reputation as a research-intensive institution, and in the framework of the general competition for reputation and funds. But there is a further intra-institutional dimension. Within universities competition has also become stronger and departments, research groups or individual professors who have been particularly successful in terms of doctoral education and training can negotiate for extra funds or other material advantages (e.g., additional human resources or better infrastructure). Traditionally a high number of successful doctoral supervisions contributed to the individual reputation of a given professor within the scientific community. This continues to be the case; however, it is complemented by the aspect that this success is also supposed to contribute to the reputation of the institution. Those less successful in the endeavour of doctoral education and training might end up not being allowed to have doctoral candidates any longer.

Multiplication of Purposes and Types of Doctoral Education

If we look at the changes in doctoral education from a European perspective we can note that the types of doctoral education and training, and with them their goals and purposes, have multiplied in recent years. This is most progressed in the United Kingdom but is also gradually extending to continental European universities. In many European countries we find an increasing differentiation between a research doctorate and a professional doctorate. However, further research has yielded altogether nine different models which will be briefly introduced in the following (Kehm, 2009).

The Research Doctorate

For the research doctorate, which is the most traditional form, the dissertation is central and expected to be an original contribution to the knowledge base of a discipline or a research domain. Independent of the fact whether the degree (or title) is acquired within the framework of a structured programme including course work or in the framework of a master-apprentice relationship, the research doctorate, as a rule, is a prerequisite for an academic career. By being responsible for the training, professorial supervisors also have a gatekeeper function. Using the example of six disciplines, Golde and Walker (2006) have characterised the main purpose of doctoral education in the research doctorate as developing students to be 'stewards of the discipline'. The goal of such a training is a scientific or scholarly ideal type, characterised as someone 'who can imaginatively generate new knowledge, critically conserve valuable and useful ideas, and responsibly transform those understandings through writing, teaching and application. A steward is someone to whom the rigour, quality, and integrity of the field can be entrusted' (Golde & Walker, 2006, p. 5). This rather normative image contrasts starkly with the image generated by Slaughter and Leslie (2000) of the successful academic as 'capitalist entrepreneur' who has recognised the demands and challenges of market orientation, competition and globalisation in the emerging knowledge societies and knows how to draw advantages from these developments.

The Professional Doctorate

A number of European countries (e.g., Austria, Belgium, Denmark, France, the Netherlands) have by now picked up the British trend to explicitly distinguish between a research doctorate and a professional doctorate. The professional doctorate is not awarded in all disciplines but restricted to subjects like business administration, medicine and health care, education, engineering, social work; that is, to subjects which have a relatively demarcated field of professional practice. In professional doctorates the title usually includes an indication of the professional field (e.g., DBA for Doctor of Business Administration or EdD for Doctor of Education) while research doctorates are typically awarded distinguishing between the sciences (Dr. Sc.) and the humanities (Dr. Phil.). Quite a number of publications have appeared over time on the professional doctorate (Bourner, Bowden, & Laing, 2001; Green & Powell, 2005; Park, 2005), and a systematic overview was recently provided by Hawkes and Yerrabati (2018). Despite the fact that the professional doctorate has been met with more acceptance in recent years, the high number of publications about this type seems to be related to some extent to the fact that in academic circles the professional doctorate is often looked down upon as a second-class doctorate so that pressure for legitimation increased.

The professional doctorate is defined as a programme of advanced studies which—apart from fulfilling university criteria for the award of the degree—is geared towards satisfying a particular demand from a professional group outside the university and towards developing research skills needed within a professional context (Bourner et al., 2001, p. 219). In the United Kingdom, professional doctorates are typically taken up by people who are pursuing a professional career and are employed. Therefore, professional doctorates are frequently offered as part-time programmes and usually require several years of professional experience. Tuition fees are often covered fully or in parts by the employer. The target group wants to gain the degree in order to be eligible for promotion in their professional field. Consequently the research work carried out for the dissertation is regarded less as a contribution to the knowledge base of a discipline but more as a contribution to the development of a professional domain. The dissertation then has a focus on the generation of new but more applied knowledge and the topic is often generated from the respective professional practice. In some areas, for example in engineering, the dissertation can also have the form of a larger or a series of smaller projects which are carried out in the framework of actual professional practice.

The Taught Doctorate

By definition, the taught doctorate consists of a substantial proportion of course work and is offered in the United Kingdom and in Portugal. Other European countries have started to introduce this type as well. Typically there will be a fixed curriculum and learning outcomes will be graded and weighted for the final grade. As with the research doctorate, students are supposed to contribute to the generation of new knowledge but they do this in the framework of a research project the results of which are summarised in a project report. The report is presented in the framework of an oral examination and is graded as well. In contrast to the two-phase doctorate in the United States (course work first, then research and writing of thesis), the course work of the taught doctorate is spread over the whole period of degree training. The oral examination and the grade of the research project report are regarded as an equivalent to a dissertation and its defence.

PhD by Published Work

The model of the PhD by published work has existed in Germany since the nineteenth century (where it is called "cumulative dissertation"). From there it spread to other parts of the world, mainly the United States but also to Belgium, the Netherlands and Sweden. At second glance the British model of the PhD by published work differs to some extent from the German model of a "cumulative dissertation". Both models are basically characterised by combining several articles which have appeared in peer-reviewed scholarly or scientific journals into a book and providing them with a coherent framework. But while this option is open for many candidates in Germany, the PhD by published work is awarded in the United Kingdom almost exclusively to members or alumni of the university awarding the degree (Green & Powell, 2005, p. 72).

This model has frequently been criticised for its lack of consistency, differences in the definition of what constitutes a publication, its threat to other forms of doctoral education, and the difficulty to provide adequate supervision. Furthermore, in this type of doctorate it is predominantly a product which is evaluated and graded and not the process of getting the degree itself. Therefore, most countries which provide this opportunity have regulations in place which determine the character and the content of the dissertation and possibly also the question whether and in which form a programme of additional studies has to be taken (Green & Powell, 2005, p. 71).

The Practice-Based Doctorate

The practice-based doctorate is a terminological specificity of the British university system but it is also awarded in Australia. It denotes the award of doctoral degrees in the Arts and in Design. While German universities, for example, award a doctoral degree in musicology or art history, the highest degree in the various arts as such (e.g., painting, sculpting, acting, singing, dancing, playing an instrument) is called "*kuenstlerische Reife*" (which can be translated literally as "artistic maturity"). No doctoral degree is awarded in these fields.

The practice-based doctorate increased in importance in the 1990s with the integration of colleges of art into the universities in the United Kingdom. The degree is awarded as a result of course work in the framework of which students are familiarised with theories and research methodologies and the presentation of a work of art or a performance as a substitute for the dissertation. The presentation or performance is accompanied by a text in which the candidate explains how he or she has arrived at the result or product by applying research methods. This is regarded as generating new knowledge through practice. Successful candidates are also expected to demonstrate how their work of art is related to other works of art in the same field (in a theoretical, historical, critical, or visual context) and to evaluate possible effects. In the field of composition, frequently not just one work is presented but a whole portfolio. In the oral examination the work of art will be presented or performed and the candidate demonstrates on the basis of the accompanying text that she or he has sufficient knowledge and appropriate skills to independently generate new knowledge.

The practice-based doctorate is contested in the United Kingdom because—compared to all other models of the doctorate—it shows the least proximity to the traditional notion of a dissertation. However, about half of all British universities offer such a doctorate (Green & Powell, 2005, p. 100ff.). In Germany there is currently a debate going on about creating the possibility of doctoral degree awards in the arts. Currently only one higher education institution, the Film University in Babelsberg near Berlin, has the right to award a doctoral degree in film making.

The "New Route" or Integrated Doctorate

The model of the "new route PhD" was developed in 2001 by ten British universities as a type of brand name with the purpose of attracting more international students, especially from Middle Eastern countries. In the meantime it is offered by more than 30 British universities. It is a four-year degree involving a one-year period of studying for a research master's degree followed by a three-year period of PhD studies. The programme basically consists of three (integrated) elements: a taught component in the area of research methods and subject specialisation, another taught component in the area of transferable skills, and the work on a dissertation (disciplinary or interdisciplinary). Admission can be granted right after having completed a bachelor's degree. The taught components are frequently offered in the framework of related Master programmes but accompany the whole four years envisaged for getting the degree. For the taught components 240 credit points are awarded (www.newroutephd.ac.uk).

However, in comparison to the research doctorate, the taught elements are more important and are also prescribed in more detail with respect to the qualifications and competences to be acquired. After having finished all the course work there is also the possibility to write a master's thesis instead of a doctoral dissertation and finish after one year with a master's degree.

In Germany, this model has become known as "fast track PhD" and is offered in specific subjects at some universities. Although the master's degree in Germany is required for admission into doctoral programmes or acceptance as doctoral candidate, this model offers transition into the doctoral phase for particularly talented students right after their bachelor's degree.

Basically the new route PhD as well as fast track PhD follow the American model of an integrated graduate education in which the master's level and the doctoral level are combined in terms of the course work to be done. However, the American model clearly separates the course work phase from the phase of writing a thesis, which follow each other in sequence and are not integrated. This American two-phase approach results in high drop-out rates after having finished the course work, or (compared to Europe) a rather long time to degree (between six and nine years). Despite the fact that a fast track to the doctoral degree is possible in exceptional cases in many European countries, the European University Association has recommended that the master's degree should constitute the rule for access into doctoral programmes or the doctoral qualification phase (see EUA-CDE website: http://www.eua.be).

Two Models of the Joint Doctorate

The model of the joint doctorate is characteristic for doctoral programmes jointly offered by two or more universities which may be located in the same region, the same country, or different countries. A study carried out by EUA (EUA, 2005) about changes in doctoral education in Europe included a survey among member institutions. Eighteen per cent of the responding universities confirmed that they offer joint doctorates. Leading countries in terms of the number of joint doctoral degree programmes are Germany, Spain, France, Italy, the United Kingdom and the Netherlands (EUA, 2005).

In the EUA study (EUA, 2005, p. 28ff.) the joint doctorate is characterised as follows:

a joint curriculum for the taught components which has been developed in close cooperation among the participating institutions; the doctoral students take courses at several universities;

an agreement signed by all participating institutions clarifying funding issues and other matters (e.g., mobility, quality assurance, degree award).

Certification of a joint doctorate is regulated in various ways, from the awarding of the degree from the university at which the candidate is enrolled, to a double degree on the basis of joint supervision (i.e., co-tutelle arrangements) and a joint degree.

Joint doctorates are predominantly awarded by universities (or more exactly by faculties and departments) cooperating in transnational networks. The advantages for doctoral students are that in most cases phases of mobility are built into the programme, that they often have more than one supervisor and have access to further experts in their field who are members of the network. However, the actual practice differs from this ideal type. Joint doctorates have a higher degree of internationalisation and more opportunities for mobility but they are often not based on a joint curriculum of the participating partner institutions.

A particular variation of the joint doctorate is the "European doctorate" which does, however, not yet exist in practice. The idea and an informal initiative came up at the beginning of the 1990s during a meeting of the Confederation of European Rectors' Conferences (an organisation which has merged with the former Confederation of European Rectors and Presidents to become EUA). The 'Doctor Europaeus', as the planned title was to be, is contested until today, although there is a consensus about promotion and improvement of European cooperation in doctoral education and mobility of doctoral students (or candidates). Currently another initiative in this direction is undertaken by the European Commission offering funding for joint doctoral programmes emerging from partner universities of an Erasmus Mundus Programme. The difficulty of putting the idea into practice is due to the fact that within Europe there is an increasing competition for best talent among institutions and on the national level a more competitive research policy and innovation strategy. Thus, best talent is not easily "shared". Still, the discussion about the 'Doctor Europaeus' has been revived in the context of the Lisbon Strategy to create a European Research and Innovation Area (EUA, 2005).

The Cooperative Doctorate

The cooperative doctorate is a German model in which professors from universities and professors from universities of applied sciences (the latter do not have the right to award doctoral degrees) jointly supervise a doctoral candidate who graduated from a university of applied sciences. Taught elements of such a degree are typically offered in the framework of a university graduate school or doctoral programme while the research topic is often developed between the candidate and his or her professor from the university of applied sciences. The degree is awarded by the university. This model has emerged in the framework of attempts of research-oriented universities of applied sciences to acquire the right to award doctoral degrees which so far has failed due to the resistance coming from the universities and lack of political will. However, it seems that in the near future this monopoly will fall. Once Germany officially introduces a distinction between research and professional doctorates, universities of applied sciences will claim to have the right to award professional doctorates. The university monopoly is already eroding at the margins. The state of North-Rhine Westphalia has decided that a group of research-strong universities of applied sciences can award (professional) doctoral degrees.

The Industrial Doctorate

The industrial doctorate is mostly awarded in engineering fields and is a rather applied degree which can be found in quite a number of European countries (e.g., Denmark, France, Germany, Italy, the Netherlands, Switzerland). Research work of the candidate is carried out, for example, in the R&D department of a company and is oriented towards the solution of a particular problem or issue. The research work is jointly supervised by a senior engineer of the company and a university professor while taught elements, theory and methodology are supervised by a university professor. Research topics frequently emerge from work in that company during an internship. There is also a European Industrial Doctorate (EID) which is supported in the framework of Marie

Skłodowska-Curie Actions. The EID requires that the two organisations involved (a university and a company) must come from two different European countries. This type of doctorate is quite common at technical universities but also has shown to have problems. Very recently a debate has emerged in Germany about the so-called cuckoos egg dissertations. It seems that a number of private sector companies have established their own doctoral programmes or try to attract young engineers with the promise of an opportunity to get a doctoral degree, all without seeking to establish a partnership with a university. Once the dissertation is finished, the companies approach a professor (or a university) with the request to organise the defence and award the degree with the threat that they will stop their research funding for that professor or university if they refuse. This has led to some protest from the side of the universities which have come up with the term 'cuckoos egg dissertations' in an official letters to policy makers asking to stop such kind of initiatives and to companies with the request to observe the sole right of universities to award the degree and seek their cooperation beforehand. Quite frequently there are also issues of confidentiality of results involved, while universities continue to insist that results of academic work should be available for open access. However, the industrial doctorate is a particularly interesting model for countries in which doctoral degree holders mostly serve the reproduction of the academic profession (e.g., Portugal, Poland, Spain) and the non-academic labour market is not very open for doctoral degree holders. With the availability of an industrial doctorate, private sector companies can experience the added value of research-based knowledge production.

To conclude, in the description of the diversification of doctoral education and training models in Europe one issue stands out. It is related to the fact that a considerable increase in numbers typically leads to a diversification of forms of training, as not all doctoral candidates aim for jobs in academia any longer and thus have different purposes and motives to get a doctoral degree. Developing a highly qualified workforce for non-academic sectors of the economy tends to be a phenomenon of knowledge societies and economies and is by now relatively well-established in Europe.

Discussion and Conclusions

The proliferation of types and models of doctoral education and training described above is an indicator of new forms of a functional differentiation, resulting not only from an increased number of doctoral candidates and their different interests and motives but also from political reforms based on narratives of the knowledge economy and society. Doctoral education no longer exclusively serves the reproduction of the academic profession but becomes also a qualification for knowledge-intensive non-academic sectors of the economy and for steps up the professional career ladder.

However, these developments have also triggered some criticism (see overview in Park, 2005, p. 201). The four main points of criticism can be summarised as follows:

- Models other than the research doctorate tend to be regarded as second-class doctorates. The quality of the dissertation and the quality of the process of getting the degree are often ranked lower in comparison to the research doctorate.
- External examiners have noted—in particular with respect to practice-based doctorates—a lack of intellectual depth, cohesion, discussion of existing literature, originality and generalisable results of the work. In addition, they have criticised methodological weaknesses and bad presentation.
- Bourner et al. (2001) criticised the new types of doctorates as often lacking clarity and coherence.
- Some experts have also voiced concerns about the growing proliferation of titles and the increasing differentiation of types and models.

Supporters of the growing differentiation of doctoral types have argued that it reflects the growing heterogeneity of reasons for getting a doctorate and these should be taken into account when shaping this phase of qualification.

However, in some European countries—typically those whose economy is less open for highly qualified doctoral degree holders—there is also a discussion going on that the European goal to increase the number of doctorate holders for the knowledge economy might lead to an overproduction of doctoral degree holders and the related danger of growing unemployment among this group of highly qualified persons. This discussion about overproduction and later unemployment or inadequate employment has been going on in some Western European countries since the 1970s (see, e.g., Teichler, 2009). The issue is not yet resolved but a widely shared view among experts is that aims to establish knowledge societies or highly qualified societies requires as many citizens as possible with high qualifications. Unemployment or inadequate employment of doctoral degree holders in this context is just a temporary phenomenon in countries whose economy has not yet caught up in all areas. Furthermore a couple of recent OECD studies were able to show that the science and technology sectors of most economies of OECD countries have much to offer for highly qualified persons, despite the fact that policies do not yet fit everywhere and solid data are still lacking (Gokhberg, Shamtko, & Auriol, 2016). Additionally, if doctoral degree holders can't find proper employment in their home countries, there are always opportunities for them in other European countries. The 2000 Lisbon Strategy of the European heads of state and government (Lisbon Summit, 2000) as well as its 2010 revision (European Commission, 2010) have indeed looked to increase the overall number of doctoral degree holders in all of Europe and to use this as a political instrument to make Europe 'the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion' (Lisbon Summit, 2000).

A further problem should be mentioned here that might arise concerning the quality of doctoral education and training due to increasing numbers. The Council for Doctoral Education of the European University Association (EUA-CDE) has made proposals how to further develop and advance doctoral education and training in Europe (also see the contribution of Amaral and Carvalho in this book). The proposed objectives include:

to enhance the quality of doctoral education in Europe by fostering debate and promoting the exchange and dissemination of good practice;

to encourage and support the development of institutional policies and strategies as well as the introduction of effective leadership and management practices;
to strengthen the international dimension of doctoral programmes and research training through improved cooperation among its members and by establishing dialogue with partner organisations in other world regions;
to identify and monitor emerging trends in doctoral education inside and outside of Europe;
to promote the doctorate as a key professional qualification and underline the importance of young researchers for a knowledge-based society (EUA Newsletter 2/2008).

Furthermore, a European-wide debate is proposed about the doctorate and its future in order to see whether responsible policy makers and practitioners will be able to agree on a joint definition of the particular form of "graduateness" a doctoral degree holder should possess. Not only could the European Qualifications Framework serve as a basis for this but a joint definition can also contribute to creating more transparency in the face of the growing diversification and differentiation of doctoral education in Europe.

In order to draw this contribution to a close I would like to make a further observation. In continental Europe, as well as in many other countries around the world with well-established and mature higher education systems, the doctorate is no longer an automatic entrance qualification into an academic career. It is a necessary but insufficient condition and decisions as well as selection processes have shifted into the postdoc phase. However, getting a doctoral degree tends to qualify one for a rather wider range of jobs as knowledge workers for non-academic labour markets. For Germany, which has an exceptionally high output in terms of doctoral degrees awarded annually, Janson et al. (2007, p. 95) have calculated that overall only about 10 per cent of doctoral degree holders eventually become tenured professors. The vast majority of the remaining 90 per cent leave the university either immediately after getting the degree or eventually. So the issue is what skills and competences do these 90 per cent of doctoral degree holders need and how can they acquire them?

Certainly, doctoral candidates today are no longer exclusively trained to become 'stewards of their discipline' (Golde & Walker, 2006) as has been the case up until the end of the 1980s and in some European countries until well into the 1990s. The extended policy field for doctoral education and training has contributed to the fact that doctoral candidates today need to acquire a considerably broader set of skills and competences. Doctoral degree holders are not only in demand in the knowledge-intensive sectors of the economy but in other fields as well, for example, services, public administration, media and so on. Having said that, two questions remain which still need further research and debate. The first question is who within the universities has the knowledge and competence to convey this extended skills set? The second question is whether academic careers in Europe with their extended periods of uncertainty and even precarity continue to remain sufficiently attractive to attract the best and the brightest.

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Quality Assurance of Doctoral Education: Current Trends and Future Developments

Sónia Cardoso, Maria J. Rosa, and Vera Miguéis

Introduction

In recent decades, doctoral education has been under considerable expansion and transformation. Higher education massification created pressure for the growth of postgraduate offerings, including doctoral education (Bitusikova et al., 2010; Clarke & Lunt, 2014). This has been reflected in an increase in the number of doctoral students, programmes and universities offering doctoral degrees (Evans et al., 2014; Frijdal, 2008; Kehm,

S. Cardoso (✉)
Agency for Assessment and Accreditation of Higher Education (A3ES), Lisbon, Portugal

Centre for Research in Higher Education Policies (CIPES), Matosinhos, Portugal
e-mail: sonia.cardoso@a3es.pt

M. J. Rosa
CIPES & DEGEIT, University of Aveiro, Aveiro, Portugal
e-mail: m.joao@ua.pt

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2006, 2007; Kyvik & Thune, 2014; Nerad, 2014a). What was once restricted to 'a small group of privileged apprentices in a handful of elite universities' has been 'replaced by tens of thousands of doctoral students in hundreds of universities' around the world (Bernstein et al., 2014, p. 7).

This growth has been accompanied by a change in the profile of doctoral candidates, which has become more diversified not only in demographic and educational terms but also regarding career aspirations (Bernstein et al., 2014; Clarke & Lunt, 2014; Friedrich-Nel & Mac Kinnon, 2017; Kehm, 2006, 2007; Nerad & Trzyna, 2008). As a result of the global labour market and technological advances, as well as the relative lack of vacancies within academia, career paths for doctoral graduates have expanded beyond the academic world (Bartelse & Huisman, 2008; Bernstein et al., 2014; Clarke & Lunt, 2014), including to industrial, governmental, private practice and entrepreneurship settings, which demand new and more diversified professional knowledge, skills and competences (Bernstein et al., 2014; EUA, 2005).

Simultaneously, doctoral education emerges as a strategic resource for the knowledge society and economy. Countries are urged to reinforce their capacities for research and knowledge production, application and dissemination and, thus, for doctoral education as a way to feed knowledge and innovation systems (Bao, Kehm, & Ma, 2016; Bartelse & Huisman, 2008; Bernstein et al., 2014; Bitusikova et al., 2010; Fortes, Kehm, & Mayekiso, 2014; Nerad & Trzyna, 2008).

Under this framework, doctoral education has increasingly become the target for policy attention and intervention both at national and supranational levels (Bartelse & Huisman, 2008; Kehm, 2006, 2011; Nerad, 2014a). In the European context, doctoral education is seen as the most significant interface between two key reform processes: the Bologna Process and the Lisbon strategy, aiming to create, respectively, the European Higher Education Area and the European Research Area (Byrne, Jørgensen, & Loukkola, 2013; Clarke & Lunt, 2014; EUA, 2005; Kehm, 2006, 2007, 2011).

V. Miguéis
Faculdade de Engenharia da Universidade do Porto, INESC TEC, Porto, Portugal
e-mail: Vera.migueis@fe.up.pt

Under the Bologna Process, doctoral education is conceptualised as a third cycle of studies (Bao et al., 2016; Bartelse & Huisman, 2008; Byrne et al., 2013), whose central distinctive element relative to the other two cycles (Bachelor and Master) is the development of knowledge through original research (EUA, 2007; Gudmundsson, 2008; Kehm, 2006). At the confluence of the two reform processes (Bologna and Lisbon strategy), the third cycle of studies was supposed to help make Europe the most competitive and dynamic knowledge-based economy in the world (Kehm, 2006), providing the knowledge-intensive sectors of the economy (and not only academia) with doctoral graduates with a specific set of skills and competences 'without losing the quality and rigour of traditional doctoral training' (Bao et al., 2016, pp. 14–15).

As a result of previous developments, doctoral education has been changing fundamentally in nature and form (Bernstein et al., 2014; EUA, 2005). Multiple programmes have emerged in a vast array of knowledge fields, many resulting from collaboration between universities and between these institutions and other sectors of society (Bernstein et al., 2014). Types or models of doctoral education, with different goals and purposes, have multiplied and are being provided by European universities: research doctorates, professional doctorates, industrial doctorates or joint doctorates (Bao et al., 2016; Bartelse & Huisman, 2008; EUA, 2005; Kehm, 2011).

The organisation and structure of doctoral programmes have become more diversified, not only across European countries but also across universities within the same country and between faculties of the same university (Bartelse & Huisman, 2008; EUA, 2005). A tendency has arisen towards more structured doctoral programmes and the establishment of doctoral/graduate/research schools (Bitusikova et al., 2010; Byrne et al., 2013; Clarke & Lunt, 2014; EUA, 2007; Kehm, 2006, 2007). Traditional doctoral programmes, based on an alliance between the supervisor and the doctoral candidate and without structured coursework, are increasingly perceived as 'inappropriate' in preparing researchers for multiple careers, as well as regarding supervision and time to completion (Bitusikova et al., 2010; Byrne et al., 2013; Fortes et al., 2014; Kehm, 2008). Therefore, there has been a significant increase in the number of doctoral programmes integrating both a teaching phase (mandatory and voluntary courses or modules) and a research phase, although not necessarily organised in formal structures as in doctoral schools (EUA, 2005; Kehm, 2011). Nowadays, a mix of different models (i.e., both individual and structured study programmes and schools) seems to coexist (Bitusikova et al., 2010). Nonetheless, the proportion of European institutions with at least one doctoral school has been growing, aiming to provide students with a 'richer' research environment (Bao et al., 2016; Bitusikova et al., 2010; Byrne et al., 2013) (see Amaral and Carvalho's chapter).

The above changes have transformed doctoral education into a matter of increasing public concern (Bao et al., 2016; Byrne et al., 2013; Denicolo, 2003; Friedrich-Nel & Mac Kinnon, 2017; Kehm, 2006, 2007, 2011). Issues such as the organisation and shape, status, access/admission, funding, duration and completion, supervision, mobility and internationalisation, development of skills and competences, and transition to labour market emerge as critical in regard to doctoral education (Bao et al., 2016; Byrne et al., 2013; Clarke & Lunt, 2014; Kehm, 2006, 2011). Hence, quality issues have moved into the foreground of debates and policy initiatives on doctoral education (Bao et al., 2016; Kehm, 2006), which is increasingly called upon to demonstrate that it is appropriately managed, efficient, transparent, fit for purpose and providing the highest-quality research education and training for the labour market (Bartelse & Huisman, 2008; Byrne et al., 2013; Fortes et al., 2014; Nerad, 2014a). Accordingly, doctoral education has come under close scrutiny of both external and internal quality assurance (Bao et al., 2016; Byrne et al., 2013; Denicolo, 2003; Kehm, 2011; Nerad, 2014a).

The purpose of this chapter is to launch a discussion about the quality assurance (QA) of doctoral education in general, and external QA in particular. Based on the analysis of the European context, the chapter begins by offering an overview on the dynamics inherent to QA in doctoral education at the supranational, national and institutional levels. Focusing specifically on the national level, an account is given on the external QA procedures and criteria aimed at doctoral education in several European countries. It is underlined that when existent, these procedures and criteria vary in terms of focus and level of detail, framed by QA systems with different purposes and regulations. Finally, and without arguing for a best way of conducting external QA, the chapter brings forward some proposals for future developments at this level.

Quality Assurance of Doctoral Education in Europe

Due to the specific characteristics of doctoral education, the evaluation and assurance of its quality are arduous, complex undertakings (Bitusikova et al., 2010; Friedrich-Nel & Mac Kinnon, 2017; Maheu, Scholz, Balán, Graybill, & Strungnell, 2014). Doctoral education is both diverse—in terms of evolution, organisation, mode of delivery, standards and so on, which are different according to country and institution—and holds a specific nature, resulting from the combination of education and the development of original research, attributes which concur to differentiate it from other educational levels (Bitusikova et al., 2010). Therefore, the standards as well the mechanisms or procedures to assess and assure the quality of doctoral education have to respect and cover its specificities, rather than automatically replicate those used for Bachelor or Master degrees (Bitusikova et al., 2010).

The challenges in this context are many (Bitusikova et al., 2010; Friedrich-Nel & Mac Kinnon, 2017), related to assuring the quality of the various aspects or dimensions of doctoral education, which comprise, among other things, student recruitment and selection, doctoral training, research, assessment, supervision and mentoring, skills and competences (Bartelse & Huisman, 2008; Bitusikova et al., 2010; Friedrich-Nel & Mac Kinnon, 2017).

In Europe, QA in doctoral education is addressed at various levels: the supranational or European level, the national level and the institutional level (Fortes et al., 2014). In the following subsections, a brief overview will be provided on the dynamics inherent to QA in doctoral education at each of these levels, with a special emphasis on the national level and, particularly, on the role of external QA.

The European Level

At the European level, both policy making and policy advising regarding QA in doctoral education have been increasingly marked by attempts to harmonise QA practices and reach an agreement on criteria against which the quality of doctoral programmes can be benchmarked (Bernstein et al., 2014). This has been induced by the European Commission and the Bologna Process, with agreements being established at the European level (e.g., the European Standards and Guidelines—ESG), with a significant impact on national (external) and institutional (internal) QA arrangements and systems (Bernstein et al., 2014; Byrne et al., 2013; Clarke & Lunt, 2014; Fortes et al., 2014).

Harmonisation has also been promoted through the action of other actors, among these, the European University Association (EUA), but also the European Association for Quality Assurance in Higher Education (ENQA) or, to a lesser extent, the European Students' Union (ESU), stand out (Kehm, 2006; Kivistö, Pekkola, & Siekkinen, 2017).

The EUA emerged as an important actor of doctoral education reform, namely through the formulation of recommendations, the promotion of research projects concerning this reform, or the launch of the Council for Doctoral Education (EUA-CDE) (Fortes et al., 2014). Additionally, the EUA has been paying permanent attention to the assurance of doctoral education quality by observing trends at this level and supporting the sharing of good practice (Bartelse & Huisman, 2008; Bitusikova et al., 2010; Kivistö et al., 2017).

In 2005, a debate promoted by the EUA and a number of university partners resulted in the definition of ten basic guiding principles for the improvement and quality of doctoral education in Europe—the *Salzburg Principles* (Bartelse & Huisman, 2008; Bernstein et al., 2014; EUA, 2005; Kivistö et al., 2017). These principles cover multiple aspects including doctoral training core components; professional career development opportunities; diversity; time duration; funding; interdisciplinary character; development of transferable skills; mobility, internationalisation and collaboration frameworks; achievement of critical mass and promotion of innovative practice; contractual understandings between students, supervisors and institution regarding supervision and assessment; and the concept of doctoral student.

In 2008, the EUA-CDE was launched as the driving force for the implementation of the *Salzburg Principles* and recommendations, as well as for the promotion of doctoral education as the central connection between the European higher education and research areas (EUA-CDE, 2018).

The *Salzburg Principles* were enhanced in 2010, by the *Salzburg II Recommendations*. Regarding QA, two major needs were highlighted: the development of QA systems in doctoral education, based on peer review, aligned with the institutional mission, linked to the institutional research strategy and sensitive to disciplinary differences; and the development of indicators (related to progression, completion, transferable skills, career tracking, etc.) based on institutional priorities (Byrne et al., 2013; Kivistö et al., 2017).

In 2016, the *Salzburg Principles* were taken forward with the purpose of providing guidelines for the continued reform in doctoral education (EUA-CDE, 2016). Universities were recommended to develop an ethos of research integrity; policies and infrastructures for online sharing and learning in doctoral education; strategies and structures to become more global and to foster the internationalisation of doctoral education; and continuous dialogue with other stakeholders, as a way to add value to doctoral candidates (EUA-CDE, 2016).

ENQA and ESU have also been contributing to the development of QA in doctoral education, although their initiatives are not as systematic or relevant as those of the EUA. ENQA has been promoting initiatives such as the 2009 workshop on Quality Assurance and Postgraduate Education, which constituted an opportunity for its members to 'exchange information, define concepts and examine best practice related to quality assurance of postgraduate education' (Bitusikova et al., 2010). In one of its policy papers, ESU addresses doctoral education in the European Higher Education Area. It states that QA is an important part of the Bologna Process and that this needs to be recognised also in the third cycle. QA of doctoral education has to be undertaken at the programme level, taking into account the coursework and research components, as well as the specific and more individualised nature of most doctoral programmes (ESU, 2010).

The Institutional Level: Internal QA

It is possible to argue that the institutional level is the one where the actual quality assurance and improvement of doctoral education take place. The Bologna Process—materialised in both the ESG and the

Salzburg Principles—has led universities to put a great effort into the development of doctoral education as well as into the assurance of its quality (Bitusikova et al., 2010; Byrne et al., 2013).

The management and organisation of doctoral education and the assurance of doctoral education's quality emerge often in separate processes, coordinated by different governance structures (Bitusikova et al., 2010; Byrne et al., 2013). Indeed, the implementation of internal QA processes directed at doctoral education can be seen as the result not only of the development of internal QA arrangements and systems *tout court*, but also of a more professional management of doctoral education, promoted by the more formal structuring of doctoral programmes (including the introduction of coursework) and, namely, the establishment of doctoral schools (Byrne et al., 2013; Clarke & Lunt, 2014). This has 'brought with it a number of processes that are *de facto* quality assurance processes, but without having been defined as such' (Byrne et al., 2013, p. 15). As evidenced by the results of the Accountable Research Environments for Doctoral Education (ARDE) survey, launched in 2011, the majority of the respondent European institutions reported including doctoral studies in their internal QA, and having processes in place to systematically monitor and increase the transparency of different aspects of doctoral education traditionally left to the discretion of academics (e.g., admission/enrolment, training, completion, assessment, supervision, etc.) (Bitusikova et al., 2010; Byrne et al., 2013). Although these processes may not be perceived as part of QA, they indeed aim to enhance quality (Byrne et al., 2013).

However, as also evidenced by the ARDE survey results, institutions have been developing QA practices specifically directed at doctoral education, which are based on the analysis of research output (publications) as well as of staff qualifications and funding; the use of diverse monitoring indicators, especially scientific publications, completion-rates and time-to-degree (these last two as indicators for supervision); and less systematically, the assessment of the outcomes in terms of graduates' careers, or the monitoring of the quality of career development support (Byrne et al., 2013). The embracing of these quality dimensions and indicators seems to suggest the adoption by institutions of an input-throughput-output model as identified by Nerad (2014b).

In regard to supervision, despite the institutions' overall implementation of procedures to monitor its formal component (through efficiency indicators, for instance) and, to a lesser extent, the use of regulations and guidelines, as well as plans for supervisors' training, it seems that some work still needs to be done concerning the assurance of its quality (Byrne et al., 2013). There are 'calls for better training of supervisors', 'more stringent assessment of supervision' and especially 'for a supervision culture' (Byrne et al., 2013, p. 29). The concern about supervision is justified by the fact that the quality both of the research experience and of its outcomes is significantly related to the quality of the supervision (McCulloch, Kumar, van Schalkwyk, & Wisker, 2016). However, it is recognised that supervision reforms can be potentially difficult and slow, as supervision involves an area which has been traditionally ruled by core academic values and linked to the master-apprentice relationship (Byrne et al., 2013).

Another issue that seems to be increasingly the target of institutions' interest is the quality of doctoral theses. Concerned with the eventual limitations presented by the 'traditional' methods aiming to measure the quality of the theses, institutions in some countries (e.g., Norway and Finland) have defined guidelines at this level (Aittola, 2017; Kyvik, 2013; Kyvik & Thune, 2014).

The National Level: External Quality Assurance

The national level involves regulation and monitoring of doctoral education quality by external QA systems.

Although subject to the same European influences framing internal QA, external QA varies widely across Europe in terms of processes and mechanisms to assure the quality of doctoral education (Bernstein et al., 2014; Byrne et al., 2013; Kehm, 2006). Diversity also exists regarding the used indicators, even if the most common ones are the completion rate, scientific publications, staff qualifications and time-to-degree. Moreover, countries that have established National Qualifications Framework (NQF), aligned with the European developments at this level (Qualifications Framework in the EHEA—QF–EHEA—and the EU

European Qualifications Framework—EQF) (Bernstein et al., 2014; Clarke & Lunt, 2014), have included doctoral studies in those frameworks, despite the challenges or even controversial nature of this decision for the case of doctoral education (e.g., defining learning outcomes) (Byrne et al., 2013; Fortes et al., 2014). In general, qualification frameworks include qualification descriptors for doctoral degrees, summarising the expected attributes for graduates (Clarke & Lunt, 2014). As an example, in England, Wales and Northern Ireland, the qualification descriptors—focused primarily but not exclusively on research attributes and outcomes—are used as a 'reference point for QAA reviewers in the Higher Education Review against which to evaluate institutional performance and graduate outcomes' (Clarke & Lunt, 2014, p. 29).

So, overall, no single 'optimal' model seems to exist for external QA of doctoral education at the European level. Aiming to understand the existing models and their configurations, thirteen European countries considered to be interesting cases in terms of QA development were analysed: Sweden, the UK, Norway, the Netherlands, Switzerland, Denmark, Germany, Finland, Italy, France, Belgium-Flanders, Portugal and Austria. The analysis was based on both the information disclosed in the webpages of QA agencies and that provided by experts (academics, researchers and QA agencies representatives) in the field of higher education from the selected countries.[1]

The analysis undertaken suggests that external QA arrangements for doctoral education range from programme accreditation, to doctoral school evaluation, to institutional evaluation/accreditation, translating different degrees of governmental steering and regulation as well as institutional autonomy and, hence, are indicative of QA approaches closer either to accountability or to quality enhancement (see Table 1).

Accountability-Driven Approaches

Portugal, Italy and Sweden are the countries where doctoral education seems to be under tighter regulation driven by accountability purposes. Doctoral programmes are reviewed by the QA agencies before being allowed to operate; detailed regulations, quality criteria and procedures exist to address these programmes.

Table 1 Main features of external QA of doctoral education in selected European countries

	Scope of external QA				External QA procedures and criteria		Purpose of external QA		Other forms of external QA or external evaluations
Country	Programmes	Doctoral schools	Institutions	Research units	Yes	No	Accountability	Enhancement	
Portugal	X				X		X		
Italy	X				X		X		
Sweden	X				X		X		
France	X	X[a]	X	X	X		X		
UK			X		X		X		
Norway	X[b]				X			X	Evaluations by the research Council of Norway; DE under the scope of Internal QA systems—NOKUT periodic supervision.
Austria	X[c]				X			X	
Denmark		X[d]				X		X	

(*continued*)

Table 1 (continued)

Country	Scope of external QA				External QA procedures and criteria		Purpose of external QA		Other forms of external QA or external evaluations
	Programmes	Doctoral schools	Institutions	Research units	Yes	No	Accountability	Enhancement	
The Netherlands						X		X	Accreditation of doctoral schools (e.g. KNAW); Research assessment.
Flanders						X		X	Evaluation within the university by the doctoral schools; Evaluations by organisations awarding scholarships; Sporadic evaluations aiming universities' research councils.

Finland	X	X	Audit of Internal QA systems; Evaluation of Finish Science; ACAF; Ministry of Economic Affairs and Employment.
Switzerland	X	X	DE eventually under the scope of Internal QA systems.
Germany	X	X	Indirect evaluation initiatives; Non-official accreditation of study programmes.

Legend: [a]Main external QA mechanism, [b]Only specialised universities and university colleges, [c]Only private universities and [d]International evaluation of graduate schools

In **Portugal**, doctoral education is mandatorily included in the assessment and accreditation of study programmes carried out by the Agency for Assessment and Accreditation of Higher Education (A3ES). Programme accreditation uses criteria which are common to first, second and third study cycles: the study programme's general objectives; internal organisation and QA mechanisms; material resources and partnerships; teaching and non-teaching staff; students and teaching and learning environments; processes; results; SWOT analysis; and improvement proposals (A3ES, 2018). In addition to these criteria, doctoral programme accreditation requires specific evidence on two particular aspects: the institution's human and organisational resources required for conducting research, and its research experience duly evaluated and reflected in relevant scientific production within the scientific area(s) of the doctoral programme(s). Regarding the first aspect, it is required that the teaching staff assigned to a doctoral programme meets minimum ratios in relation to its composition and qualification (A3ES, 2013, 2014), and have an active, relevant and internationally recognised role in the research developed within the doctoral programme's scientific area. Doctoral programme accreditation is also dependent on the existence within institutions of adequate and high-level research environments, specifically taking into account the results of the assessment of research units conducted by the Foundation for Science and Technology (FCT) (Decree-law 65/2018).

Agenzia Nazionale di Valutazione del Sistema Universitario e della Ricerca (ANVUR), the QA agency in **Italy**, is responsible for the accreditation of doctoral education within the framework of specific legislation and guidelines issued by *Ministero dell'Istruzione dell'Università e della Ricerca* (MIUR) (ANVUR, 2018). These guidelines define, in terms of indicators and parameters, the requirements for the accreditation of doctoral programmes of both universities and Italian Qualified Training and Advanced Research institutions.

The requirements are quite detailed and different for both types of institutions. At the programme level, universities, in particular, have to observe the following (MIUR, 2014):

1. Scientific qualification, evidenced by the results in the Evaluation of Research Quality exercise or, alternatively, by the scientific production in the last five years.
2. Themes and curricula: reference to related and coherent research themes and methodologies; an adequate number of teaching staff with respect to the research themes, in programmes with a curricular component; consistency of the scientific production, in programmes with a strong multidisciplinary character.
3. Teaching staff: compliance with the conditions determined by a set of indicators related to its composition, qualification, scientific activity and outputs, including indexed (Scopus and Web of Science) publications.
4. Sustainability, infrastructures and training: confirmed by the number of grants (or equivalent) and research budget available to students, existence and adequacy of infrastructures, equipment and training activities.

In addition to these requirements, the Italian Qualified Training and Advanced Research institutions must also provide evidence on the development of training and research activities, the absence of profit, organisational requirements and availability of resources.

In 2015 the Higher Education Authority (UKÄ) in **Sweden** proposed a new model for evaluating doctoral education, comprising all disciplines, including fine arts. The model constituted part of the proposal for a new QA system, implemented in 2016 (ENQA, 2018), which was based on a clear link between UKÄ's reviews and institutions' QA processes (UKÄ, 2018b). Programme evaluation is one of the components of the Swedish QA system, and there are specific guidelines (published in 2016 and updated in 2018) for the evaluation of third-cycle programmes (UKÄ, 2018a, 2018b). Four assessment areas, which contain one or more assessment criteria, are addressed (UKÄ, 2018b):

1. Preconditions: includes assessment criteria related to the programme staff (e.g., number and combined expertise of supervisors and teaching staff) and environment (e.g., research quality and scale, collaboration with the surrounding society, both nationally and internationally).

2. Design, implementation and outcomes refers to the qualitative targets (what doctoral students need to have achieved upon receiving a degree) selected for evaluation under the forms of proficiency knowledge and understanding; competences and skills; and judgement and approach. It also comprises the extent to which programme design, implementation and outcomes include a gender equality perspective, are subject to follow-up and include improvement measures and feedback to relevant stakeholders.
3. Doctoral student perspective: criteria related to students' physical and psycho-social work environment as well as their role in the improvement of the programme.
4. Working life and collaboration: criteria related to the way the programme is designed and implemented to be useful and develop doctoral students' preparedness for working life both within and beyond academia.

To sum up, the model for assessing doctoral education focuses on the evaluation of three main components: doctoral students' achievement of learning outcomes; breadth and quality of research linked to the educational environment; and the institutions' internal quality work (ENQA, 2018). Doctoral dissertations are not included in the evaluation; instead, assessment material consists of the institutions' self-evaluation, the general study plan for the third-cycle subject, randomly selected individual study plans, and interviews with the programme's representatives and students (ENQA, 2018; UKÄ, 2018b).

Between Accountability and Enhancement

In countries such as France, the UK, Norway, Austria and Denmark, control and regulation of doctoral education is less tight than in the cases described above. Although governmental steering for accountability purposes can also be identified, this is combined with quality enhancement. Hence, it can be assumed that the assurance of doctoral education quality is based on a combination (to varying degrees) of external regulation and institutional autonomy.

In **France**, doctoral education is targeted by several external quality assurance processes promoted by the High Council for Evaluation of Research and Higher Education (Hcéres). One of the processes is the evaluation of doctoral schools and colleges.[2] The evaluation of doctoral schools is carried out according to a specific framework (Hcéres, 2018a, 2018b, 2018c, 2018d), which contains a set of references, objectives and criteria meant to allow schools to build their own assessment (internal evaluation mechanism or self-assessment) (Hcéres, 2016a, 2017a). It is organised in three quality management domains: (1) school operation and scientific support (e.g., school organisation and governance; scientific and student recruitment policies); (2) supervision and training of doctoral students (e.g., supervision policy, student follow-up and training); and (3) follow-up of doctoral graduates' professional careers (e.g., mechanisms for follow-up of career progression) (Hcéres, 2016a, 2017a). According to the official text ruling doctoral programmes (*Arrêté du 25 Mai 2016, Version Consolidée au 19 Novembre 2018*), doctoral schools must also set up specific mechanisms for the evaluation of curricula and training activities (e.g., doctoral student surveys) and discuss results internally.

Additionally, the evaluation of doctoral education is envisaged in a less direct way by other evaluation methods. In the external assessment of higher education and research institutions, doctoral education is addressed in the evaluation of the link between research and training and, in particular, of the research and training policies designed to develop this link. Specifically, institutions must demonstrate that doctoral studies are part of the institutional research and training policies and that a policy for doctoral student recruitment and follow-up aiming to promote their success and employability is defined (Hcéres, 2016b, 2017b, 2018e). In the evaluation of research units, doctoral education is targeted in relation to the fulfilment of criteria concerning the quality of research products and activities and the organisation and life of the research unit (Hcéres, 2016c, 2017c, 2018f).

The **UK** Quality Assurance Agency for Higher Education (QAA) promotes several institutional reviews for all types of institutions using a variety of methods (QAA, 2018b). Additionally, QAA has the task of setting and monitoring the standards of UK higher education including the development of the UK Quality Code for Higher Education (QAA, 2018a). The Quality Code is the touchstone in reviewing higher education. It explains 'what higher education providers are required to do, what they can expect of each other, and what students and the general public can expect of them' (QAA, 2018b). The existing Quality Code (2013–2018) sets out a number of expectations that all providers of UK higher education are required to meet and which are translated into indicators of sound practice. The expectation about research degrees (including doctoral degrees) which higher education providers are required to meet emphasises the research environment (QAA, 2013, p. 8):

> Research degrees are awarded in a research environment that provides secure academic standards for doing research and learning about research approaches, methods, procedures and protocols. This environment offers students quality of opportunities and the support they need to achieve successful academic, personal and professional outcomes from their research degrees.

Indicators of sound practice concerning this expectation have to do with: higher education provider arrangements; research environment; selection, admission and induction of students; supervision; progress and review arrangements; development of research and other skills; evaluation mechanisms; assessment; research student complaints and appeals (QAA, 2013).

The QA system in **Norway** is based on the assumption that QA should be carried out through internal QA systems (NOKUT, 2018a). Institutions need to have these systems implemented targeting all levels of studies, including doctoral education (Norwegian expert 1). The QA agency—NOKUT—periodically supervises these systems and concludes on their adequacy according to the criteria stipulated in the Academic Supervision Regulations (NOKUT, 2018a).

Moreover, different accreditation regimes apply to different types of institutions: while universities are self-accrediting (i.e., they do not need to apply to NOKUT for accreditation of their doctoral programmes), specialised university institutions and university colleges must seek accreditation for their programmes (NOKUT, 2018b, 2018c; Norwegian experts 1 and 2). Nevertheless, NOKUT may freely supervise[3] doctoral programmes (as well as the other degrees), regardless of whether they are accredited or recognised by the agency or by institutions with accreditation authorisation (NOKUT, 2018d).

Accreditation and supervision processes follow NOKUT's Academic Supervisions Regulations (NOKUT, 2018e). These regulations especially emphasise doctoral programmes' academic environment, by setting as a requirement that this 'environment must consist of academic staff with at least associate professor qualifications' (NOKUT, 2018e). Moreover, and as with all degree programmes, the 'academic environment must be actively engaged in research and academic development work and/or artistic research, and be able to demonstrate documented results with a satisfactory quality and scope in relation to the programme's content and level' (NOKUT, 2018e).

Doctoral education has also been a focus of external evaluations by the Research Council of Norway—RCN (Norwegian experts 1 and 2). Therefore, to some extent, external QA of doctoral education is part of the responsibility of this Council and NOKUT (Norwegian expert 1). Nevertheless, RCN reviews are not part of the external QA system as such (Norwegian expert 2).

As for the organisation of external QA in **Austria**, there are differences by higher education sector, with different methods and processes being used in each case. The Agency for Quality Assurance and Accreditation in Higher Education (AQ) promotes the accreditation of private universities and universities of applied sciences and their programmes. It also promotes audits of institutions' internal quality management systems, including those of public universities (AQ, 2018). This has repercussions for the way doctoral education quality is assured: while public universities act rather freely, private universities have to go through accreditation processes (Austrian expert). As defined by the accreditation rules applicable to all degree programmes, assessment areas include the programme and its management, staff, quality assurance, funding and infrastructure, research and development, and national and international cooperation (BMWFW, 2014).

In **Denmark**, the 2013 Accreditation Act marked the transition to institutional accreditation, replacing an external QA system based on programme accreditation. Therefore, there is no doctoral programme accreditation (DAI, 2018; Danish expert 1). Instead, QA of doctoral education occurs through international evaluations of graduate schools, which are mandatory and regulated in the Danish (Consolidated) Act on Universities (the 2011 University Act). Evaluations have to occur every five years and must be undertaken by an international panel selected by the university. Although no formal guidelines are defined at the national level, most evaluations that occurred until 2015 covered the following areas of graduate schools and doctoral programmes: organisation, structure and management; supervision, internationalisation; academic hiring; student recruitment; duration and completion-rates; quality assurance; work environment.

Enhancement-Driven Approaches

In a final group of countries—the Netherlands, Belgium-Flanders, Finland, Switzerland and Germany—the quality of doctoral education seems to be mainly left to universities, under their QA systems. This suggests a high level of institutional autonomy and an emphasis on quality enhancement as the guiding purpose of the external QA of this educational level.

In the **Netherlands**, the Accreditation Organisation of the Netherlands and Flanders (NVAO) is the body responsible for the assessment and assurance of the quality of higher education. NVAO assesses universities' internal QA systems through institutional audits, and their programmes' quality, through accreditation. Nevertheless, none of these mechanisms include doctoral programmes (NVAO, 2018).

External QA of doctoral education is only undertaken through its inclusion in the national research assessment exercise which assesses research conducted at Dutch universities and is organised by the Netherlands Organisation for Scientific Research (NWO), the Association of Universities in the Netherlands (VSNU) and the Royal Academy of Arts and Sciences (KNAW). According to the Standard Evaluation Protocol (SEP), doctoral programmes are assessed regarding supervision and instruction of doctoral candidates. More specifically, issues such as the institutional context of the doctoral programme, selection and admission procedures, the programme content and structure, supervision and the effectiveness of programme and supervision plans, quality assurance, supporting candidates' transition to the job market, duration, success rate, exit numbers and career prospects, are taken into consideration (VSNU, NWO, & KNAW, 2016). Nevertheless, the research assessment exercise does not imply formal policy consequences. The assessment results are only meant as management information for the university leadership. Therefore, the university remains responsible for the quality of doctoral education (Dutch expert 1).

Although comprising different evaluation mechanisms (initial accreditation, programme accreditation, internal QA assessment and institutional review), the QA system in **Belgium-Flanders** has as underlying rationale to reinforce institutions' autonomy by offering them the opportunity to substantiate the responsibility for their own quality policy (NVAO, 2018). Regarding doctoral education, its quality 'is evaluated within the university by the doctoral schools themselves. Recently there was also an evaluation by the government of the so-called OJO-fund which funds the work of doctoral schools and was put into motion earlier this decade' (Flemish expert). This evaluation does not address the quality of supervision or graduates' work. However, there are sporadic evaluations whose focus does not seem to be the individual/research group/department/faculty level. Some of these evaluations are mainly about processes at the university level and how governmental funds are managed. Therefore, it seems that doctoral education 'falls between the cracks of regular quality assurance practices'. No 'integrated external quality assurance of doctoral education' exists; rather, only 'more ad-hoc' practices are in place, which focus only on parts 'of the larger picture of doctoral education' (Flemish expert).

In **Finland,** external QA places emphasis on the development of internal QA. Education providers are encouraged to develop quality (FNAE, 2018), and higher education institutions, in particular, are encouraged to implement quality systems, which are audited by the Finnish Education Evaluation Centre (FINEEC) (FINEEC, 2018a). So, external QA relies on mechanisms for more remote supervision or regulation through less-intrusive instruments under the increasingly rooted assumption of university autonomy and responsibility for reforms (Kivistö et al., 2017).

Until 2018, audits comprised an evaluation of samples of degree programmes, including doctoral programmes, which were assessed based on their planning, implementation and effectiveness of the quality work (FINEEC, 2018b, 2018c). For the third round of audits (2018–2024), a new model was designed based on the central premise of institutions' autonomy to develop their quality systems according to their own needs and goals (FINEEC, 2018d). In this context, no reference is made to the selection of samples of degree programmes nor to the possibility of evaluating doctoral programmes (see FINEEC, 2018e). Nevertheless, under the 'The enhancement of education' section of the manual, it is expected that institutions regularly monitor and evaluate their degree programmes 'to ensure that they are up-to-date with regard to the latest research findings and the changing needs of the society and working life' (FINEEC, 2018e).

Doctoral education is included in other evaluations outside FINEEC's scope, as is the case of the evaluation of the level and rank of Finnish science (promoted every three years). Moreover, the Academy of Finland (ACAF) tracks the employability of doctoral graduates, while 'the Ministry of Economic Affairs and Employment steers innovation policy, and therefore, in part, doctoral education as well' (Kivistö et al., 2017, p. 298).

External QA of higher education in **Switzerland** is conducted by the Swiss Agency for Accreditation and Quality Assurance (AAQ) based on different types of mechanisms (institutional accreditation; programme accreditation; voluntary study programmes and institution reviews). Nevertheless, doctoral education does not seem to be envisaged by any of these mechanisms, which suggests that QA at this level is addressed by institutions, under their internal QA systems (AAQ, 2018a). Indeed, QA systems are recognised as the central mechanism allowing institutions to ensure the quality of teaching, research and services to society while awarding them autonomy and full responsibility for their QA (AAQ, 2018b).

In **Germany** there is no compulsory external QA procedure for doctoral education (German expert). No references are made to it in the criteria defined for programme accreditation or system accreditation (accreditation of the institution's teaching and learning quality management system) (German expert). Therefore, the assurance of doctoral education quality seems to be under the sole responsibility of universities.

Nevertheless, some initiatives have been promoted, albeit indirectly addressing doctoral education quality. That is the case of a position paper published by the German Science Council for Sciences and Humanities in 2011 (WR, 2011) establishing quality criteria and standards for doctoral programmes, which 'are usually applied/followed' by institutions (German expert). Furthermore, accreditation agencies operating in Germany can offer 'accreditation' of doctoral programmes, although this is not an official accreditation by the German Accreditation Council. An agency that has this procedure is the Central Evaluation and Accreditation Agency (ZEvA), responsible for QA in higher education in the state of Lower Saxony (German expert). However, it was not possible to identify criteria or standards specifically for doctoral programmes. In the Baden-Wuerttemberg state, there is also a general commitment to the QA of the doctoral thesis laid down in the higher education law, together with a general duty of establishing a quality management system (German expert).

As revealed by the previous analysis, regardless of the configurations assumed by external QA in various European countries, several important dimensions are already being considered in regard to how doctoral education quality should be developed and promoted. Among these dimensions, it is possible to identify some cross-cutting ones to which special attention and further consideration could be given, such as candidates' recruitment, teaching staff qualifications and research, and graduates' integration in the labour market. Next, an attempt is made to discuss some proposals for future developments regarding QA in doctoral education.

External QA of Doctoral Education: Proposals for Future Developments

As argued in the literature, significant changes have been and are still occurring in doctoral education, which is no longer restricted to elite and individual research work conducted under the supervision of a master, and is no longer a direct access route to a place within academia.

Specifically in Europe, this has paved the way for internal and external QA to encompass doctoral education. Thus, while for a long time the quality of doctoral education did not really represent an issue and (when it did) it was under the exclusive purview of universities, in recent decades, and especially with the Bologna process, this has changed: not only has there been a more systematic implementation and greater organisation of internal QA practices of universities around doctoral education (Bitusikova et al., 2010; Byrne et al., 2013), but the latter has also become a target of external QA systems. The chapter sought to provide a general overview of QA of doctoral education in Europe, with a special emphasis on external QA.

Eventually framed by the evolution and degree of maturity of external QA systems, their underlying quality culture and perspective, as well as by the social and political specificities of European countries and their higher education systems, external QA of doctoral education varies from being more regulated and accountability-driven to privileging institutional autonomy and quality enhancement. For instance, in Portugal, the tighter regulation of doctoral programmes existing nowadays, based on accreditation and relatively detailed regulations and quality criteria, seems to be explained by decades of rapid and somewhat unregulated growth in these programmes with the consequent need to adjust their offer and quality. The idea is that once these aspects are 'normalised', a less-intrusive external QA intervention, with greater emphasis on quality enhancement, can take place.

In addition, external QA also covers many of the crucial dimensions of doctoral education (e.g., candidate recruitment, teaching staff qualifications and research activity, graduate integration in the labour market) in different forms and degrees, expressed in more or less evident and exhaustive regulations envisaging this level of studies, directly or indirectly.

Not intending to judge the different existing models and their effectiveness, there still seems to be room for improving the external QA of doctoral education. Even though there are no simple solutions, some proposals may be advanced as potentially relevant. These proposals are put forward, nevertheless taking into account the fact that doctoral education is a delicate issue for universities given, not only their autonomy but also the fact that they are the privileged places for promoting quality at this level (Bitusikova et al., 2010; Byrne et al., 2013). Moreover, it is acknowledged that any proposal regarding external QA development should avoid promoting overly tight and detailed quality criteria. This 'has proven less effective in achieving expected policy goals' while preventing universities from self-regulation (Kivistö et al., 2017, p. 296). Finally, proposals are suggested keeping in mind what Ruth Neumann emphasises in her chapter (see Neumann's chapter), that the discipline is the core of doctoral education and, therefore, the differences and specificities regarding disciplines must be respected by external QA.

A first proposal has to do with supervision, an aspect which deserves more attention due to its critical importance for the doctoral degree (Bitusikova et al., 2010; EUA, 2005; Friedrich-Nel & Mac Kinnon, 2017). External QA could consider assessing the quality of supervision and mentoring (Bitusikova et al., 2010). For instance, when analysing the profile of teaching staff, aspects such as the following could be considered: the workload of each supervisor, consisting not only of the number of supervisions but also of all the other academic workload (EUA, 2005, 2007; Friedrich-Nel & Mac Kinnon, 2017); the number of thesis defences in which each member of teaching staff has participated; and the preparedness for supervision, including the attendance of training programmes on supervision (Friedrich-Nel & Mac Kinnon, 2017). Moreover, and since the quality of supervision is primarily a responsibility of universities (EUA, 2005, 2007), it could be relevant for external QA to encourage and support them in the development and dissemination of good practices regarding supervision and mentoring. Indeed, according to the ARDE survey, supervision was the area in which most institutions revealed the least satisfaction and most reforms were being planned (Byrne et al., 2013). Developments at this level could include the clear definition and inclusion in institutional regulations of aspects such as the supervisors' qualifications, responsibilities and duties (EUA, 2005, 2007) and a 'transparent contractual framework of shared responsibilities between doctoral candidates, supervisors and the institution' (EUA, 2007, p. 11). In some countries, such as the UK, awareness of responsibilities is promoted through handbooks, guidelines and codes of conduct for supervisors and students, and continuous professional development (EUA, 2005, 2007). External QA could therefore verify the effective existence of such good practices when assuring the quality of doctoral programmes.

Considering that supervision is a shared compromise and responsibility, external QA could also address the student voice regarding this issue, using a procedure similar to that adopted in Sweden to assess students' perspectives on the doctoral programmes and their role in the improvement of these programmes. This procedure could even be extended to include student satisfaction with the general doctoral experience.

Although recognising that some European countries already address this issue in a more direct (e.g., UK) or indirect way (e.g., Portugal, Italy, Norway), another aspect that could be further considered by external QA has to do with the development of an effective research environment within doctoral programmes. This could possibly be achieved by paying more attention to the quality of research activities, not only of teaching staff but also of doctoral students. Regarding the teaching staff, external QA could take into consideration both the number of publications in a given period of time and their quality. As for doctoral students, external QA could ensure that they are 'included as partners and co-researchers in research projects and research groups' (EUA, 2005, p. 17). To this end, indicators such as the number of students integrating the research units and research project teams associated with doctoral programmes, as well as the scientific outputs resulting from doctoral work (e.g., number of publications, communications in scientific meetings, patents, etc.), could be used. Additionally, external QA could also consider the way institutions are building strong research environments and, thus, achieving a critical mass of doctoral candidates, namely by developing innovative structures (e.g., doctoral schools or other structures); promoting 'quality research work and training' 'through the involvement of active research groups, research clusters and networks' (EUA, 2005, p. 16); and providing opportunities (including financial) for students to participate in an enlarged research environment (e.g., inter-institutional doctoral schools, European summer schools, scientific conferences, etc.).

As previously discussed, research is increasingly relevant to national economies and labour markets, thus researchers need to be prepared for different labour settings, requiring new professional knowledge and skills. This seems to justify paying more attention to a 'globally defined set of expected outcomes' for doctoral education (Bernstein et al., 2014, p. 22). As it happens in Sweden, to some extent, external QA could look closer at the way in which learning outcomes are defined for doctoral programmes. Specifically, it could analyse if learning outcomes address new professional knowledge and skills, as well as how transparently they are being communicated to employers and other stakeholders, promoting a better idea of doctoral graduates' credentials (Bernstein et al., 2014; Maheu et al., 2014). Moreover, external QA could include as an outcome indicator the integration of doctoral graduates in the labour market. As doctoral education has become more diversified, it would also be important to align external QA with its different models (e.g., professional doctorate, industrial doctorate, etc.) and their specificities (see Kehm, 2011), namely regarding the criteria for assessing the quality of teaching staff or the achievement of the proposed objectives which, in principle, are supposed to be different from those of the research doctorate.

In addition to the previous proposals, a final and, possibly, more important suggestion could be that external QA should systematically assess how far institutions integrate the assurance of the quality of their doctoral programmes in internal QA practices and systems. In this context, external QA could ensure that internal QA systems effectively address doctoral programmes by paying attention to their specificities and encompassing the monitoring and improvement of fundamental aspects such as, for instance: student recruitment and selection, doctoral training, research, assessment (including of doctoral thesis), supervision and mentoring, skills and competences, employability and internationalisation. Additionally, and due to their relevance for doctoral education, external QA could monitor the degree of implementation of the *Salzburg Principles* within universities. Universities' alignment with these principles is already a concern in some European countries, as for instance in Finland (see Kivistö et al., 2017) where external QA is based on internal QA systems auditing.

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Notes

1. A total of fourteen experts: three from Norway, two from Denmark and the Netherlands, and one from each one of the other countries, with the exception of Portugal, Sweden and the UK, where no expert has been consulted since the information available was considered to be sufficient.
2. Colleges are constituted by a group of doctoral schools with the aim of coordinating their activities and organising and giving visibility to their doctoral policy (Hcéres, 2018d). The evaluation of doctoral colleges is offered to institutions on a voluntary basis (Hcéres, 2018a, 2018b, 2018c). The reference framework for the external evaluation of a doctoral college is structured in three domains which are slightly different from those applied to doctoral schools (Hcéres, 2018d): (1) doctoral college institutional positioning; (2) doctoral college competences and activities (e.g., involvement in the operation of the doctoral schools, the supervision and training of doctoral students; and monitoring of graduates' career path); and (3) doctoral college organisation, operation and steering (e.g., organisation form, operation rules and resources).
3. As stated by NOKUT on its website (2018d): 'Norwegian educational institutions are responsible for their own quality assurance and for ensuring that the study programmes they offer meet the requirements of applicable laws and regulations. Because responsibility for the quality of the education clearly rests with the institutions, NOKUT has an extensive right to supervise them. The purpose of the supervisory activities is to ensure that Norwegian study programmes meet the requirements that apply, and to verify that the institutions follow up the quality of the education they offer. Institutions that provide higher education shall have procedures and practices in place for reviewing their own accreditations.'

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Part II

The Meso Level: Institutional Readjustments

From the Medieval Disputation to the Graduate School

Alberto Amaral and Teresa Carvalho

Introduction: Masters and Doctors

Mainly since the new Millennium, doctoral training in higher education institutions has been under deep transformation. An important result of these changes is the emergence of new institutional structures to organise

A. Amaral (✉)
Agency for Assessment and Accreditation of Higher Education (A3ES), Lisbon, Portugal

Centre for Research in Higher Education Policies (CIPES), Matosinhos, Portugal
e-mail: alberto.amaral@a3es.pt

T. Carvalho
Department of Social, Political and Territorial Sciences, University of Aveiro, Aveiro, Portugal

Centre for Research in Higher Education Policies (CIPES), Matosinhos, Portugal
e-mail: teresa.carvalho@ua.pt

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doctoral training leading to the appearance of graduate or doctoral schools in several European countries. This chapter reflects on the historical evolution of doctoral training in Europe to question the institutionalisation of a new cultural-cognitive framework shaping the training at this level with the creation and expansion of doctoral schools.

In Europe the traditional model of the research-based PhD without a taught component, and modelled on the traditional master-apprentice relationship, still prevails despite some recent changes (Kehm, 2006, p. 76). However, the research-based doctorate is a relatively recent acquisition of universities. In medieval times, there was a title (Master in the University of Paris, Doctor in the University of Bologna) which certified that an individual was able to teach in a university (Simpson, 1983) or, in other words, it meant, 'the holder of it had achieved total mastery of the discipline which he had studied' (Verger, 1992, p. 145). While in the Arts and Philosophy faculties the usual designation was Master, in other areas the title was Doctor, for example, in Theology, Law and Medicine.

For many years, the Master was considered equivalent to the Doctor, but in the sixteenth century, there were heated debates between holders of the Master's, who wanted to become Doctors, and traditional Doctors, debates that lasted for a long time. A syllogism was even formulated by Georg Walther, in 1641:

> *The master's is the highest degree in philosophy*
> *The doctor's degree is superior to the master's*
> *Ergo, the doctor of philosophy does not exist.* (As cited in Clark, 2006, p. 193)

This elevation of Master to Doctor of Philosophy was an unsolved issue for about a quarter of a millennium, from 1550 to 1810. At last, with the founding of the University of Berlin in 1810, the philosophy faculty was proclaimed as the foundation of the university and the Doctor of Philosophy without any additional qualification was established, thus expressing the unity of the faculty and all knowledge (Clark, 2006, p. 197).

Some specific criteria, similar to the Dublin descriptors, adopted in 2005 as the Qualifications Framework of the European Higher Education Area, were established, defining clearly what the Master and the Doctor of philosophy were, an interesting precursor of the new and fashionable learning outcomes and skills:

> *The master's degree is awarded to whoever can skilfully renew and well order what has been learnt, and thus promises to be a useful link in the transmission of knowledge between generations. The doctor's degree is awarded to whoever shows Engenthümlichkeit [personality, peculiarity, originality] and Erfindungsvermögen [creativity] in the treatment of academic knowledge. [Wissenschaft]* (Wright, 1817, as cited by Clark, 2006, p. 211)

Since then, the association between the doctoral degree and the creation of new knowledge has been institutionalised in the Higher Education field in Europe. Nevertheless, in the last two decades major changes have been occurring. This chapter intends to reflect on these changes by presenting the historical process of the evolution of PhD training and the factors leading to transformations in current times. Using the analysis of the main institutional structures doctoral education can assume, the possibility of normalising the institutionalisation of doctoral schools in Europe is discussed.

The Historical Route in Doctoral Education

The Medieval Disputation

When universities began to be established in the Middle Ages, procedures for being awarded a title of Master or Doctor were described in great detail and in general consisted of three stages (Verger, 1992, pp. 144–145). Procedures started with an examination, which determined if the candidate complied with the necessary requirements regarding his morality and previous studies. This was followed by a private examination, in general a disputation over a theme 'which was drawn by lot the previous evening or in the morning' (Verger, 1992, p. 145). If he passed he was awarded the title of *licenciatus* but before he could teach he had to go through a third stage, a public examination where he was bestowed with the attires of 'a master, namely biretta, gloves and a book'

(Verger, ibid.) and performed his 'first magistrial act, in general a disputation with students on a theme of his choice' (Verger, ibid.).

In the seventeenth century the master was awarded after a written thesis and a disputation and 'in 1771 the Dr. phil. (PhD) was formally recognised in Prussia however it was not a research based degree' (Bogle, 2017, p. 1), demonstrating instead mastery of the knowledge in a subject and erudition. But the theses were not based on original research; they were in general a written piece that could be used in a disputation, and in many cases, they were written by the professor not the student, who was then charged with the task of defending the ideas of the master in a public disputation.

Some theses had rather appealing titles, good examples being a thesis presented at the University of Leipzig in 1704 under the title *On Scholars Who Hastened Their Deaths Through Overmuch Study (De eruditis studiorum intemperie morten sibi accelerantibus)* or the 1702 thesis presented at the University of Rinteln under the title *On the Reasons Why Not Few Scholars Bring Nothing to Light (De causis cur nonulli eruditi nihil in lucem emiserint)* (Clark, 2006). As referred to by Clark (2006, pp. 214–215), the titles of those theses were quite diverse and could include works on academics who were cobblers, on those who lived to be more than seventy years old, on those who died on their own birthdays, on those who were bastards, on those who spoke with angels and on those who had made pacts with the devil.

Universities were rather removed from research concerns, and orthodox academic science was comprehensively derided: nature 'was studied bookishly, slavishly following the texts of the Ancients; the main aim was victory in vain, logic-chopping disputations rather than truth to nature. University science was a wilderness, bringing forth neither fruit nor light' (Porter, 1996, pp. 531–532). Critics were rather harsh. Giordano Bruno in his conflict with Oxford referred to 'the discourteous impoliteness and brazen ignorance of their doctors' (Bruno, 1584, p. 104), and Adam Smith (1776, pp. 1316–1317) claimed that 'In the University of Oxford, the greater part of the public professors have, for these many years, given up altogether even the pretence of teaching'. Westfall argued that seventeenth-century Cambridge was 'approaching the status of an intellectual wasteland' (1980), and Francis Bacon considered that in institutions for the cultivation of learning 'everything is found adverse to the progress of science' (Bacon, 1620). Bernal argued that 'the great developments of seventeenth and eighteenth century science took place not because of, but in spite of, the place science occupied in education' (Bernal, 1967, p. 71), which is consistent with Rupert Hall's reminder that 'universities were expected to teach boys, not be research institutes' (1970, 133, as cited in Porter, 1996, p. 533).

The Research Doctorate and the Emergence of the Research University

The emergence of the modern research university is associated with the implementation of the research doctorate, the PhD. The research-based PhD was developed at the University of Berlin, founded by William von Humboldt in 1810 as the first modern research university (Wyatt, 1998). Being awarded a PhD required 'successful attendance at seminars, submission of an acceptable thesis, and the passing of a comprehensive oral examination, and the emphasis was on original and creative research (Goodchild & Miller, 1997)' (Park, 2005, p. 191–2). The implementation of the 'research seminar' (and lab) was instrumental in the development of this new research degree. It allowed the training of advanced and graduate students and, as seminars were allocated a budget, they also had the means to offer scholarships and fund research. This new research-based model attracted a large number of graduate students to Berlin, replacing Paris as 'the Mecca of scholars and scientists across the world' (Rüegg, 2011, p. 11).

Humboldt implemented the ideas of the theologian and philosopher Friedrich Schleiermacher, who considered that the university should 'stimulate the idea of science in the minds of the students, to encourage them to take account of the fundamental laws of science in all their thinking' (Schleiermacher, 1808, pp. 32–33) and proposed the research seminars in which 'the scientific spirit, awakened by philosophical teaching, would penetrate more deeply into the particular, to research, combine, and create something of its own, and to confirm by the correctness of its judgement the insight it has gained into nature and the coherence of all knowledge' (1808, p. 39).

The traditional PhD, as introduced in the University of Berlin, was a research degree 'awarded or demonstrating ability to carry out academic research and produce new knowledge' (Park, 2005, p. 189):

> *The objective is to deliver an original and significant contribution to the research literature in the field of study. A broad understanding of the field she/he is working in is often an additional criterion, as well as that the quality should be such that academic publication of the dissertation is likely*. (Huisman & Naidoo, 2006, p. 6)

This new model, associating doctoral education with the creation of new and creative knowledge, began to be disseminated all over Europe and gradually became the institutionalised model.

The Napoleonic reform of higher education created the Imperial University and introduced the PhD in 1810. To become a doctor in the Faculté de Sciences de Paris, the candidate had to present two theses either in mechanics and astronomy, in physics and chemistry, or in the three parts of natural history, and the degree had to mention which of the sciences was considered (Mourier, 1856). To be accepted, a thesis had to present new results (*les thèses relatives aux sciences physiques et naturelles ne seront admises à la discussion, si ces thèses ne renferment des résultats nouveaux* [Mourier, 1856, p. 12]). The first degree was awarded in 1811 to Bourdon with a thesis in mechanics (*Exposition des lois du mouvement d'un corps solide autour d'un point fixe, précédée de la théorie des moments d'inertie et des axes principaux*) and a thesis in astronomy (*Du mouvement elliptique des planètes*) (Mourier, 1856).

The PhD was also introduced in the Netherlands in 1815, while in Switzerland the first PhD degrees were awarded in 1833 in Medicine in Zurich and in 1875 in Law in Geneva.

The implementation of the research PhD in the UK was a rather slow process. British universities were confronted with strong pressures from the government, which showed imperial concern that 'students from the dominions would go to Germany or the United States and be weaned away from the mother country' (Aldrich, 2006). Only in 1917 did the representatives of universities decide to implement the PhD:

> *For the better promotion of research in this country, and for the encouragement of advanced work by "graduate" students from abroad, a degree or title of Doctor should be instituted, attainable after a period of not less than two years whole-time work devoted to advanced study or research* … (Aldrich, 2006)

Oxford was the first university to implement the research doctorate in 1917 and the first degree was awarded in 1919. The University of London only introduced the PhD in 1919 and Cambridge awarded the first PhD in Mathematics in 1924. Initially, holding a PhD was not a necessary condition to teach in a British university. In Cambridge 'there was no feeling that a research degree was necessary for its own graduates' (Aldrich, 2006), and some argued that 'a research degree was not needed because their staff were "smart enough without the need of further education"' (Bogle, 2017).

The Emergence of the Structured Doctorate: The Graduate/Doctoral Schools

Drivers of Change

More recently, some drivers of change have been transforming the PhD from what Clark (2006, p. 195) jocularly described 'as a secret garden or an activity that takes place behind closed doors between consenting adults' into a more structured and bureaucratised experience, taking place in the emerging 'graduate schools' or 'doctoral schools'.

Drivers of change of doctoral education have been identified as its massification and professionalisation (and of careers) and the development of quality assurance systems (Andres et al., 2015). Data from OECD show that on average in 2000, 1% of young people earned doctoral degrees compared to 1.6% in 2009 and 1.8% in 2015 in OECD countries (2.0% in EU_{22}) (OECD, 2014, 2017). Doctoral educational is highly internationalised—about 25% are international students (OECD, 2017)—and most doctoral degrees are in STEM areas (44%) (OECD, 2017). Although Kehm (2006) reported some evidence that the labour market has not been able to absorb all these highly qualified individuals, other authors indicated that holders of a doctoral degree have very high employment rates, from 93% to 99% (Auriol, Misu, & Freeman, 2013; OECD, 2017). In any case, the fact that an increasing number of PhD graduates has to look for employment outside the academy has raised the question of having the skills adequate for those new jobs.

Massification and working outside academia has led to the increased professionalisation of the PhD. In a number of papers and reports, there is reference to the need to provide PhD graduates with 'generic skills', namely those needed for creative enterprises (EUA, 2009; Fiske, 2011; Gilbert, Balatti, Turner, & Whitehouse, 2004; OECD, 2012). The European Commission (2011) notes 'It is essential to ensure that enough researchers have the skills demanded by the knowledge based economy. Examples include communication, teamwork, entrepreneurship, project management, IPR, ethics, standardisation etc.' In the Salzburg Recommendations (I and II), the European University Association recognises that 'doctoral training must increasingly meet the needs of an employment market that is wider than academia' (EUA, 2005, p. 2) and that 'Offering training in transferable skills, including understanding the ethics of research, is central, and should be a priority for doctoral schools and programmes' (EUA, 2010, p. 3). In 2007 the European University Association together with the American Council of Graduate Schools, the Canadian Association for Graduate Schools, the Deans and Directors of Graduate Schools of Australia and the Association of Chinese Graduate Schools signed in Banff, in the Canadian Rocky Mountains, the *Banff Principles on Graduate Education* (2007), a set of nine generic principles, including 'develop global career competencies and awareness in graduates'.

The same tendencies were evidenced in the U.S. The fast expansion of the number of PhD students and graduates, with many being unable to obtain a position as professors in higher education, led Maresi Nerad (1967) to state that in the U.S. 'Congress and professional associations today are calling for a reduction in PhD production, claiming that American universities unnecessarily overproduce doctorates' and that industry leaders complained that PhD holders were not well prepared for the world outside academia.

In the UK, the 2002 report by Sir Gareth Roberts on *The supply of people with science, technology, engineering and mathematics skills* recognises there are 'mismatches between the skills of graduates and postgraduates and the skills required by employers [e.g., transferable skills]' (2002, p. 2) and that 'institutions are not adapting quickly enough to the needs of industry or the expectations of potential students' (2002, p. 11) and recommends that 'the training elements of a PhD, particularly training in transferable skills' should be considerably improved (2002, p. 11) (see Horta, this book).

The progressive role of quality assurance in higher education has also drawn the attention of universities to the need for complying with externally imposed quality standards. In the UK (Metcalfe, Thompson, & Green, 2002), the HEFCE recognised that PhD graduates were not prepared for undergraduate teaching and had problems in the transition from academia (p. 16) and proposed standards on areas such as research training environment, supervision arrangements and examination. In 2009 the UK Council on Graduate Education (Clarke & Powell, 2009) recognised that there were weaknesses in supervision, selection of external examiners, completion rates and inadequate training of students in 'research techniques and quantitative methods' and referred to difficulties in monitoring and assessing generic skills. In the same line, there was a general concern with the high attrition rates across disciplines in doctoral programmes (Nettles & Millet, 2006) and the time-to-degree completion rates which increased in some disciplines, particularly in education (Wao & Onwuegbuzie, 2011).

The Bologna Process, the European Ministers and the Commission

In Europe, the implementation of the Bologna Process has played a significant role in shaping a more structured doctoral degree. The Ministers of Education in the Bergen communiqué (2005) considered that 'The core component of doctoral training is the advancement of knowledge through original research' and urged 'universities to ensure that their doctoral programmes promote interdisciplinary training and the development of transferable skills, thus meeting the needs of the wider employment market'. They invited the European University Association to prepare a report on the further development of the basic principles for doctoral programmes, to be presented to Ministers in 2007.

In the 2007 London Communiqué, the ministers recommended closer alignment of the EHEA with the European Research Area (ERA) as an important objective and recognised 'the value of developing and maintaining a wide variety of doctoral programmes linked to the overarching qualifications framework for the EHEA'. Ministers invited 'our HEIs to reinforce their efforts to embed doctoral programmes in institutional strategies and policies, and to develop appropriate career paths and opportunities for doctoral candidates and early stage researchers' and referred to other crucial issues which included 'the development of transferable skills and ways of enhancing employability' (London Communiqué 2007).

In the Leuven/Louvain-la-Neuve 2009 meeting, Ministers recommended that 'Doctoral programmes should provide high quality disciplinary research' and '… public authorities and institutions of higher education will make the career development of early stage researchers more attractive' (Leuven Communiqué 2009).

In the Bucharest 2012 meeting, Ministers proposed the following: 'taking into account the "Salzburg II recommendations" and the Principles for Innovative Doctoral Training, we will explore how to promote quality, transparency, employability and mobility in the third cycle, as the education and training of doctoral candidates has a particular role in bridging the EHEA and the European Research Area (ERA)' (Bucharest Communiqué, 2012).

In the more recent Paris 2018 meeting, Ministers agreed that qualifications that signify completion of *the third cycle* are awarded to students who:

- have demonstrated a systematic understanding of a field of study and mastery of the skills and methods of research associated with that field;
- have demonstrated the ability to conceive, design, implement and adapt a substantial process of research with scholarly integrity;

- have made a contribution through original research that extends the frontier of knowledge by developing a substantial body of work, some of which merits national or international refereed publication;
- are capable of critical analysis, evaluation and synthesis of new and complex ideas;
- can communicate with their peers, the larger scholarly community and with society in general about their areas of expertise;
- can be expected to be able to promote, within academic and professional contexts, technological, social or cultural advancement in a knowledge-based society (revised NQF framework, Appendix III, Paris Communiqué (2018)).

The European Commission has also been active in this area. The European Science and Research Commissioner, Janez Potočnik (European Commission, 2006), said that 'universities are power-houses of knowledge generation' and '… they will need to adapt to the demands of a global, knowledge-based economy, just as other sectors of society and economy have to adapt'. In other words, the Commission wants universities to adapt the outcomes of their programmes to the short-term needs of the economy and this includes doctoral training, as 'a primary progenitor of new knowledge, which is crucial to the development of a prosperous and developed society' (European Commission, 2011, p. 1). In the *Report of Mapping Exercise on Doctoral Training in Europe. Towards a Common Approach* (European Commission, 2011, p. 7), the Commission argues that 'The classical model of the master-apprentice relationship is gradually becoming less important and more and more universities are setting up doctoral schools that deliver structured programmes … [providing] coursework on disciplinary and transferable skills alongside their original research'. In that same report, the Commission considers the inclusion of training in transferable skills as one of the best practice principles for innovative doctoral training, arguing that 'It is essential to ensure that enough researchers have the skills demanded by the knowledge based economy. Examples include communication, teamwork, entrepreneurship, project management, IPR, ethics, standardisation, etc.' (European Commission, 2011, p. 6) and the Commission suggests involving the industry in curriculum development and doctoral training to ensure skills match the industry's needs.

The European University Association and the League of European Research Universities

The European University Association (EUA) in its 2013 report *Quality Assurance in Doctoral Education—results of the ARDE project* (EUA, 2013) mentions that as early as the 1990s some countries (Netherlands, Denmark, Germany) started to create more structured forms of delivering doctorates. However, it was with the inclusion in 2003 of the third cycle in the Bologna Process that structured programmes with some taught elements became increasingly popular, in some cases including elements of Bologna such as the ECTS. This more professionalised organisation of the doctorate usually had the form of a doctoral school and the *EUA Trends Reports* illustrate its very fast development. The EUA Trends surveys show that from 2007 to 2010 the percentage of respondents listing at least a doctoral school increased from 29% to 65%, and the 2013 ARDE report already registers 80%.

One of the reasons for the increasing interest in doctoral schools was the evidence collected from surveys of PhD students complaining of shortcomings in their supervision ranging from 15% to 25%. The Salzburg II Recommendations (EUA, 2010) 'underlined the institutional responsibility for supervision stating that "Supervision must be a collective effort with clearly defined and written responsibilities". This statement reflects the change from a private relationship to one where the university as an institution takes direct action' (EUA, 2013, p. 29).

Another reason reported by the EUA was the realisation than an increasing number of PhD degree holders would follow alternative careers to the academic one. This led to the implementation of structured programmes with a career development component even if 'training through research seems to be an excellent preparation for a number of careers, and particularly for management positions' (EUA, 2013, p. 36). One of the recommendations of Salzburg II (EUA, 2010) was that the outcome of a PhD is now a 'doctorate holder with specific research and transferable skills and experiences, which can be used in a wide range of careers' (EUA, 2013, p. 36) and that 'transferable skills are an important component of career development' (EUA, 2013, p. 37).

In a similar way, the League of European Research Universities (LERU), in its 2010 report entitled *Doctoral degrees beyond 2010: Training talented researchers for society*, considered that doctoral programmes aim to train researchers to become 'creative, critical and autonomous intellectual risk takers in pushing the boundaries of frontier research' and individuals 'trained to have a unique set of high level skills' and considers doctoral graduates as having excellent training allowing them to go into roles 'where deep rigorous analysis is required' (LERU, 2010, p, 3). The acquisition of these skills requires that the modern doctorate should be the intersection of two complementary processes: professional research activity and personal development (LERU, 2010, p. 9).

Knowledge Economy and Changes in Academic Work

Clark Kerr (1982) listed about eighty-five institutions from the Western world already established in 1520 and which still exist today under recognisable form and performing similar functions without interruption: the Catholic Church, the Parliaments of the Isle of Man, Iceland and Great Britain, some Swiss cantons and about seventy universities. Why are universities so resilient? Burton Clark (1983) explained this resilience with the fact that universities dealt with knowledge. In universities knowledge is discovered, preserved, refined, passed on and applied, which conferred universities a number of important characteristics including professional autonomy (Mintzberg (1979) referred to universities as professional bureaucracies); the concentration of the locus of power in the lower levels of the organisation; and the great fragmentation of higher education institutions (Weick (1976) considered that Universities were 'loosely coupled' systems). These characteristics of higher education, put together, explain the great capacity of adaptation and survival of its institutions. Institutional fragmentation (Clark, 1983) and organisational diversity make it easy to suppress, aggregate, divide or add new units or new knowledge areas without unsettling the institution.

However, despite all that apparent stability, when one looks below the institutional surface it is found that many transformations have occurred, one of the reasons being the new role of knowledge in societies. Neave argued that these changes were the consequence of 'the rise to pre-eminence of Economics as the prime driving force in the higher education of non-totalitarian societies and very particularly those in Western Europe' (Neave, 2004, p. 131), while Mokyr considered that 'economic interests, no matter how remote, have become increasingly important in driving and directing the growth of useful knowledge in the past century and a half' (Mokyr, 2002, p. 10). This dominance of knowledge as an increasingly important production factor, relative to the traditional ones—land, labour and capital—will have an impact on universities.

In Europe, the Bologna Process has developed a utilitarian view of higher education as a key element in a strategy of matching the needs of economic growth and competitiveness (Sin & Neave, 2014). Higher education institutions are under permanent pressure to supply the labour market with graduates who have the skills necessary for the short-term needs of the economy. These skills change all the time and are evaluated as learning outcomes. However, 'this permanent demand to match skills requirements serves as a mechanism to limit the relative autonomy of the education system vis-à-vis capitalist production' (Streckeisen, 2009, p. 194).

Taking this particular context into account, the main intent in education at the third level in Europe is not only to increase the volume of PhD students but also to 'construct a very particular kind of doctoral graduate who is intended to be a carrier of commercial entrepreneurial values and practices, whose raison d'être is the generation of knowledge (which either is or can be) transformed into an explicit commodified form' (Loxley & Seery, 2012, p. 37). To a great extent, the institutionalised idea of doctoral education in the European political discourse is associated with economic instrumentalism. There is no doubt that the graduate/doctoral school and the structured doctorate correspond to a more managerialist view of the doctorate, including a component of customer satisfaction, be it the doctoral student or the future employer. There is a strong corporate approach to postgraduate education, which is ultimately aligned to national aims and objectives.

This discussion on changes in doctoral education is aligned with broader changes in academia. In the last three or four decades the intrusion of market values and mechanisms has been identified in almost all of Western Europe (Amaral, Magalhães, & Santiago, 2003; Paradeise, Reale, Bleiklie, & Ferlie, 2009). Although the reforms have varied among countries and institutions, there is a general tendency towards a decline in state financial support of higher education, putting the organisational emphasis on quality in the sense of efficiency and production, with funding mechanisms more centred on the number of graduates; splitting research and teaching funding; and supporting institutions' symbolic capital in their research productivity (measured by the number of patents or papers published in indexed international journals).

As a result, there are also relevant changes in the way knowledge is produced. Research used to be shaped by the 'classic' forms of science that Ziman (1994) called 'Academic Science' and Gibbons et al. (1994) defined as the traditional model of knowledge production. With the emergence of political and entrepreneurial pressures to induce ruptures in these 'traditional' modes of knowledge production, attempts were made to reverse priorities, with the economic and utilitarian dimensions becoming overvalued in research policies and less relevance being given to the social and cultural character of research (Amaral et al., 2003; Slaughter & Rhoades, 2004). Hence, different forms of science, other than basic or applied science, emerged in the higher education institutional field. They could be classified, following Ziman (1998, 2000), as 'post-academic/post-industrial science' or Mode 2 knowledge production, following Gibbons et al. (1994). These new forms of science made Ziman (1994, 2000) propose a new acronym—PLACE (Proprietary, Local, Authoritarian, Commissioned and Expert)—to define the social and institutional conditions under which science was now being produced.

The consequences of these changes for academics as a professional group and for academic work have been widely analysed (Barrier & Musselin, 2009; Carvalho, 2017; Enders & Musselin, 2008; Høstaker, 2006). The discussion has centred on: the extent to which academics' individual autonomy has been questioned (Altbach, 1980; Carvalho & Diogo, 2018; Henkel, 2005; Shattock, 2001); the potential deprofessionalisation of the academics' professional group, expressed in its declining status and in changes in professional identity. To more pessimistic views concerning the declining status (Halsey, 1992; Readings, 1996), other perspectives are evidenced, highlighting relevant differences based on age/generation (Santiago et al., 2015) or on the academics' position in the professional structure (Carvalho & Diogo, 2018; Musselin, 2011). However, although academics recognise the existence of tendencies to be more aligned with an entrepreneurial identity (Ylijoki & Ursin, 2013), the literature reveals that they tend to maintain the core of their professional values (Santiago & Carvalho, 2012).

In this discussion, less attention has been devoted to the changes in the academic division of work (see Nyhagen & Baschung, 2013). Nevertheless, the existent studies address the complexities of changes emerging from the differentiation of working conditions (Barrier & Musselin, 2009), with the increment of a 'reserved army' of academics with diverse precarious employment conditions (Cardoso et al., 2019; Carvalho & Diogo, 2018) and an increasing specialisation in teaching, research or administrative/management activities (Teichler, 2015).

In this context of complexities and intertwined dynamics, new organisational structures have been created at universities more on the basis of demands from society than on internal institutionalised norms relying on professional or disciplinary ethos (Nyhagen & Baschung, 2013).

The decrease in state research funding has forced institutions to find new funding sources, and the recurrent use of doctoral students and post-docs to develop exclusively teaching or research tasks which are aligned with the new modes of knowledge production, can also be identified as external pressures to impose a new archetype of doctoral education. These pressures often result in new organisational structures with an interdisciplinary and inter-institutional character that have broken with the traditional professional structure based on disciplines (Becher, 1989). Doctoral or graduate schools[1] represent a good example of this type of structures.

Doctoral/Graduate Schools in Europe

As a consequence of these pressures and political initiatives, the number of doctoral schools in Europe is fast increasing. The European Commission (2011) has collected a substantial amount of data on the development of doctoral schools and structured doctoral programmes. The analysis of these data demonstrates that the way European countries have been creating new organisational structures to address doctoral training is far from being convergent and homogeneous.

Some countries have set up doctoral schools while others have not. Nevertheless, there is a tendency in all European countries towards the emergence and establishment of structured doctoral programmes.

In Austria, a national structure emerged to fund the structured doctoral programmes (*Doktoratskollegs*): The Austrian Science Fund (FWF) (EC, 2011). In Belgium, all Flemish universities have set up doctoral schools according to the EUA principles. The Flemish government finances universities to create thematic and interdisciplinary doctoral schools. These schools offer training (including transferable skills) to doctoral candidates and link their doctoral programmes to labour market outcomes (EC, 2011). In Denmark, the University Act of 2007 requires the establishment of graduate schools to enhance quality of doctoral education based on interdisciplinary training and the development of skills transferable to the labour market (Crossouard et al., 2015). A good example of the way doctoral training began to be organised is Aarhus University where doctoral training is offered in four large PhD schools (EC, 2011). Since 2005, doctoral schools have been set up in all six public universities in Estonia (EC, 2011). The Academy of Finland has tried since the end of the nineties to create more structured forms of doctoral education (Finnish Ministry of Education, 1997). A national graduate school system is now in place. Most universities have a single graduate school model to support doctoral education, with doctoral students belonging to a doctoral school in their university and to one of the university's doctoral programmes (Crossouard et al., 2015). Although being one of the European countries with a strong tradition in doctoral education, France has also seen some changes in this field, particularly since the reforms of 2000. At that time, 124 higher education institutions offered doctoral degrees through 311 doctoral schools (Chambaz et al., 2007). German Universities have recently established Graduate Academies, or Research Schools, which encompass university-wide structures for training of doctoral candidates (sometimes including offers for MA-students and/or postdocs). Examples are the universities of Jena, Bremen, Bochum, Freiburg, Halle, Hannover, Heidelberg, München, Stuttgart and Rostock. These graduate schools are based on the principle of training outstanding early stage researchers within an excellent research environment (EC, 2011). In Hungary, doctoral studies were introduced in 1994, based on the 1993 Act (Pusztai & Szabó, 2008). Doctoral training is currently carried out at higher education institutions in 170 thematically organised 'doctoral schools' (EC, 2011).

The professional doctorate in education was introduced in the Republic of Ireland in 2004. The intention was to incentivise the development of generic and transferable skills, from induction to research through to career planning and commercialisation of research (EC, 2011; Loxley & Seery, 2012). There are no specific mentions of doctoral schools in this process. In a similar way, there are no national rules for the organisation of doctoral schools in Italy. However, some Italian universities set up schools to coordinate structured doctoral programmes following the Salzburg principles. These follow two models: thematic schools (mainly in big universities) and University doctoral schools (where programmes in different fields are coordinated by a single university structure). Examples of the second model are Camerino, Ferrara, Macerata, Molise, Piemonte Orientale, Roma II and Sienna (EC, 2011). In the Netherlands, PhD programmes are offered by research universities in Graduate Schools (associated with an individual university) or Research Schools (often formed by a consortium of institutions to pursue ongoing projects and areas of investigation). Norway has established a network of schools across disciplines to create a critical mass of students and teachers/supervisors on a specific research topic/area. Organised doctoral programmes were introduced in all fields in 1993. The White Paper on Research (2008–09) maintains that all doctoral education must be organised in doctoral programmes, which primarily consist of research activity conducted under academic supervision. In 2007, a pilot programme of national research schools was established and there are now six thematic research schools in this programme. However, HEIs have also taken the initiative to establish their own national networks. PhD education takes place within doctoral programmes. In addition, PhD students may be connected to thematically organised doctoral schools (EC, 2011).

The notion of doctoral school does not seem to be a very popular structure, or even an organisational unit, in Portugal. As of now, only eight universities have a doctoral school, the majority of them being new universities (Nova, Aveiro, Porto, Beira Interior, Évora, Madeira, UTAD and Catholic University). Although all these universities have signed a common agreement to constitute a network of doctoral schools in Portugal, the existence of a doctoral school with legal statutes seems to be effective only at the University of Aveiro and Nova de Lisboa. The University Nova has a well-established doctoral school since 2013. The school offers fifteen courses on transferable skills training. Nova's school aims to contribute to the excellence of its doctoral training; to provide cross-disciplinary and complementary training to PhD students and their supervisors; to promote interdisciplinarity and transdisciplinarity; to share best practices in doctoral programmes and promote cross-institutional cooperation, at both the national and international level; and to contribute to network creation and collaborations between students and professors at Nova. The University of Aveiro has also created a doctoral school with the mission of coordinating third-cycle activities while implementing specific measures to enhance the employability of doctoral degree holders based on training needs and market requirements.

In Spain some steps have been taken to establish doctoral schools in several Spanish universities, through the recently created Campuses of Excellence, most of which bring together several universities and specialise in a given scientific field, to facilitate and promote research (Castro, Guillén-Riquelme, Quevedo-Blasco, Bermúdez, & Buela-Casal, 2012; Jiménez-Ramírez, 2017).

In 2005, the *Conférence universitaire de Suisse occidentale* (CUSO) began to set up joint doctoral programmes in Switzerland (as supportive and complementary structures). For 2012–2016, the Rectors' Conference of the Swiss Universities (CRUS) launched, complementary to existing institutional doctoral schemes, a national programme aimed at offering young scientists inter-institutional programmes that enable research networking and better integration. ETH Zurich requires all doctoral students to take a certain amount of coursework ('doctoral studies'). The École Polytechnique Fédérale de Lausanne provides eighteen doctoral programmes. Each doctoral programme is responsible for recruiting students, organising their supervision, regular evaluation, and organising an offer of advanced level courses (EC, 2011). Finally, university-wide graduate schools for doctoral candidates of all disciplines are common in the UK. The graduate school is responsible for the overall provision of training and development, although this may be delivered centrally or locally within disciplines (EC, 2011).

Typologies of Doctoral/Graduate Schools

The information available for these countries reveals that the emergence of doctoral schools is, in most cases, developed at the institutional rather than the national level. This may be indicative of the high level of autonomy higher education institutions still have to define their own strategies and develop their own initiatives at the third level of education, but it is also possible to raise the hypothesis that higher education institutions are more aware and more keen to implement the political advice and initiatives of the European Commission, and even of the EUA, than their national governments. From the previous analysis, it is possible to identify different typologies of doctoral schools according to their organisational model:

(1) **Supra-institutional doctoral schools**—created at a national level, these doctoral schools bring together different higher education institutions in order to offer multi- and trans-disciplinary doctoral training in areas considered as strategic for the economic and social development of the country. The doctoral training offered to students is inter- and/or cross-institutional, and there is concern with the quality of the supervision. Currently there is also concern with capacity-building at the level of teaching staff. Although directly

dependent on the state, they have financial, administrative and scientific autonomy.

(2) **Institutional doctoral schools—**created at the level of the institution, these schools offer multidisciplinary doctoral programmes within the institution. They have an autonomous structure, with specific facilities and administrative staff, and they have a clear identity within the organisational structure. Institutional doctoral schools congregate the teaching programmes and develop efforts to create a community of doctoral students. They are responsible for the organisation of admissions, courses and seminars and they also assume the responsibility for quality assurance.

(3) **'Virtual' doctoral school—**some institutions have a doctoral school with no other objective than that of aggregating the administrative issues associated with doctoral education. They do not necessarily have specific infrastructures or administrative facilities. The programmes are organised and developed at the organisational unit level (as faculties or departments), most of the times on a disciplinary basis. Doctoral students, most of the time, do not even have knowledge about the existence of the graduate school.

(4) **Organisational unit doctoral schools—**in this case, a higher education institution such as a university can have several doctoral schools established at the organisational unit level, meaning at the faculty, school or departmental level. They use the infrastructure and administrative facilities of the faculty/department and mainly carry out the administrative work associated with the PhD programmes.

The four models can coexist within a country and when the graduate schools are created at the intermediate level, they can also coexist at the institutional level. The training programmes offered by these graduate schools necessarily include a great diversity. They include teaching programmes, research-only programmes and 'scientific' as well as professional programmes. Within these schools the programmes can also be financially supported by a diversity of sources, such as national support through state programmes for research and innovation; philanthropic institutions; private companies or for-profit institutions; European programmes such as ESF, Erasmus Mundus or European Research Council

(ERC), among others. The professional identity of students in these programmes may also differ, taking into account the national higher education cultural and normative contexts. While in some countries they are mainly considered as students (in quite a similar way to any other higher education level), in others they become members of research teams, considered as researchers, while in others they are considered as academic staff.

Taking the diversity of organisational structures in doctoral/graduate schools into consideration, it is not possible to talk about the existence of mimetic isomorphic phenomena. However, it is undeniable that in all European countries a new archetype of doctoral education has been emerging. The narratives on knowledge society/economy present in European political discourses have resulted in institutional or inter-institutional structures at the macro-, meso- and micro-levels (in the form of supra-institutional, institutional, virtual or organisational unit doctoral schools). What seems to be common to all these different structures is the need to design doctoral programmes and academic socialisation in a way that allows students and PhD holders to transform themselves into entrepreneurs with commoditised skills that have relevant value in the labour market. In this context, the European political discourse has had a practical implication in all European countries, with the creation of diverse doctoral/graduate schools, translating, in this way, the institutionalisation of new archetype of doctoral education in Europe, more aligned with market requirements and with the entrepreneurial ideal.

Conclusions

The historical route of doctoral education reveals that the social representations and the procedures to obtain the doctoral degree have not been immutable, but instead have changed under several influences. While in the Medieval University the procedures were the same for obtaining a master's or a doctoral degree, their main purpose being associated with teaching duties, with the emergence of the research university in the XIX century, the PhD was assumed as the research doctorate, with its main purpose being now associated with the production of new knowledge.

In the Middle Ages and early modern times, the doctoral degree was not related to research and was a certificate of erudition in a particular domain allowing someone to teach in a university. The Pope allowed the *studia generalia* to confer the *licentia ubique docendi*, meaning the qualification to teach in any university under the Pope's jurisdiction. The oral disputations were the main instruments to decide on the merit of the candidates. The major transformation of the doctorate came with the emergence of the research university in 1810 in Berlin. The Doctor of Philosophy was then established and the written thesis presenting original results of research became the standard. The general rule was that of a private relationship between a professor and a research student, and the main objective of the doctorate was to train new researchers who, in general, would be hired by universities. Gradually, the new social representations of PhD training and the new procedures started to be institutionalised all over Europe.

With the emergence of the new Millennium, several pressures influenced the de-institutionalisation of the previously dominant notions of doctoral training: the massification of the PhD and its professionalisation (and of careers), the development of quality assurance systems, the influence of supranational institutions like the European Commission or the European Universities Association (EUA), claiming the need for more market-oriented competencies to allow using PhD training as an instrument to promote social and economic development. In Europe, the Bologna Process had a determinant influence on the changes promoted at the level of PhD courses.

Most of all, recent changes in the training of graduates are associated with globalisation and the development of the knowledge society, which will require well-educated populations. This requirement promotes the emergence of mass higher education systems in countries with still low participation rates, and a movement towards universal higher education systems in countries with higher participation rates. The increase in the number of new PhDs is associated with the demands of the knowledge society and, as higher education institutions will no longer hire most graduates, it is necessary to endow them with skills appropriate to the needs of the knowledge-based economy. This has led to the emergence of doctoral (or graduate) schools. From the analysis of these new organisational structures created in European countries, four main ideal types can be identified: supra-institutional doctoral schools; institutional doctoral schools; virtual doctoral schools and organisational doctoral schools.

It is expected that these new doctoral schools have the capacity to create an entirely new social, cultural and organisational dynamic with routes both into the academic and business worlds.

The emergence of these organisational structures to accommodate 'third level' education demonstrates the attempt to maintain a relation with the previous levels, but exist as a separate institutional, as well as inter-institutional, domain. The expected effects of the creation of these new structures are aligned with the knowledge society-economy narratives. First, it is expected that the new organisational structures can incorporate both academic and entrepreneurial values, as well as *modus operandis*, framing a new social, organisational and institutional order. In this way, the boundaries between the knowledge produced inside and outside higher education institutions are expected to be broken, based on new partnerships between public and private, and for-profit and non-profit institutions that may arise to stimulate knowledge production and, especially, knowledge utility. Secondly, and in alignment with this, it is expected to promote a change in the doctoral students' and doctoral holders' identity. In creating a new cultural-cognitive framework for doctoral education, higher education institutions are also inducing a reconstruction of the students' and PhD holders' identity from 'purely academics' to 'entrepreneurs', meaning individuals capable of entering the commercial world and commoditising their skills and knowledge. Finally, these structures are also viewed as determinant to position higher education institutions in the highly competitive and lucrative institutional postgraduate arena, increasing their attractiveness for international students and staff. A new archetype of doctoral education is present in all European countries. However, the coexistence of distinct ideal-types of doctoral/graduate schools reveals the inexistence of mimetic isomorphic tendencies. Taking this into account, new research on the organisational dynamics underlying the creation of these schools is needed. It is relevant to know what the main influences are in their creation. Are there bottom-up and top-down processes? And who are the key actors in their creation, implementation and development? It is also relevant to analyse the consequences or effects of their implementation for students, academic staff and knowledge production and dissemination. To what extent have these organisational structures been able to impose a new research agenda and what are the results concerning the potential commodification of knowledge? Additionally, given its interweaving with academic life and different disciplinary domains, it would be interesting to analyse how academics respond to it. Do they resist, acquiesce or just simply ignore changes in the dominant cultural-cognitive framework of doctoral education?

Note

1. Graduate schools include different postgraduate levels such as masters and PhDs. Doctoral schools only include PhDs.

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How Effective Are Doctoral Schools? Organisational Characteristics and Related Objectives

Lukas Baschung

Introduction

Gumport (1993) explains the competitive force of top-tier American universities by their Graduate Schools, among other things, which strongly relate graduate education and research. Concretely, American doctoral students pass through coursework and examination within a department-based Graduate School and then do their doctoral research within the same department. When studying doctoral education in Germany, France and Britain and comparing it to American doctoral education, Clark noticed that European doctoral students become research students or 'junior academic staff cut free from organized instruction' (Clark, 1995, p. 157). Indeed, traditional European doctoral education was, and in some cases still is, based on the apprenticeship model

L. Baschung (✉)
Haute école de gestion Arc; HES-SO, University of Applied Sciences Western Switzerland, Neuchâtel, Switzerland
e-mail: lukas.baschung@he-arc.ch

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consisting of the transmission of knowledge, skills and behaviour through the supervisor. In other words, only one person was in charge of doctoral students, instead of an organisation like an academic department.

American Graduate Schools had already existed for more than a century (Clark, 1995) when European universities and (sometimes) ministries in charge of higher education started thinking about doctoral education's reorganisation. The latter especially means increasing doctoral education's degree of structure, often through the creation of 'doctoral schools' (see also Amaral and Carvalho in this book). Indeed, the word 'structure' has become popular in the context of the Declaration of Bologna, among others. Given the minimalist degree of organisation of the European apprenticeship model, a lot could be invented from scratch (Teichler, 2006). However, no unique model has been recommended by the Bologna movement, nor has one been implemented (for a typology of doctoral schools in Europe, see Amaral and Carvalho in this book). Although inspired by American Graduate Schools, a large variety of organisational forms have been invented and established. As evidenced by other chapters in this book, it is important to notice that one term covers different realities. For instance, the term 'doctoral School' does not yet mean only one organisational form. In reality, this term as well as others—for instance, 'Research School'—includes various organisational forms and activities. While certain doctoral schools remain within their disciplinary and institutional boundaries, others go beyond them. Thus, doctoral schools may be organised in a mono-institutional—that is, within one same higher education institution (HEI)—or an inter-institutional way—that is, in collaboration between several HEIs. Activities may cover for instance doctoral student recruitment, further education, supervision, scientific exchange, tracking and career, or only some of these (Baschung, 2016). It is important to note that, at least in the cases addressed in the present chapter, doctoral schools are organisational structures which have been *added* to the existing apprenticeship model. In other words, each doctoral student is still enrolled as such within his or her faculty—or according to the used terminology, department—and has a formal supervisor. In addition, he or she may also be part of a doctoral school. Thus, doctoral schools do *not* necessarily *replace* but complement the apprenticeship model.

The beginning of European doctoral education's reform varies according to the country and even the HEI. However, at least in some cases, experience with doctoral schools already lasts more than a decade. Hence, the question of doctoral schools' effectiveness may be asked. The present chapter examines this question, especially regarding the doctoral schools' organisational structure. Therefore, the identification of the reform's underlying objectives and their relationship with the organisational structure of doctoral schools are put in the centre of this analysis. The latter is carried out on the basis of public management literature and data dealing with Swiss higher education. Indeed, a study of Swiss doctoral schools showed that various organisational forms emerged. Some doctoral schools are organised within only one HEI, whereas others follow an inter-institutional logic. Collected data stems from the national level and four case studies, covering varying organisational forms and scientific disciplines.

Swiss higher education is mainly publicly funded. Therefore, it makes sense to borrow concepts of public management when discussing organisational forms and their effectiveness. On the basis of this discussion, which is carried out in the next section, several hypotheses are made regarding the effectiveness of doctoral schools. These hypotheses are then examined in the following parts dedicated to the objectives, activities and organisational structures of Swiss doctoral schools. Final results are summarised in the conclusion.

Organisational Forms and Their Effectiveness in the Public Sector and Higher Education

Effectiveness is a central element of the New Public Management (NPM) narrative. Explicit standards and measures of performance are defined, objectives are fixed and output is controlled (Hood, 1991). However, other concepts of public management, like Network Governance, emerged and put into question the effectiveness of NPM itself. It has been argued that collaborative organisational forms could be even more effective. Central elements of the Network Governance narrative consist of a greater range of interacting actors, lateral rather than vertical forms of management, shared coordinating power, self-organising and self-steering capacity as well as sharing of knowledge and 'best practices' within the network (Ferlie, Musselin, & Andresani, 2009). According to

Agranoff and McGuire (2001), knowledge development and learning occur best in networks. Since those two elements correspond exactly to the core mission of HEIs, it is not astonishing that the network governance narrative also had been detected in higher education (Deem, Hillyard, & Reed, 2007; Paradeise, Reale, Goastellec, & Bleiklie, 2009). Lang (2002) indeed indicates that HEIs may have good reasons to cooperate with other HEIs. He distinguishes four kinds of reasons: first, in order to do things that they would not be able to do individually because of lacking financial resources; second, in order to gain a competitive advantage in the educational market; third, in order to guarantee institutional survival; fourth, because of common history, culture, language and geography.

If these reasons seem to be rather rational (except perhaps the fourth one), the question of effectiveness has to be asked. Is cooperation within networks necessarily improving the implementation of (higher education) policies? A first answer, which is given by Lundin (2007) in the context of the Swedish active labour market policy, is: it depends on the public policy's degree of complexity. The more complex a public policy is, the more it is probable that inter-organisational cooperation has an added value. On the contrary, if the problem underlying the public policy is rather simple, its implementation remains rather unaffected by cooperation. However, it causes high coordination costs. Schalk, Torenvlied, and Allen (2009) furthermore demonstrated for Dutch colleges for the training of primary education teachers that being part of a network does not automatically have a positive impact on a HEI's performance. It is the quality ('embeddedness') of the network's internal and exchanged resources and relationships—that is, credible commitment and degree of trust—that makes a difference in performance.

Kenis and Provan (2009) explain that measuring performance or effectiveness of networks has to be done very carefully since what is understood by effectiveness necessarily has a normative component. Therefore, criteria for measurement have to be appropriate. In this context, they underline that 'The fact that a network scores low on a certain criterion may be related to the fact that that particular network, based on its structure, mission, and so on, cannot score highly on that criterion' (Kenis & Provan, 2009, p. 444). The appropriateness may vary according to several factors, including three exogenous factors: first, the form of the network, varying between a shared governance network, a network led by one member organisation and a network managed by an administrative organisation; second, the type of inception, that is, mandated or voluntary bottom-up networks; third, the developmental stage, distinguishing between newly emerging and more mature networks. Kenis and Provan (2009) estimate that voluntary bottom-up initiated and rather mature networks are considered as having more chances to be effective than mandated and recently created networks. Concerning the three organisational forms, the quoted authors evaluate them in terms of involvement of all network participants, flexibility, sustainability, legitimacy and efficiency rather than in terms of effectiveness. However, it seems plausible to us to consider that larger networks are more difficult to steer than smaller ones. As a consequence, we make the hypothesis that mono-institutional institutions and small networks *a priori* are more effective than large networks. In addition, since administrative organisations ought to support the network members by taking charge of part of the organisational work, we also make the hypothesis that networks managed by an administrative organisation are more effective than a shared governance network whose members coordinate their activities themselves. A network led by one member organisation may be effective, yet, not necessarily for all network members.

When coming back more specifically to effectiveness of HEIs, Cameron's study carried out in the 1970s (Cameron, 1978), which has been validated again by more recent studies (Ashraf & Abd Kadir, 2012; Kwan & Walker, 2003), identified three general types of criteria for organisational effectiveness: goal achievement, acquisition of resources in the environment and internal organisational processes. In addition, nine specific effectiveness dimensions for HEIs were identified, among which are four student-centred ones: educational satisfaction, academic development, career development and personal development of students;—plus: faculty and administrator employment satisfaction, professional development and quality of the faculty, system openness and community interaction, ability to acquire resources and organisational health. His study showed that no HEI operates effectively on all dimensions and that different profiles of effectiveness can be detected. However, once a profile of effectiveness is identified, a detailed analysis of effectiveness can be made (Cameron, 1978).

Based on the arguments mentioned in the present section, the following hypotheses are made concerning the effectiveness of doctoral schools:

- Hypothesis 1 (effectiveness-profile): Doctoral schools' activities and degree of cooperation are directly related to their objectives.
- Hypothesis 2 (organisational-effectiveness): Doctoral schools' form (mono-institutional organisation or different types of networks), type of inception and developmental stage have an impact on their effectiveness.
- Hypothesis 3 (effectiveness-profile): Doctoral schools are particularly effective regarding the objectives they have chosen.

Methodology and Data

Two parallel approaches are necessary in order to examine the effectiveness of Swiss doctoral schools and, more particularly, the mentioned hypotheses. On the one hand, the development of the Swiss landscape of doctoral schools has to be analysed as a whole. On the other hand, the question of effectiveness has also to be dealt with in a more detailed way on the basis of case studies.

The first approach is carried out on the basis of four elements: first, the elaboration of a database of Swiss doctoral schools through desktop research; second, interviews with key actors at the national and regional levels (Swiss National Science Foundation, Rectors' Conference of the Swiss Universities, University Conference of Western Switzerland). Both elements were realised during the years 2006 and 2007; third, document analysis in order to follow the evolution of the Swiss landscape of doctoral schools until 2018; fourth, analysis of relevant statistics provided by the Swiss Federal Statistical Office (Bundesamt für Statistik [BFS]).

Concerning the second approach, four case studies have been chosen in order to cover various organisational forms (one mono-institutional doctoral school, three inter-institutional network doctoral schools with different degrees of cooperation) and disciplinary fields. In accordance with

Becher and Trowler's (2001) typology of academic fields, each of the four case studies covers (mainly) one type of field: life sciences representing the hard-pure field, engineering sciences the hard-applied type, an interdisciplinary doctoral school in humanities the soft-pure type, and finance the soft-applied type. Two forms of data have been used: interviews and annual reports. The former were carried out during the years 2007 and 2008 with fifty-four actors from various HEI levels concerned with doctoral education, from doctoral students and supervisors, to doctoral school administrative and academic leaders, to vice-rectors. Annual reports allow for observing the doctoral schools' evolution between 2007 and 2017.

The Landscape of Swiss Doctoral Schools: Development, Objectives, Activities and Organisational Structure

The Swiss landscape of doctoral schools is definitely not the result of any centrally planned public policy. On the contrary, it is the result of many different initiatives taken by the federal government, the Swiss National Science Foundation (SNF) which is funded by the federal government, the Rectors' Conference of the Swiss Universities (CRUS) and—first and foremost—the universities and the academic professions themselves. This kind of situation is rather typical for Swiss higher education and can be explained by the federal and therefore strongly decentralised character of the Swiss state, the increased institutional autonomy of Swiss HEIs, and also the incremental emergence of the idea of doctoral schools.

In 1997, several reports (Lévy, Roux, & Gobet, 1997; Maurer & Zeltner, 1997) highlighted the insufficient supervision of doctoral students as well as their work overload due to important teaching duties. Among other things, these reports contained the recommendation to establish doctoral schools. Hence, the latter were seen as a mean to improve doctoral students' supervision. This issue was again raised in a report published in 2010, pointing to important differences in terms of supervision frequencies between doctoral students of 'hard sciences' and 'soft sciences', the latter clearly having fewer meetings with their supervisor than the former. This report also demonstrates a strong correlation between meeting frequency and student satisfaction (the more meetings, the higher the satisfaction) (Young, Curty, Hirt, & Wirth Bürgel, 2009).

The echo provoked by the 1997 report at the federal level was rather weak and consisted of the timely limited funding of eight individual doctoral schools, from 1998 on and in the framework of the politically oriented programme 'Switzerland: Towards the Future', launched by the SNF, and aimed at strengthening the social sciences. Furthermore, timely limited funding has been provided since the beginning of 2000 for the establishment of 'National Centres of Competence in Research (NCCR)', which were meant to establish a kind of doctoral school (without precise requirements). In 2006, an SNF programme called 'Pro∗Doc' specifically dedicated to the establishment of small doctoral schools began, first exclusively in the field of social sciences. In parallel and in the context of the Bologna reforms, CRUS put the reform of doctoral education on its agenda. Thanks to specific federal funding, CRUS had the ambition to create a complete offer of doctoral schools, covering all scientific fields, in order to give all doctoral students the opportunity to enter a doctoral school. However, this plan was abandoned and the obtained funding was added to the SNF Pro∗Doc programme. CRUS stated that this programme should increase the quality and attractiveness of the PhD (Baschung, 2013).

In 2011, Pro∗Doc was stopped and in 2013 CRUS developed its own, yet again federally funded, programme. This time, CRUS (which became the 'Chamber of Universities' of 'Swissuniversities', the Rectors' Conference of all Swiss HEIs) wanted to offer doctoral schools for as many doctoral students as possible. These doctoral schools had to be established as networks contributing to the scientific socialisation of doctoral students through different activities (community-building and courses). Formal requirements consisted of a minimum of twenty students coming from at least two HEIs, in order to assure critical mass (www.swissuniversities.ch; consulted in July 2018). The federal funding was always to be provided for a four-year period; therefore, a new solution had to be found for the 2017–2020 period. Indeed, another funding source was obtained and the related objectives were enlarged. In addition to the increase in the quality and attractiveness of the PhD, this programme was also meant to create good career conditions for doctoral students, to diversify the offerings according to the needs of the various scientific fields and to continue the development of the doctoral level. These last two points especially concern the collaboration with the rather young universities of applied sciences (UAS) and universities of teacher education (UTE), who currently do not have the right to award PhDs themselves. If Swissuniversities is hoping that the needs of UAS and UTE will justify another specific federal funding for the period 2021–2024, it clearly plans digressive funding for traditional university-based doctoral schools during the period 2017–2020, with the objective that traditional universities will continuously integrate the funding of the hitherto federally funded doctoral schools into the ordinary universities' budget (Conférence suisse des hautes écoles [CSHE], 2016).

As mentioned, HEIs and the academic profession did not rely on the implementation of these politically initiated doctoral schools. In parallel to the above-mentioned initiatives, several HEIs developed their own doctoral schools or assured the further existence of doctoral schools which were founded with timely limited federal funding; for instance, doctoral schools established within NCCRs.

The Swiss Federal Statistical Office's graduate survey offers the following snapshot regarding the number of doctoral students (among those who finished their PhD in 2014) who had the opportunity to pursue activities within a doctoral school, and those who used this opportunity (Table 1).

Thus, a small majority of doctoral students had the opportunity to enter a doctoral school, yet with important differences between the scientific fields. The variation of the fact whether doctoral students entered a doctoral

Table 1 Offer of doctoral schools and degree of use

	Offer of doctoral school		Doctoral school followed	
	%	+/–	%	+/–
Total	52.6	1.8	87.8	1.6
Human and social sciences	55.3	3.6	79.6	4.0
Economic sciences	68.0	6.9	86.3	6.2
Law	23.1	6.7	**	**
Exact and natural sciences	58.7	2.6	92.1	1.9
Technical sciences	40.4	3.8	92.8	3.4

Source: Swiss Federal Statistical Office; provided on demand
**Less than 25 cases

school may also depend on formal obligation. As a matter of fact, large differences are seen in the analysis of formal obligations (Baschung, 2008).

The same graduate survey also details what kind of activities take place within doctoral schools. Four kinds of activities have been identified: first, courses and seminars for doctoral students (in 84% of all doctoral schools); second, scientific writing, presentation and publication courses (62%); third, disciplinary (57.2%) and interdisciplinary (38.2%) research colloquia; fourth, research management (31.6%), media (24.6%) and other courses related to the profession and practice (29.1%). Interestingly, doctoral schools in human and social sciences suggest fewer courses and seminars for doctoral students than average (75.4%), but more disciplinary (68.3%) and interdisciplinary (31.6%) research colloquia. Thus, the need for scientific exchange seems to be stronger in human and social sciences than in other scientific fields.

Finally, no national data is available regarding the organisational structure of doctoral schools. However, given the formal requirement related to most of the politically initiated doctoral schools consisting of a network structure of at least two HEIs, many doctoral students may have attended a network doctoral school. In addition, the largest initiative of doctoral schools developed by universities themselves, that is, the today thirty-three *Conférence universitaire de Suisse occidentale* (CUSO)[1] doctoral schools, are all organised in an inter-institutional way.

Contextual Data at the National Level

Four main objectives have been mentioned in the national context with respect to doctoral schools, namely the increase of the PhD's attractiveness (1), the improvement of the supervision quality (2), the creation of good career perspectives (3) and the improvement of the PhD quality (4). However, since, on the one hand, no unique public policy has been developed at the national level, nor implemented on a systemic level and, on the other hand, created doctoral schools have different organisational forms and especially activities, it is difficult to examine on a national basis to what extent doctoral schools are effective regarding the mentioned objectives. Thus, case studies are needed to demonstrate the relation

Table 2 Number of doctoral students

Indicator/year	2000	2017
No. of doctoral students	13,494	25,209
Number and % of Swiss doctoral students	8440/62.5%	11,243/44.6%

Source: Swiss Federal Statistical Office; www.bfs.admin.ch

between doctoral schools' organisational form and activities on the one hand, and effectiveness on the other hand.

Nevertheless, available data at the national level is used in order to provide a general description of the case studies' context. First of all, regarding the PhD's attractiveness, it has to be noted that, as in many other countries, the number of doctoral students has sharply increased since about two decades (Table 2).

This increase is partly due to the HEIs' massification as a whole. Indeed, all Swiss HEIs have been growing in terms of number of students, staff and research funding during the last two decades. Total funding of traditional universities doubled from about 4 billion CHF in 2000 to over 8 billion CHF in 2017 (Staatssekretariat für Bildung und Forschung [SBF], 2005; www.bfs.admin.ch). In this context, it is important to note that most doctoral students of Swiss HEIs have paid positions at a traditional university, usually as teaching or research assistants (BFS, 2010). From this point of view, the increase in the number of doctoral students is not surprising. However, since the number of doctoral students has almost doubled, whereas the number of Bachelor and Master students, and the number of professors, has increased about by half during the same time period, one can suppose that the number of doctoral students' positions have deliberately received particular importance (Baschung, 2018). The second interesting observation concerns the number of foreign doctoral students. Today, they constitute the majority of the doctoral students, and the main reason for the increase of the total number of doctoral students. No fundamental policy change, like in the field of visa regulation, has happened since the beginning of the 2000s. The only noticeable change concerns the possibility for non-European graduates to stay six months after graduation in Switzerland in order to find a job. After this period, they generally have to depart. Before the introduction of this rule, they had to depart immediately after graduation.

Nonetheless, it is uncertain if this new rule fundamentally changed the attractiveness of the Swiss PhD. Thus, explanation for the increase of foreign doctoral students has to be found in the case studies.

Regarding the second identified objective, the improvement of the supervision quality, available data does not allow any monitoring since no inquiry about doctoral students' satisfaction regarding their supervision has been realised since the study of Young et al. (2009). Consequently, any systematic impact due to doctoral schools' activities cannot be demonstrated either.

Available data is more abundant regarding the creation of good career prospects for doctoral graduates. Generally, the picture seems to be quite positive, at least if one is looking at data stemming from the graduates' surveys, which are realised by the Swiss Federal Statistical Office. The percentage of unemployed doctoral graduates one year after graduation varies between 2.3% and 4.7% during the period 2002–2016.[2] Generally, this percentage is slightly lower than that of graduates at the master's and especially bachelor's level of traditional universities (universities of applied sciences and teacher education are not taken into account for this comparison). Five years after graduation, only 0.5% to 3.0% of doctoral graduates are unemployed, depending on the year. Again, doctoral graduates seem to be less concerned by unemployment than graduates at lower levels (Horta also notes in this book that one of the types of motivation for doing a PhD may be better employment prospects). In other words, it seems to be worth doing a PhD when it comes to job security. Income of doctoral graduates generally is also 15% to 21% higher than master's graduates' salary. This might be explained to some extent by the age difference at graduation. Still depending on the year, between 88.6% and 96.5% of doctoral graduates are in jobs that require a HEI diploma, which is systematically higher compared to graduates at the master's level. Finally, around a third of all doctoral graduates are already in a leading position one year after graduation, compared to 12.5% to 14% of master's graduates (Table 3).

In view of the sharp increase in the number of doctoral students, it is indeed remarkable that doctoral graduates still find positive conditions in the Swiss labour market. However, this might be relativised to the extent that a significant portion of graduates are foreigners and are profession-

Table 3 Objective 3—create good career perspectives

Indicator/year of graduation	2002	2004	2006	2008	2010	2012	2014	2016
% of graduates unemployment (1 year after graduation)	3.3%	3.1%	2.7%	3.3%	2.3%	4.2%	4.7%	4.6%
% of graduates unemployment (5 years after graduation)	1.9%	0.5%	1.3%	1.4%	3.0%	2.2%	–	–
% of adequacy between job and diploma (1 year after graduation)	96.5%	93.7%	88.6%	92.0%	89.7%	91.3%	89.9%	89.8%
Standardised median gross income in CHF of master vs. doctoral graduates	75/ 91 K	73.5/ 89.2 K	74.2/ 92.8 K	77.5/ 91.1 K	78.2/ 90.2 K	79.5/ 92.1 K	78.1/ 90.1 K	76/ 90 K
% of doctoral graduates in leading positions	–	–	36.9%	38.3%	30.1%	31.4%	33.1%	33.9%

Source: Swiss Federal Statistical Office; www.bfs.admin.ch

Note: Adequacy was measured on the basis of the question 'Did your job require a HEI diploma?'

ally more mobile than Swiss graduates (Baschung, 2018). Thus, their working conditions are not really known. Finally, case studies are again necessary to see whether and to what extent doctoral schools contribute to the graduates' career perspectives.

Regarding the fourth mentioned objective, it is difficult to measure the absolute quality of doctoral education or its academic outcome as such. However, it is possible to measure to what extent doctoral graduates consider themselves competent regarding different dimensions. Table 4 shows that only two types of skills seem to be slightly more strongly developed by doctoral graduates who attended a doctoral school in comparison to the ones who did not, namely social skills and planning and organisa-

Table 4 Objective 4—improve the quality of the PhD

Indicator	Doctoral school followed	No doctoral school followed
Specific skills	6.1	6.1
Social skills	4.1	3.8
Planning and organisational skills	5.3	5.1
Communication skills	5.2	5.1
Learning and problem-solving skills	6.0	6.0
Personal skills	5.6	5.5
Interdisciplinary skills	3.9	3.9

Source: Swiss Federal Statistical Office; www.bfs.admin.ch; provided on demand.
Note: The scale goes from 1 to 7

Table 5 Objective 4—improve the quality of the PhD

Indicator	Doctoral school followed	No doctoral school followed
PhD duration in years		
Human and social sciences	5.0[a]	5.6[a]
Economic sciences	4.5[a]	4.7[a]
Law	**	4.4[b]
Exact and natural sciences	4.5	4.4
Technical sciences	4.6	4.6
Total	4.6	4.8

Source: Swiss Federal Statistical Office; provided on demand
Note: a: variation coefficient >2.5% and <5%; b: variation coefficient > 5% and <7.5%
**Less than 25 cases

tional skills. Thus, the way out of isolation seems to have a positive impact. For instance, doctoral students' gatherings seem to allow for learning how to interact in academic (and maybe other types of) environments and foster exchange of good practices in terms of planning and organisation.

In the case of human and social sciences, skills improvement in terms of planning and organisation seems also to have an impact in terms of overall PhD duration, since doctoral graduates who attended a doctoral school needed five years to complete the doctoral degree, whereas their colleagues who did not needed more than half a year more (see Table 5). However, in absolute terms, the PhD duration is rather a criterion of efficiency than effectiveness or PhD quality.

Objectives, Activities and Organisational Structure of Four Case Studies

As mentioned in the methodological section, four case studies have been chosen in order to cover diversity in terms of organisational structure and academic disciplines. This breadth should allow a more concrete examination of the fixed hypotheses. The present section suggests a synthetic presentation and evaluation of the case studies in terms of objectives, activities, degree of cooperation, form, type of inception and developmental stage.

Objectives related to doctoral education's reform through the establishment of doctoral schools vary between different actors of HEIs, from doctoral students, supervisors, doctoral school administrative and academic leaders to vice-rectors. Table 6 summarises the different mentioned objectives as well as the doctoral schools' activities as detected in the different case studies.

A first type of activity concerns the doctoral students' *recruitment* process. Concretely, instead of announcing PhD positions individually, they are advertised collectively in the name of a doctoral school. A recruitment committee, composed of several professors, analyses the applications resulting from the two or three application deadlines. A second activity consists in the offering of *courses*. Such courses may be specifically related to a mono- or interdisciplinary scientific field, or may consist of transferable skills courses. Some doctoral schools also provide *multiple supervision* through a thesis committee, composed of several members. Doctoral students regularly meet such a committee and discuss the scientific problems they face. A fourth activity is represented by *enlarged scientific exchange* among doctoral students themselves. In contrast to informal exchange among doctoral students, such opportunities are deliberately organised by doctoral schools in the framework of seminars, conferences and retreats. Some doctoral schools also *track* doctoral students' progress in a more administrative way. They oblige all involved actors—that is, doctoral students and their supervisor(s)—to regularly—for instance, every six months—give an account of the advancement of the thesis project. In case of serious problems, thesis projects can be reoriented or abandoned.

Table 6 Objectives mentioned by interviewees and activities carried out by doctoral school

Doctoral school	Mentioned objectives	Recruitment	Curricular component	Multiple supervision	Scientific exchange	Tracking	Career
Life science Zurich graduate school (Uni Zurich and ETHZ)	Create the next generation of leaders in life sciences (academia and industry)	x					x
	Educate independent researchers						
	Rationalise the recruitment process	x					
	Develop discipline-specific competencies through courses		x				
	Foster social and scientific integration of doctoral students				x		
	Enlarge supervision			x			
	No related objective mentioned					x	
EPFL doctoral school	Uniform recruitment procedures as quality assurance measure	x					
	Attract the best doctoral students	x					
	Increase the number of doctoral students						
	Improve the course offer for doctoral students		x				
	Improve the integration of doctoral students				x		
	Develop professional networks for doctoral students				x		
	Prepare for the non–/academic labour market						
	No related objective mentioned					x	

Pro∗doc Aesthetics (Uni Basel and Berne)	Shorten doctoral education's duration				X	
	Structure doctoral education					
	Improve scientific exchange and supervision through networks			x		
	Foster interdisciplinary research		X			
	Improve the preparation of the next generation for the Swiss academic labour market		x			
Swiss finance institute PhD programme (Uni Geneva, Lausanne, Zurich, Lugano and EPFL)	Place the graduates in prestigious universities, thanks to the attraction of the best doctoral students and the provision of the best possible education	x	x	x		x
	Improve the reputation of the Swiss finance institute					x

Note: ETHZ: Eidgenössisch Technische Hochschule Zürich (Federal Institute of Technology Zurich); EPFL: Ecole polytechnique fédérale Lausanne (Federal Institute of Technology Lausanne)

Finally, some doctoral schools also developed activities to actively promote doctoral graduates' *career*. Activities range from providing information about the non-academic job market, transferable skills courses and sending students to important scientific conferences where they present their 'job market paper'.

With two exceptions, all activities can be related to a given objective. From this point of view, indicated activities are coherent with declared objectives. Thus, the first part of hypothesis 1 can be confirmed: doctoral schools' activities depend on their objectives.

Principally based on the exogenous factors of effectiveness developed by Kenis and Proven (2009) and own reflections developed in the theoretical chapter, the case studies' organisational characteristics first are described and second are evaluated regarding their predisposition for effectiveness. Each out of the four criteria is assessed and gets between 1 and 3 points.

Based on Table 7, the LSZGS and EPFL doctoral school seem to have the best predisposition to be effective. The conditions for the Swiss Finance Institute (SFI) Doctoral programme are still rather good, while the Pro∗Doc Aesthetics only gets half of the potential points.

Effectiveness of Doctoral Schools: Examining the Attainment of Specific Objectives

When evaluating the effectiveness of HEIs, Cameron (1978) concluded that HEIs have specific effectiveness profiles. Thus, they chose their organisation in order to favour effectiveness regarding certain criteria rather than others. The previous section presented the description of the case studies' effectiveness profiles (Table 6). In other words, we now should be able to examine to what extent the doctoral schools are effective with regard to their specific objectives. This is done on the basis of plausibility and available data.

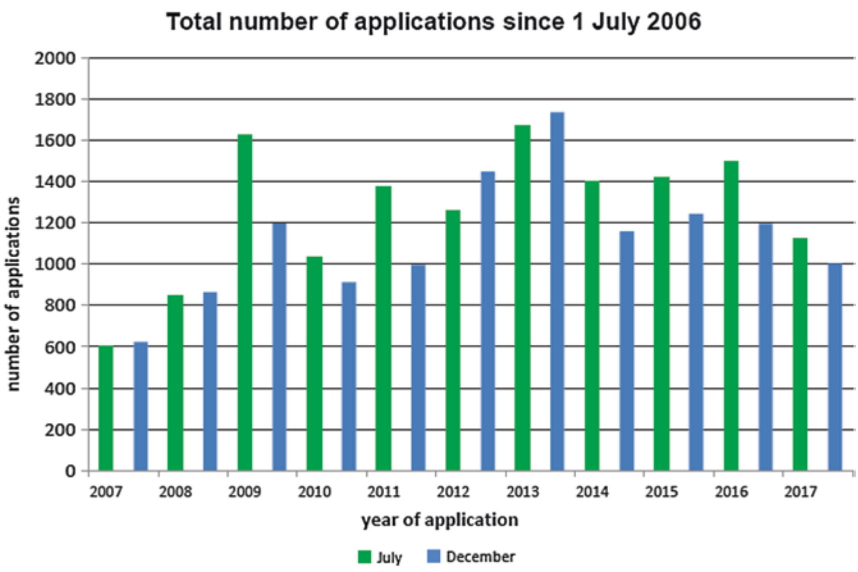
If some LSZGS objectives are rather vague (e.g., create the next generation of leaders in life sciences, educate independent researchers) and therefore difficult to evaluate, others are simpler to examine. For instance, the objective 'Rationalise the recruitment process' can be measured by

Table 7 Organisational characteristics and their evaluation regarding potential effectiveness by doctoral school

	LSZGS		EPFL DS		Pro∗Doc Aesthetics		SFI DS	
Degree of cooperation (number of involved HEI)	2 HEI	++	1 HEI	+++	2 HEI	++	5 HEI	+
Organisational form	Managed by admin. Units	++	Managed by 1 admin. Unit	+++	Shared governance network	+	Shared governance network	+
Type of inception	Bottom-up	+++	Top-down	+	Bottom-up (with constraints)	++	Bottom-up	+++
Developmental stage: First and last year of existence	2005–…	+++	2003–…	+++	2006–2009	+	(1997–…) 2006–…	+++
Total evaluation		10		10		6		8

the type of recruitment process which has been established, and its results. Since the creation of the LSZGS in 2005, doctoral students are officially recruited in the framework of two yearly application rounds (in July and December). Worldwide advertisement, for instance in the journal *Nature*, is done in the name of the doctoral school. Potential doctoral students apply for one of the currently seventeen PhD programmes housed by the LSZGS. The preselected candidates are then invited to a three-day recruitment process in Zurich, with all expenses covered by the doctoral school. Though this recruitment process attracts a varying number of candidates over the years and application rounds, there seems to be a certain effect, since the initial number of about 600 candidates per application round in 2007 increased to more than 1700 candidates in 2013 and has always been over 1000 candidates during the last six years. Applicants come from a hundred different countries (Graph 1).

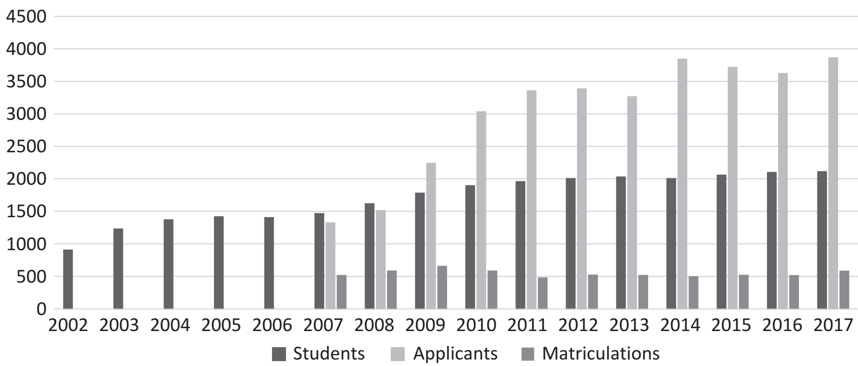
Thanks to the application to a PhD programme instead of only one PhD position and a recruitment process run by committees composed of several PhD supervisors instead of only one supervisor, potential



Graph 1 Number of applications to the LSZGS. (Source: Bachmann (2018))

matches between PhD positions and candidates are more probable and are also likely more adequate than with a traditional one-to-one recruitment procedure. Indeed, according to interviewed LSZGS actors, the three-day recruitment procedure allows matches which otherwise would not have happened. In addition, multiple applications to several supervisors from the same PhD programme can also be reduced. From this point of view, the objective of a more rationalised recruitment procedure certainly is achieved. However, the annual reports also indicate that by far not every doctoral student is recruited by the described procedure (called Track I). In 2017, 58% of all current doctoral students are still directly recruited by group leaders (called Track II). 'Because not all open positions can be filled during a given recruiting round and some outstanding applicants don't want to wait for 6 months, if they have just missed an application deadline, all programs also accept "track II" candidates' (Bachmann, 2018, p. 13).

The EPFL doctoral school has similar objectives as the LSZGS. Objectives like 'Uniform recruitment procedures as quality assurance measure', 'Attraction of the best doctoral students' and 'Increase the number of doctoral students' can be examined to a certain extent. This last objective has been clearly achieved since the number of doctoral students more than doubled since the creation of the EPFL doctoral school (Graph 2).

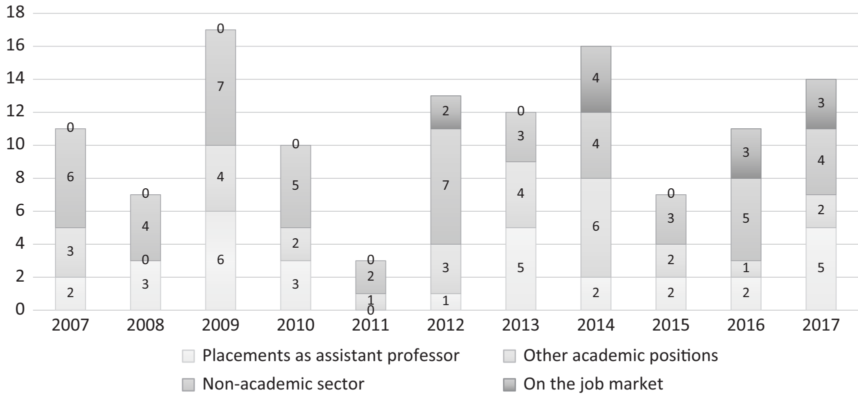


Graph 2 Evolution of the number of applicants, matriculations and students at PhD level at EPFL. (Sources: EPFL 2011–2018 (for applicants and matriculations); Swiss Federal Statistical Office; www.bfs.admin.ch (for students))

It is difficult to evaluate to what extent the EPFL doctoral school recruited 'the best students', however, the ratio between applicants and newly matriculated students shows that the choice of candidates strongly increased during the last ten years (ratio from 2.6 in 2007 to 6.6 in 2017). Finally, the recruitment procedure is uniform to the extent that every PhD applicant has to fill in an online application form, requiring letters of recommendation, among other things, and to choose one of the twenty PhD programmes. Each programme has its experts committee, which evaluates the applications, according to the programme, two to three times a year. In some cases, these application deadlines are followed by Skype interviews and/or hiring days. Baschung (2013) observed that HEIs with such recruitment practices indeed attract more foreign doctoral students than HEIs which recruit their doctoral students in a more traditional way. Thus, the increasing number of foreign doctoral students and the total number of doctoral students can be largely explained by such new recruitment practices.

It is difficult to examine to what extent the Pro∗Doc Aesthetics programme attained its objectives, since it only existed for four years (from 2006 to 2009). However, interviews with involved actors, carried out during the programme's existence, showed the ambiguity regarding the objectives 'shorten doctoral education's duration' and 'more structure'. If there was a consensus on the necessity to pursue these objectives, it has also been underlined that a too-high amount of training activities may be counterproductive and too much structure should not be introduced either, in order to avoid a strong 'school like' character (*Verschulung*). Scientific exchange and supervision in the framework of networks are evaluated positively. It seems to represent a real benefit, to the extent that it allows doctoral students to get out of isolation and to enlarge their horizons. Concerning the 'development of interdisciplinary research', both doctoral students and supervisors underline how difficult it is to go beyond traditional disciplinary boundaries.

Finally, the SFI PhD programme's main objectives are, first, to place the graduates in prestigious universities, thanks to the attraction of the best doctoral students and the provision of the best possible education and, second, to improve the reputation of the Swiss Finance Institute. This first part of the objectives is clearly oriented towards the final goal of



Graph 3 SFI doctoral graduates' placement on the labour market. (Sources: SFI (2008–2018))

placing graduates in prestigious universities. An analysis of the SFI annual reports between 2007 and 2017 allows tracking what kind of job the graduates have a few months after graduation (Graph 3).

Almost 50% of all 122 graduates quickly found a job in the academic job market, 25% even found a job as assistant professor. This is clearly above the Swiss average; 33% of Swiss doctoral graduates (28% in economics and law) found a job in academia one year after graduation (BFS, 2018). Among the forty-two HEIs where academic placements of SFI graduates took place, thirty-three HEIs figure in a specialised ranking in the field of finance, the Arizona State University ranking. The latter is based on the number of published articles in four academic journals, specialised in finance.[3] Within this ranking, twenty-one HEIs out of the forty-two are part of the top hundred HEIs and eleven HEIs are even in the top fifty. Thus, the objective of placements in prestigious HEIs has been attained to quite some extent.

The improvement of the SFI's academic reputation represents the second final objective. Reputation can be measured by academic rankings based, among other things, on reputation. Yet, when consulting different rankings like 'QS' or 'THE', finance is only suggested combined with accounting. In addition, SFI member universities only figure as individual institutional units and not in aggregated forms as the 'Swiss Finance Institute'. One exception with regard to these two issues is the ranking suggested by the Arizona State University. If one compares SFI's ranking between 2006/2007 (38th rank) and 2016/2017 (6th rank),[4] the improvement is considerable. This may contribute to SFI's reputation.

Rather than compare the absolute effectiveness between the four case studies, this section's goal was to examine hypotheses 2 and 3. Regarding hypothesis 2, the doctoral schools' form, type of inception and developmental stage seem to have an impact on their effectiveness. The tendencies in terms of potential effectiveness, calculated in Table 7, have been confirmed, though they have to be refined. Concerning the hypothesis 3, according to which doctoral schools are particularly effective regarding the objectives they have chosen, the partial results seem to confirm this hypothesis, although available data did not allow for systematic examining the attainment of all objectives.

Discussion: The Role of Organisational Structure Regarding Effectiveness

Regarding the first hypothesis—that is, doctoral schools' activities and degree of cooperation depend on their objectives—the four doctoral schools' activities are coherent regarding the identified objectives. Furthermore, cooperation takes place in order to achieve them. In the case of LSZGS, the PhD students' recruitment needed rationalisation and it made sense to do that on a scale with a critical mass, suggested by two neighbouring HEIs, active in the same academic field within the same city. EPFL's objectives were clearly centred on EPFL as an institution (increase the number of PhD students, uniform the recruitment procedure, recruit the best doctoral students) and, in addition, EPFL's geographical neighbours (Universities of Lausanne and Geneva) have quite a different academic profile (except common points in the field of life sciences). Last but not least, EPFL has itself a critical mass to organise one doctoral school. Thus, a collaboration was less 'natural' and not really necessary. The situation is different in the case of humanities and finance. The given academic (sub-)fields are so small in Swiss higher education that a cooperation is necessary in order to improve the doctoral students' scientific exchange (Pro∗Doc Aesthetics), for instance, or to improve the reputation (SFI).

However, what roles do the doctoral schools' organisational characteristics play regarding effectiveness? Kenis and Provan's (2009) exogenous factors indeed seem to have a certain impact on the doctoral schools' effectiveness. For instance, concerning the type of inception, completely bottom-up initiated networks seem to have quite a long lifespan. Consequently, their developmental stage becomes increasingly mature. Thus, there seems also to be some relation between those two factors. However, the factors evaluated in Table 7 are not completely predetermining either. All examined doctoral schools with demonstrated high effectiveness have a different organisational form, varying from management by one or several units, to shared governance. If the organisational form of management by one unit theoretically is the most effective, other forms also seem to work in certain conditions. In addition, the number of network members is not necessarily predetermining either. In other words, it seems possible to compensate exogenous factors, which *a priori* are not the best preconditions for effectiveness. Indeed, Agranoff and McGuire (2001) point to a number of factors, which favour successful network management. In contrast to Kenis and Provan's (2009) exogenous factors, they are rather endogenous factors like trust, mutual dependency, resource availability, catalytic actors, managerial ability and common purposes. These factors could not be investigated systematically in the present chapter. Yet, on the basis of the identified objectives, it is striking that the SFI's interviewed actors are the most unanimous regarding the objectives. Furthermore, in contrast to the Pro∗Doc Aesthetics whose funding stopped after four years, the three other doctoral schools have resources which allow their operation over a longer period of time.

Conclusion

How effective are doctoral schools? This question cannot be answered in a general way, not even for one single, yet federal, country like Switzerland. On the one hand, the related reform in the Swiss context is not (yet) systematic nor homogeneous in terms of activities and organisational characteristics. On the other hand, available data does not allow a general conclusion. HEIs or even single doctoral schools have their own objectives. Some of them place rational recruitment procedures on the top of their agenda, whereas others prioritise training and supervision activities and/or career development. The described case studies illustrate that doctoral schools may indeed make an important contribution to the achievement of effectiveness through particular measures.

What about the impact of the organisational aspects? On the basis of the case studies, it can be said that no organisational form is superior to another in absolute terms. Exogenous factors indeed have a certain impact on the doctoral schools' effectiveness. For instance, voluntary bottom-up initiated and rather mature networks definitely have better chances to be effective than network doctoral schools whose funding is finished after a four-year period. Mono-institutional doctoral schools' organisation is *a priori* less complex and more effective than inter-institutional networks. However, the case studies also showed that exogenous factors are not completely predetermining. Endogenous factors like the degree of convergence on objectives also play an important role. Thus, common objectives can even compensate weaknesses in terms of exogenous factors, like high coordination costs of large networks.

Hence, the organisational form and the type(s) of activities of doctoral schools should be and generally are chosen according to the objectives. Simply copying the American Graduate School or another model is not necessarily the right thing to do for every situation. On the contrary, it is worth spending some time thinking about the objective of a doctoral school within its disciplinary and institutional context and making sure this objective is shared by all involved actors. The organisational characteristics and activities can then be built around it, ideally without neglecting the remaining endogenous factors like trust and managerial ability.

Notes

1. CUSO includes all traditional universities of the French-speaking part of Switzerland.
2. (www.bfs.admin.ch).
3. *Journal of Finance, Journal of Financial Economics, Review of Financial Studies, Journal of Financial and Quantitative Analysis*.
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Leadership and Institutional Change in Doctoral Education in a Neoliberal Policy Context

Ruth Neumann

Introduction

This chapter examines the role and influence of leadership at the most senior university level in establishing institutional change at doctoral and research levels within a highly competitive, tightly funded and corporatised environment for higher education. This national context for an institutional leadership study has international relevance with managerialism in the international public university sector becoming increasingly pervasive. The competitive, corporatised Australian higher education environment arises from the implementation of New Public Management (NPM) policies in line with neoliberal influences. NPM supplants bureaucratic structures to encourage market-based institutions where the focus shifts from inputs and processes to outputs and performance deter-

R. Neumann (✉)
Macquarie Graduate School of Management, Macquarie University, Sydney, NSW, Australia
e-mail: ruth.neumann@mq.edu.au

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mined by quantifiable measures. Within a competitive external funding environment, university executives are expected to operate as company directors while the core business of the university—teaching and research—has long operated along collegial lines.

Set within this neoliberal policy context, this chapter discusses an empirical, ten-year case study covering 2001–2010. The case study examines the role and influence of leadership at the most senior university levels in establishing institutional change at doctoral and research levels in a well-established research university. It presents a unique opportunity to examine a university over time and in depth as it embarked on an important, even ambitious, change programme to move the university from an institutional lagger in the research student area to a national leader. It demonstrates the speed with which change can be successfully achieved and highlights the importance and value of leadership with a strategic vision which encompasses academic values and disciplinary cultures in an established research university.

The case study and its findings are discussed within the framework of organisational change, its management and the pivotal role played by academic leadership. It considers the drivers which successfully enabled change and moved the university from a lagger to a leader in innovation for doctoral study and research leadership at a national level. Most importantly this is about planned change by the most senior of university academics with responsibility for the research and research student portfolio of a major research university in Australia.

There are five sections. The first presents the literature on organisational change theories. These theories provide the framework for the case study and the interpretation of the research findings. The second discusses the broader (inter)national and institutional contexts in which the case study is situated. In the third section the case study is presented. The scope of the case study research is outlined. It then discusses why and how the change process was started and who was involved. It records key markers in the institutionalisation of change, the drivers and processes and documents the many achievements within the leadership vision. Fourth the chapter discusses whether the university had in fact really changed, and, if so, how this was achieved within the organisational change and leadership framework adopted. The chapter concludes with observations on the effective management of planned organisational change and the role of academic leadership within this process at a time when managerialism is becoming more prevalent in universities internationally.

Organisational Change, Change in Organisations and Leadership: Theoretical Framework

Conceptually the present chapter focuses on organisational change that is planned, initiated top-down and consequently of a transformative nature (Demers, 2007). Designed to be organisation-wide, it involves a deliberate move by an organisation in the underlying strategy from that used in the past. It is also about how to successfully bring about a change process and ensure for its continuing implementation, adaptation and management. As such it is about the leadership needed to achieve this outcome and the ability to navigate and utilise the multiple facets within complex organisations such as universities.

Organisation theory is used in this research to analyse and interpret the case study findings. Organisation theory, a large and diverse field, has a considerable literature spanning the theoretical and practitioner-based. No one theory is utilised, rather the cumulative evolution of theories on organisational change. Demers notes about organisational change theories that earlier theories are not replaced but incorporated and added on to 'with the new [theories] partly emerging from and coexisting with, the old [theories]. The older approaches don't disappear … different layers are added' (Demers, 2007, pp. 229–230).

The layered, multifaceted nature of organisations has been highlighted by the idea of frames or perspectives to provide multiple lenses which integrate the major conceptual aspects of organisational theories (Bolman & Deal, 2003). The structural frame emphasises the importance of formal roles and relationships, within a university particularly the institutional-faculty nexus and the faculty-departmental nexus. The human resources frame recognises that organisations are inhabited by people and are composed of groups of individuals with more or less compatible values and interests. The political frame views organisations as realms where power and influence underpin the competition of mostly scarce resources among individuals and groups such as between departments and faculties. The symbolic frame views organisations as held together by shared values and culture, often shaped over time, and in a university by the different disciplines or knowledge forms, rather than by goals and policies. These frames offer a plurality of view since they are not mutually exclusive.

The frames also highlight the skill needed in undertaking successful change processes, raising the question of leadership. A contested concept, leadership has been defined as human communication and social influence intended to change or enable actions and mindsets in the attainment of common goals (Bolden, Hawkins, Gosling, & Taylor, 2011; Johnson & Hackman, 2018). Within a university leadership must explicitly acknowledge the university and disciplinary contexts which outweigh any corporate culture (Trowler, 1998). Higher education researchers have highlighted the necessity for, and general neglect of, the symbolic or cultural frame (Bensimon, 1989a, b; Bolden, Gosling, O'Brien, Peters, & Haslam, 2012; Dill, 1982; Rhoads & Tierney, 1992; Trowler, 1998).

In terms of understanding and analysing change within universities, their structural organisation and nature are particularly pertinent. The organisational notion of loosely coupled systems (Weick, 1976) in which the various sections or groupings within the organisation are viewed as related to each other while simultaneously preserving their own identity and individuality has long been recognised as germane. It is organisation into specific structures that provides authority and legitimises the distribution of power. Specifically, the distinct components in considering universities are the institution itself, the basic unit in which individual academics reside, operating in both normative and operational modes (Becher & Kogan, 1992). While not necessarily neatly differentiated in practice, the normative and operational modes recognise that what people in organisations count as important and how they behave, may or may not be identical. Also relevant within the overall organisational framework is a central authority or national government making policy or funding arrangements that affect the internal organisational components of universities.

Among these distinct components, the institution and the internal knowledge structures, whether faculties, departments or disciplines, form the core organisational interaction. This master matrix of institution and disciplines provides the avenue of authority, work and belief (Clark, 1984). It is knowledge that is the business of the university and 'the concentration on knowledge is what academics have most in common. But what they have least in common is common knowledge, since the bundles they tend are specialised and separated one from another' (Clark, 1984, p. 107). The 'bundles of knowledge' or disciplines are recognised as having a powerful role with both epistemological and social aspects of academic work (Becher, 1989; Biglan, 1973a, b). Disciplines underpin the conduct of not only research but also teaching (Neumann, 2001, 2003b; Neumann, Parry, & Becher, 2002). The discipline is the heart of the PhD process, housing the doctoral research project, the home of the student-supervisor relationship and the central force in the acculturation of new researchers. Fundamental to any institutional change process for doctoral education is the understanding of, and ability to work with, the role and power of disciplines and disciplinary cultures together with overarching academic values and academic culture which serves to unify the institution.

Embarking on a transformational change process within a university must take account of the 'small worlds, different worlds' that make up university academic life (Clark 1987, 1989) and be inclusive of all levels: the institution, the faculty, the department/discipline level and that of the individual academic and doctoral student. The symbolic view of leadership within a university sees academic communities as distinctive cultures (Bensimon, 1989a, b; Rhoads & Tierney, 1992) with multiple discourses where the imposition of a dominant, corporate, discourse will fail (Trowler, 1998). Recent research specifically relates academic leadership to the construction, promotion and maintenance of academic values and identities (Bolden et al., 2012).

The case study presented in this chapter shows how the change process took account of all organisational levels but from the very beginning worked to 'bring on board' the heart of the university, the intersect of institution and discipline. The leadership challenge is to manage change that accommodates the collegial basis of universities while navigating the management demands of the external new public management environment which is philosophically at odds with traditional university premises. These external contexts are outlined in the following section.

(Inter)National and Institutional Contexts

Change occurs within a context. The continuing centrality of the student-supervisor relationship in doctoral education is not isolated or immune from the wider university or the even broader government policy environment within which it is ultimately nestled.

At the broadest, international-level neoliberal policies and NPM provide the policy context. A politico-economic theory, neoliberal higher education policies create new relationships between universities, the state and society with consequent implications for university management and leadership. Economic imperatives dominate and usurp political and social ones. For some decades, neoliberalism and NPM have been influencing the public policy agenda in many European- and English-speaking nations (Streckeisen, 2018). Australia was early off the mark with NPM with national higher education policies since the late 1980s changing the Australian higher education sector. The earliest examples were government research policy and institutional amalgamations to achieve scale and competitive advantage. However, doctoral education had remained relatively immune from such changes.

The beginning of the twenty-first century within Australia was one of momentous, if comparatively quiet, transformation of the management of doctoral education. Universities were differentially positioned to capitalise on the most fundamental federal government policy change for doctoral research and its funding since the 1950s (Neumann, 2002). A national study of the doctorate (see also Table 1) at this time of transition (Neumann, 2003a) demonstrated the importance of institutional and senior academic leadership to move from operating largely in what has been termed anecdotally as a 'cottage industry' to providing a more public, structured and managed research environment for doctoral study.

Table 1 Research overview

Year/s	Activity	Comment
1999	Federal Government White Paper	Released 24 December 1999, on research and research training
2001	Commence national study doctoral education	Multi university, doctoral education experience
2002	Complete national study	
2003	Commence institutional case study	Single university, had participated in national study, first focus groups
2004–2010	Institutional case study	

National Policy

Australian universities, with a few exceptions, are public, autonomous and established by Acts of State parliament but, since the mid-1970s, funded by the national government. This presents a set of idiosyncratic government and management relationships. Constitutional responsibility lies with the states but funding and, de facto, policy rests with the national government. As autonomous institutions, universities exercised overwhelmingly collegial forms of governance and 'management'. Since the late 1980s neoliberal public policy has been increasingly dominant in establishing neoliberalism in the form of New Public Management (NPM) within the public sector and gradually entrenching managerialism within public universities. The context has created apparently contradictory organisational principles—competition, external control and internal autonomy. Until 1999 national higher education policy has focussed almost exclusively on undergraduate education, postgraduate coursework and research policy. Research students and the PhD remained relatively untouched and arguably in management terms somewhat neglected but strongly still under collegial governance forms.

Since the formal commencement in 1957 of government PhD and scholarship funding (Murray Report, 1957) national government policy for research students has had as recurring themes: relevance of the doctorate; the quality of supervision; numbers of research student completions and time-to-completion; and, the most suitable method for the provision of government funding of staff and students. In 1999 the first major report with recommendations in relation to the PhD since the Murray Report of 1957 appeared. Entitled *Knowledge and Innovation: A Policy Statement on Research and Research Training* (Kemp, 1999), but commonly referred to as the 1999 White Paper, it represented a shift from funding doctoral enrolments to funding universities on numbers of annual doctoral completions. Known as the Research Training Scheme (RTS), it introduced a performance-based funding formula within a tight time-to-completion requirement of three years for receipt of government funding. Doctoral students taking more than three years would not be funded by government grants. This presented a significant departure to funding universities based on all enrolled doctoral students.

The White Paper statement positioned itself clearly within the rhetoric of the knowledge economy with government focus on the extent to which doctoral education effectively meets national needs and strengthens a nation's global competitiveness. The doctorate was the last bastion within the higher education domain to receive formal government focus, with more than a decade of university corporatisation under the influence of neoliberal higher education policies (Neumann, 2002; Neumann & Guthrie, 2002; Ryan, Guthrie, & Neumann, 2008). These NPM reforms have seen major transformation in the funding, organisation and work practices in universities (Jones, Guthrie, & Steane, 2001; Neumann & Guthrie, 2002). The corporatisation of research has government policy focus on objectives, outputs, outcomes and measurement indicators. A similar outcome was envisaged in the White Paper policy statement with recommendations that were instrumentalist and competitive in focus and intent. They triggered immediate attention and a university scramble for positioning within the national research funding pecking order. They further demanded institutional review of the management and organisation of doctoral study to ensure capability of competing for the changed funding pool, the tool used to leverage change.

The consequences of outcomes-based policy and funding changes introduced with the White Paper on research and research training (Kemp, 1999) have been studied nationally (see e.g. McWilliam, Singh, & Taylor, 2002; McWilliam et al., 2002; Neumann, 2003a, 2010a, 2010b). One national study of doctoral education and its diversity at this time of transition (Neumann, 2003a) highlighted the differential capacity for universities to cope with this fundamental change from upfront funding of enrolments to outcomes-based funding of completions if completions occurred within the new three-year government-mandated timeframe. The study was conducted 2001–2002 just prior to the commencement of the new funding policy and presented an ideal time to examine university doctoral management and practices, capturing the 'old' and how universities transitioned to the 'new' funding environment. In terms of management, the study found that universities with a proactive leadership approach were well placed to quickly adapt to a more publicly accountable and competitive environment. However, most universities in the study reflected reactive leadership and as such were poorly positioned to manage the changed funding circumstances.

The Institutional Context

The national study of doctoral education (Neumann, 2003a) provided an insight into university management at the institutional level at a time of transition into a neoliberal policy environment for doctoral education. It showed that overall the management and administration of doctoral students within universities at the start of the new millennium followed either a centralised or a decentralised model of administrative organisation. By this stage in nearly all universities policy responsibility for doctoral students had transferred to the deputy vice-chancellor-research (DVCR) portfolio in recognition of their central role in the university's research productivity (DEST, 2003; Powles, 1984). At an institutional level the administration of doctoral students was mostly still managed together with all undergraduate and coursework students. The management of doctoral study at the time of the release of the White Paper policy statement has been described as 'ad hoc', a 'cottage industry', 'pre-industrial' (Bradley, 2000; Chubb, 2000). However, there was evidence of experimentation with different structures over the decade of the 1990s, including with graduate schools and there was growing institutional awareness that the needs and requirements of research doctoral students were not being met if administered together with undergraduate coursework students. The release and imminent implementation of the White Paper recommendations brought a recognition that universities needed to move 'from a recruitment model for higher education research students, to a selectivity and concentration model' (Senior Manager 109, in Neumann, 2003a, p. 12.) and to 'professionalise' the institutional management of the doctorate (Neumann, 2010a, 2010b, 2013).

The national study highlighted that there were several important features the well-positioned universities had that were either lacking or very poorly developed in the remaining universities in the study (Neumann, 2003a). The key features, though not all present in any one university, were:

1. Institutional policy responsibility should reside with the deputy vice-chancellor-research rather than in an undergraduate student portfolio. Ideally this would incorporate doctoral students in the overall university research planning.
2. At the most senior university level there should be a separation of the policy and pastoral roles for doctoral students with the deputy vice-chancellor-research holding overall policy responsibility but a separate university dean holding responsibility for the important pastoral and ombudsman roles needed for effective institutional-level oversight.
3. There should be a more centralised administrative structure specialising in the administrative needs of doctoral students from recruitment to graduation.
4. A clearly articulated and transparent policy in the funding at institutional and faculty levels of the costs of doctoral research was required to adequately support the costs of doctoral research.
5. The incorporation of a formal research, monitoring and quality assurance component was helpful to inform ongoing institutional policy and practice.

A key theme emerging from the study was the role and ability of the individual, at institutional and faculty levels, to effect change. Senior university managers perceived themselves to have different levels of power vested in their role (Neumann, 2003a). Within universities this is a central issue. Universities essentially represent a flat organisational structure where power is diffused and change is more readily achieved through discussion and persuasion rather than any top-down power vested within the role. Thus, the ability to effectively alter internal structures and systems to capitalise on significant funding change from the external environment is imperative, as is the ability to effect change in a flat organisational structure.

The timing of the national study, at the cusp of the first significant government funding change for doctoral education in four decades, provided 'a baseline for later follow up studies to examine trends and change in the doctoral education experience' (Neumann, 2003a, p. 2). An opportunity in the form of a single institutional case study of one of the participating universities presented itself on completion of the national study.

The Case Study

The Case Study Research

The case study university, a medium-sized, well-established research university with an international research profile, was one of the universities that participated in the national doctoral education study of 2001–2002 (see Table 1). Compared with other universities in the study, the national snapshot showed the case study university to be an institutional lagger in terms of the organisation, administration and internal policy strategy for doctoral students.

The research was initiated in 2003 by the deputy vice-chancellor-research (DVCR) and formed a key component in monitoring and informing the change process discussed in the sections that follow. As such it had many elements of action research. It was funded through a university special grant, was approved through the normal university ethics committee process with informed consent provided by all participants.

It was envisaged and progressed as a multiyear institutional case study. The qualitative components undertook focus group and individual interviews with around 100 commencing doctoral students annually, thus a total of around 500 commencing doctoral students for the case study. As a comprehensive university the full range of science, humanities and professional (excepting medicine) disciplines was represented. Annual participation ranged 46–64%. The student focus groups were complemented with a small number of annual interviews with academic and administrative middle managers within the faculties and departments. Further, annual interviews and structured surveys were undertaken with withdrawing students, participants of the commencement programme (see below) and international students. From 2006 annual research student satisfaction surveys of all enrolled doctoral students were conducted and aggregate data analysed in order to monitor the ongoing success of institutional changes in relation to the management of doctoral education and supervision quality. The annual research was further contextualised with national doctoral graduate data including the national postgraduate research experience questionnaire (PREQ) data and reports to ensure further tracking of institutional performance with national outcomes.

Confidentiality was assured to all participants through the university research ethics process. Only aggregated data was reported ensuring no identifying individual information in any reporting. All reports, recommendations and university, faculty and departmental action on the annual recommendations were publicly available on the university website in addition to the normal university reporting mechanisms.

Within the duration of the case study papers were presented and published in national fora, with a number of academic papers cited in this chapter. Further the DVCR and university dean (UD) reported on institutional developments in their respective peer arenas including the meetings of deputy vice-chancellors research and the regular Deans and Directors of Graduate Studies (DDOGS) meetings and discussions. The emphasis of both the case study findings internally and in the external contexts was on openness and learning from the research.

The role of the researcher and author was at all times independent but within the parameters of action research. The role was to undertake the research with stakeholder involvement in (re)defining the objectives and research questions and finding and testing solutions to bring about change within context. Multiple data sources and open scrutiny of the research by multiple stakeholders were important means to counteract potential bias. The researcher had active roles in all aspects of the case study: its conduct, reporting and monitoring the implementation of the annual case study recommendations. This brings a particular strength through first-hand experience and insight into the changing institutional research culture. Established and appropriate research techniques were adopted to bring about informed change involving data-driven reflective processes to achieve transformative practices. There was no interference in the conduct of the research at any time by the DVCR, the UD or members of the Doctoral Committee (DC). They were however key players/actors and stakeholders in the processes as will be seen in the sections that follow.

The Change Process: Why, How and Key Players

The appointment of an innovative executive leader as deputy vice-chancellor in the research portfolio marked the beginning of a significant institutional change programme. As noted above the university was identified as an institutional lagger in terms of management and strategy in the national study. With doctoral students representing around 5% of the total student enrolment, in line with the national profile, the university had been becoming less competitive in terms of attracting those students. In the new competitive outcomes-based funding environment this signalled a declining share in the national funding pool unless internal changes to address the changed external environment were undertaken.

Within the first months of commencing in the position, the DVCR introduced a number of significant structural changes. The first was to dissolve the committee for postgraduate studies which had been in existence, unchanged, for some decades. A new university academic committee was established with oversight for doctoral students ('the doctoral committee') which importantly included a policy, strategy and quality assurance focus. Its remit was to *strategically manage* doctoral student matters from pre-enrolment through to graduation. This was a significant change. The previous committee for postgraduate studies, although also a standing committee of the University's academic board, encompassed all postgraduate coursework and research students, where because of the sheer numbers of postgraduate coursework students, research matters relating to doctoral students could receive lesser attention. Its terms of reference were more restricted with only limited scope to effect real policy change; it also lacked the advantage of direct Executive involvement.

The new committee met monthly and operated to align doctoral research matters with the University's research strategic plan. It was also to develop the appropriate strategies and policies to allow the university to operate effectively in the new competitive national funding environment for doctoral study. Of major significance was that the doctoral committee (DC) was to be chaired by the DVCR and over the decade or so of this DVCR's incumbency it was rare for the DVCR to miss chairing a meeting of the doctoral committee. In line with the importance that the DVCR gave to the new doctoral committee, membership of the committee was inclusive. Faculty deans were invited to attend initial meetings of the committee together with their faculty representative for doctoral students. Faculties were strongly encouraged to have as their representative academics at professor or associate professor level. It was argued that given the importance of doctoral students to the University's research productivity, academics established and respected in their discipline and with a research and doctoral supervision track record should be on the DC. The DVCR argued the importance of the academic seniority of the faculty representatives on the DC making the case that it was senior, established and respected members of the discipline that carried academic authority to persuade academics in the discipline to make change to established practices. This proved germane for the fundamental funding and supervision changes to come. The DC also included two doctoral student representatives. The DVCR placed large importance on student representation and involvement and argued for the representatives to come from different faculties and supported and encouraged them to exercise their voice not only in the DC but within the faculty and department.

Finally, within the first three months of this new doctoral committee, the DVCR introduced and gained 'buy-in' from the DC and the faculties to undertake this case study. The case study began in 2003 (see Table 1) as a series of focus groups of doctoral students in the first 6–12 months of their doctorate. The study was one of several initiatives in quality improvement and more effective candidature management introduced by the DVCR. From the outset the study was seen as a form of action research (Greenwood & Levin, 2000, pp. 86, 85) to provide 'solutions to real-life, open-ended problems' and assist as 'a vehicle for changing some of the internal structures' and practices within the university and faculties deemed to be needed to compete in a corporatised, competitive national funding context.

The case study undertook annual studies (see section above) and the reports of the annual studies to the DC were seen by senior management as an invaluable performance monitoring tool and 'an integral part of the whole tracking of our performance' (DVCR, 2006) and have been previously reported (Neumann, 2006, 2010a, 2010b, 2013).

The scope of the focus groups and the areas to be examined with commencing students were determined in the DC with faculty deans and their academic representatives involved in defining the study objectives and constructing the questions to guide the research. Strong interest in, and support for, the study was expressed. It was to provide a benchmark for change over the coming years, with subsequent annual focus groups to explore the quality of the commencing research experience *and to gauge the effectiveness of key changes instituted* at both university and faculty levels in each previous year. The case study reported its findings annually to the DC and made recommendations with allocated action responsibility. The annual report was available to all participating students and placed on the University's website. From the second year of focus groups (2004) a feedback loop was introduced whereby faculties, the UD and the DVCR reported on their actions to the DC. The intent was to solve the real problems in change faced by the faculties and the university within context and in a participatory way. The emphasis was on open discussion among academic peers across the disciplines about achievements and obstacles to change implementation. It became a valuable vehicle to share good practice examples and provide peer support and encouragement across faculties, thereby strengthening the academic and research culture of the university.

There were two further significant structural changes initiated in the first year of the new DVCR. The first was the appointment of a University Dean (UD) for doctoral students. The UD, while in the DVCR portfolio, was a separate, independent unit and, in line with the best practice features highlighted by the national study (see earlier section), held responsibility for the pastoral and ombudsman role for all doctoral students as well as responsibility for supervision quality. This senior academic position formed an important link between the DVCR policy role and the faculties.

The final significant structural change was the creation of a centralised administrative unit responsible for all administrative aspects of the management of doctoral students' candidature. Residing within the DVCR portfolio the unit was tasked with administering and managing all aspects of candidature. The staffing complement within the unit was commensurate with the scale of the university's research activity. Any administrative policy changes in relation to candidature management arising from the DC were to be implemented and administered by this unit. The administrative head of the unit had a direct reporting line to the DVCR, not the UD.

Within the first 12 months of the new DVCR four of the five 'best practice' organisational structures identified in the national study (see section above *Institutional contexts*) had been put in place: institutional policy responsibility for doctoral students residing within the DVCR portfolio; a separate, independent UD with pastoral responsibility for doctoral students at institutional level; a centralised administrative structure specialising in doctoral student administration from pre-enrolment through to graduation; the incorporation of a formal research monitoring and quality assurance component in the form of this case study. Importantly deans and senior academic managers within the faculties were 'on-side', or at least engaged and involved in a change process. The DC was constituted and operated to encompass the various disciplinary practices and cultures—an aspect which was to continue to have central importance. Collectively these structural changes and the individual appointments to senior positions became the key drivers for change and change implementation. The fifth best practice structure identified in the national study, transparent funding mechanisms, was to become one of the initial major policy changes and is discussed in the next section.

Key Stages and Markers of Change

Given the scale and duration of the case study three stages can be identified (see Table 2). The structural changes (see the section above) achieved within the first year enabled a swift consolidation of Executive authority and leadership. The second stage, encompassing the following three years,

Table 2 Key stages and markers in the institutional change process

National study participation Doctoral education experience **2001–2002**	Institutional case study: Stage 1 Commencement of change process & consolidation of executive authority **2003**	Institutional case study: Stage 2 Major change process with 4 key change markers **2004–2007**	Institutional case study: Stage 3 Consolidation of changes and expansion into new areas **2008–2010**
Declining doctoral enrolments	Appointment of executive leader	Marker 1: Compulsory commencement programme	Ongoing fine-tuning as needed
Management stagnation	Establishment of new doctoral committee	Marker 2: Establishment of funding model for doctoral research and administration	Integration of monitoring and quality assurance
Outdated administrative structures	Involvement of senior academics in new committee	Marker 3: Development of new supervisory model	Move into newer, more progressive changes
Ad hoc processes, not necessarily doctoral specific	Commencement of case study to track effectiveness of changes	Marker 4: Managerial expansion through new middle management structures	
	Establishment of new doctoral administrative centre		
	New senior management appointment of University Dean		

saw the introduction of major changes. Open discussion grounded in language emphasising academic and research cultures formed an integral part of the process. Further the annual focus groups with commencing students were complemented with exit surveying of non-completing students, focus groups with the increasing enrolment of international students and student feedback on all major programmes introduced. The continual engagement with students, and through the DC, the faculties enabled ongoing adjustments and fine-tuning. The evolving narrative was consistently underpinned by the necessity for change to improve in-time doctoral completions but at the same time was deeply embedded in a strengthening of university and faculty research cultures. Increasing the University's share in government funding was crucial to the university's research capacity and performance and the need to re-gain lost ground in attracting high-calibre doctoral students.

Of the many changes during this second stage, four were important markers of change. These were (1) the introduction of compulsory orientation courses for commencing doctoral students; (2) the introduction of a transparent funding model for the costs of doctoral research; (3) the development of a supervisory model; and (4) the expansion of the managerial model by boosting middle management and thus the institutionalisation of the managerial perspective. Respectively these four changes addressed the accessibility of information, transparency in funding the costs of doctoral research, quality assurance in the supervision process, and, strengthened management accountability. They are discussed in more detail below.

First Marker: Compulsory Commencement Programme

The first change marker is the introduction of a compulsory biannual commencement programme for new doctoral students. Its purpose was to provide commencing students with an overview and introduction to research at the University and thus enable a smooth transition to doctoral research. It clarified roles, responsibilities and mutual expectations of the doctoral research process. It outlined physical and financial resources available to support doctoral research and how to ensure access to them. Importantly it introduced all the key people, starting with the DVCR, so that students could put a face to the position and the name. It was complemented by similar programmes within the faculties and departments to provide discipline-specific information and practices. This programme was immediately welcomed by students who universally commented on feeling more connected to the University with the bonus that it fostered a strengthening of both institutional and disciplinary research cultures. As argued for example by one student:

> I felt that the commencement programs made it very clear that we were part of the wider university research family, the DVCR made that very explicit, as did the University Dean, so I thought it was great. (P505)

Second Marker: Establishment of Funding Model

The second marker was the establishment of a funding model to provide a transparent and accountable method of supporting faculties and students for the costs of doctoral research. The financing of doctoral research within the university had long been obscure and contentious. The national study had shown that doctoral research within universities remained under-resourced. Transparency of funding had not been achieved in any of the universities and understanding doctoral research funding at institutional level remained elusive and opaque. A senior academic manager in the national study had summarised the problem as follows:

> I want to know where the money that's coming into the faculty for the support of the research training students is going. It's going to support first year teaching programs, is it? That's the area where I think a [senior manager] is going to have a real impact, is to trace that line through and say, 'well is the money that's being given to the faculties to support research and to develop research training being used for that purpose? [Senior academic manager 132] (Neumann, 2003, p. 96)

It is a strongly contested area within universities and their faculties and one that takes courage to tackle. As with the national study, the focus groups highlighted that financial support for doctoral research was variable and ambiguous. This was reinforced in academic discussions within the DC. Further the focus groups highlighted that the vast majority of commencing students had not considered the costing of their research or from where financial support would be drawn. The new funding model was to operate in addition to the University's well-established international conference fund and the provision of scholarships for full-time doctoral students. The model addressed the financial support needs for doctoral research in a consistent and visible manner through the funding of direct research costs and the recognition of costing supervisor time to ensure the provision of adequate supervision. The model allocated government funding for research students, together with a significant additional institutional financial component, across three disciplinary cost bands calculated on a weighted equivalent full-time student. The guidelines for annual faculty expenditure were that 25% needed to be spent on the direct support of doctoral student research project costs, no more that 50% was to be spent on the provision of supervision and the balance of 25% could be used by faculties for the support of relevant technical/administrative staff and other infrastructure. As an incentive to manage within-time completions a substantial lump sum was reserved as a reward payment to faculties for each on-time completion. Faculties managed the various funding components which had to include the establishment of individual student accounts. Faculty deans were required to report directly to the DVCR on the annual expenditure of these funds. The model is outlined at the orientation programme and the complementary faculty orientation is required to address how students can access funds in practice. Annual student feedback on doctoral research funding was received through the focus groups and later through the annual doctoral experience survey. Through reporting to the DC, there was very immediate feedback and indication of whether doctoral students had ease of access to funds.

Third Marker: Development of Supervisory Model

A modern, reliable supervision model including supervisor development and workloads was the third marker. It was driven by the University Dean and the DVCR's agenda of quality assurance to improve the University's performance in doctoral completions. Feedback from students consistently showed strong satisfaction with their principal supervisor with typical comments:

> [M]y relationship with my supervisor is the best thing. (N205)

> Well the best part has been my supervisor [who] is absolutely brilliant and very enthusiastic. … a no-nonsense person who has given thorough feedback … and is also very generous with his time. (H206)

There was nevertheless sufficient variability across the disciplines around a range of supervision aspects to warrant closer institutional attention to consistency in supervision quality and completion monitoring. The model developed progressively with several components. The first was the introduction of a supervisory panel comprising a main supervisor and at least one associate supervisor to be allocated and formally confirmed within the first six months of commencement. The intent was to ensure that a student could not unexpectedly be left without a supervisor as well as to cater for situations where a project benefits from a range of expertise. It also provided for the formal mentoring of less experienced supervisors by their more experienced colleagues. There were criteria, based on past supervision expertise and track record, on who could be a principal supervisor, leading to formal supervisor registration within the university. Guidelines were developed within the DC on the maximum number of full-time doctoral supervisions per supervisor at any one time. Academics with less doctoral supervision experience were required to be both mentored and to undertake a supervisor development programme. The funding model outlined above provided faculties with money to allocate towards supervisory time but also provided a means of transferring funds across faculties and departments to compensate for supervisor time contributed outside the faculty of doctoral enrolment. The intent was to ensure that supervisory time factors would not inhibit cross-disciplinary research. Finally faculties were required to establish mechanisms for annual doctoral progress monitoring and supervision satisfaction by both student and supervisor and to act quickly on identified areas of concern.

Fourth Marker: Managerial Expansion Through Middle Management

The fourth and final marker was managerial expansion through strategic middle management positions. Introduced after the other change markers, this was a direct response to ongoing student feedback which highlighted variability and inconsistency between the faculties in the doctoral research experience. With the institutional-level changes embedded and working successfully, the DVCR moved to reduce these faculty inconsistencies and thereby strengthen overall institutional quality assurance. A formal and expanded faculty middle management structure was introduced which mirrored key aspects of the institutional research management structure. The middle-level management positions created for all faculties were an associate dean research, an associate dean doctoral and a dedicated full-time senior faculty administrative position for doctoral matters from pre-enrolment to graduation. The latter liaised closely with the university doctoral administration unit and also formed a link with any departmental administrative positions. The associate deans doctoral were or became the faculty representatives on the DC and it was envisaged that there would be a close working relationship with the UD. The associate dean doctoral position held the expectation of 60% doctoral administration and management with the remaining time for research and supervision. The intention was to ensure sufficient time to carry out the expanded management and administrative requirements arising from the major changes instituted in the previous years. The duty statements for the academic and administrative positions were developed through the DVCR and UD and were competitively filled through internal advertisement. This middle management structure visibly strengthened the importance placed on doctoral students both within the university and the faculties. It further formalised and legitimised what had been operating in some faculties, especially science, for many years and provided consistency of management across the faculties. Communication channels between faculties and central university administration were intensified and consolidated. It was designed to strengthen quality assurance in the monitoring of doctoral student progress, faster action in cases of lack of supervision and increased pressure on departments and supervisors for more in-time completions. This faculty re-organisation achieved specialised, dedicated and funded doctoral support from commencement to completion.

Final Stage of the Change Process

The final stage (from 2008 to 2010) formed a period of consolidation and building on the successes and achievements (see Table 2). The annual focus group outcomes reflected the diversity of the doctoral education experience within the university but also highlighted practices that doctoral students valued highly and did not wish to lose. Among these were freedom and flexibility in research and the quality of the supervisory relationship. By the fifth year of the DVCR tenure the experience of undertaking a doctorate at the university had been transformed. Student feedback through the focus groups reflected this:

> I found that this university actually wanted to meet me. … That really impressed me because everybody else saw you as a number. (E105)

> I was impressed that the Uni wanted our feedback. I got the letter and then didn't respond and then I got the phone call. Wow! I was amazed. (J205)

There was a marked change in advancing a client service focus and attention to the administrative needs of doctoral students at all levels within the University. The annual focus groups of commencing doctoral students were central to identifying areas for change, monitoring the effectiveness of the new policies and practices. They provided a benchmark in gauging the effectiveness of organisational changes from the year prior by highlighting differences, strengths and weaknesses among and within faculties. As noted by the DVCR,

> you have to have all the things in the right place, your strategy has to be completely integrated and that is what this first year experience project is about. It is about understanding how that looks from a student point of view and how effective it is. (DVCR 2006)

From this third and final stage the mechanisms for student feedback moved from focus groups to more wide-ranging annual surveying of the doctoral experience. The integration of the student voice in monitoring the implementation of the policy process had become both well-established and a natural process. The case study turned to the development and introduction of in-candidature surveying and the formalisation and extension of a suite of surveys, with targeted interviewing in sensitive areas such as withdrawing and exiting students. Annual reports with action recommendations and the established faculty feedback loops remained. Open discussion within the DC continued and the institutional research climate and culture gained strength.

The most difficult issue to resolve remained the development of a supervision workload formula to ensure adequate time for both supervisor and doctoral student. This was a vexed matter for faculty deans because it went to the heart of managing scarce resources and remained an ongoing discussion and negotiation area for the DVCR. In this third stage, along-side the continual policy fine-tuning and vigilance in minimising weak links in performance, the DVCR policy strategy broadened to encompass still bolder and more innovative areas. These go beyond the scope of the case study, but the leadership vision brought an ever-closer connection between the university's research and doctoral student strategy by embracing research concentrations and internationalisation.

Was There Real Change and How Was This Achieved?

The appointment of an innovative executive leader as DVCR started a deliberate, considered and ambitious change programme in relation to doctoral education within a university which had been identified as an institutional lagger in a national snapshot of doctoral education at a time of transition. Operating in an extremely competitive higher education environment and with a new outcomes-driven government policy for the funding of doctoral students, reversing a declining doctoral enrolment base was imperative. The change programme operated swiftly, on many fronts and achieved tangible outcomes. In the period 2002–2008, there was a doubling of the actual number of doctoral students from 800 to 1600 and an increase in the proportion of international doctoral students from 19% to 35%. Importantly for gaining government funding, by 2008 completions had moved the university into the top-ten Australian universities for doctoral study compared with a low ranking base of below 20 in 2002. In terms of commencing students the university had also positioned itself within the top ten. These are noteworthy changes in performance.

Many new structures and processes assisted in the management of the doctoral process. The centralised administration unit ensured dedicated and specialised attention to all administrative matters from pre-enrolment to completion and recognised that doctoral students formed part of the university's research domain. The compulsory university and faculty orientation programmes covered student information needs and worked to ensure a smooth transition into doctoral research. The funding model provided clarity and transparency in supporting the costs of doctoral research with each student assured direct access to research funds. It recognised faculty costs for supervisor time and resources and financially rewarded on-time completions. The supervisor model ensured supervision provision, provided mentoring for new supervisors and assisted in the management of supervisor workloads. It also monitored doctoral progress and for students clarified roles and expectations. These structures together provided important quality assurance tracking mechanisms for the university and for faculties. They improved completion times and enhanced the doctoral environment.

Feedback mechanisms were embedded from the start of the DVCR incumbency. Designed to track policy performance, they pointed to necessary adjustments and fine-tuning. Annual focus group studies and surveys produced reports with allocated action recommendations and feedback loops that were presented, discussed and endorsed by the DC. These reports, combined with the funding and supervisor models, enabled faster institutional and faculty responses to areas of need and also allowed more targeted doctoral student support. They also provided transparency in decision making and practice. Annual focus group evidence showed that within a 3–5 year period the doctoral experience had fundamentally altered and that students perceived that their research environment had changed for the better.

The concrete developments outlined above help to form an assessment of 'success' in the repositioning of the university in its performance on a national level within the neoliberal environment of Australia's public universities and the corporatisation of doctoral education through changed government policy. With the appointment of the new DVCR the university turned around its declining share in doctoral student enrolments, improved its within-time completion rates and hence secured increased competitive doctoral funding from the government. Within the university there were structural changes, a new doctoral committee and management appointments to meet external quality assurance reporting. However, these external observable changes do not tell the full story, nor do they indicate whether performance changes are likely to be long-lived and whether there has been real change on the ground.

The performance improvement is directly attributable to the deliberate institutional strategy and successful change process. In keeping with the definition of transformational change, the organisational culture for research changed and strengthened as a direct result of the underlying strategy. The management of doctoral education changed from an ad hoc operation at the level of the individual research professor to a deliberate tactic in its institutional research strategy and with the eventual *institutionalisation of the managerial perspective* new modes of behaviour became the norm.

Senior Leadership and Its Role in Successful Institutional Change

These changes were quickly and seamlessly achieved. The process is instructive. Organisational theory principles help understand and interpret these change processes and events. Starting with a strategic leadership vision, the

DVCR navigated organisational complexities utilising the structural, human resource, political and symbolic lenses. Studies have shown that effective organisations and leaders use multiple lenses but that in practice the structural and human resource frames are used more frequently than the political and symbolic lenses (Bensimon, 1989b, 1990; Bolman & Deal, 2003). The case study highlights adept use of all four lenses.

The organisational master matrix of institution-discipline was placed at the centre of the change process thus explicitly *recognising and including the powerful role played by disciplines*. The discipline is the home of the doctoral research project where student-supervisor work is undertaken. The DVCR understood and respected this and worked with this throughout the change process. It is disciplinary values that feed into a shared set of academic values and culture. Bringing the disciplines on board ensures deeply embedded change within a university. The aim was to produce normative and not simply operational change (Becher & Kogan, 1992).

Entwined in the managerial narrative was the narrative of the overarching academic and research culture which encompassed the disciplines and acknowledged the important disciplinary variations which formed part of a common set of academic values. A highly successful scientist with a national and international research reputation, the DVCR was accepted and respected as a research leader and outstanding doctoral supervisor. This *credibility among peers was critical* when embarking on major change, especially change that touches the heart of academic matters such as supervision and digs deep into faculty finances as with the funding model. There was care in senior appointments, such as the UD, to ensure that any individual academic reputation was similarly unassailable. It was difficult for faculty deans to refute the DVCR argument about the level of academic seniority to represent the discipline on the DC and to work as catalysts for changed practice within. Without this the changes in the supervisory model and funding model could not have occurred so swiftly and successfully. Utilising the DVCR's academic authority and personal power of persuasion within the DC, among the faculty deans, and across other university committees, the change process involved an ongoing dialogue and discussion about the rationale, need and importance of change to improve the university's research performance and realise the DVCR strategic vision. The external policy narrative was translated into an institutional context and imperative and overlaid with the academic narrative. There were constant accommodations for specific disciplinary needs within the detail of the supervisor and funding models. The resulting models and mode of implementation were widely accepted but the detail of the model remained 'a work-in-progress'.

Important among the academic discussions was whether the DVCR was imposing a large science model of research and supervision on all parts of the university through the funding and supervision models. Early discussions of a supervisory panel centred on a perception of the imposition on humanities of an experimental sciences team supervision approach. Open and frank discussion canvassed supervision practices across the disciplines and how improvements for supervisors, doctoral students and the department could be achieved. Important institutional quality assurance matters were recognised, consensus reached and incorporated in the model. There were similar discussions about the costing of research in humanities fields. The DVCR argued that humanities research was not cost neutral and that focus group comments from humanities students highlighted the high research costs that students were bearing personally. This stimulated discussion within humanities departments on identifying actual research costs such as access to archival records which were then recognised as legitimate research costs to students which should be supported by the funding model. Discussions such as this, arising from the student focus groups and in the DC, continued within faculties and departments. Given the openness of all discussions this stimulated and improved research culture and climate across all areas of the university. The compulsory commencing student orientation programme reinforced the view that doctoral students were part of a broader university research culture.

The disciplinary, research and academic dialogue employed by the DVCR placed people at the centre of the process. This included doctoral students. They are co-researchers, co-publishers and integral to a research university. Language played a central role. There was a clear spectrum of researchers ranging from doctoral students as researchers-in-training to professors. In discussions and new policies there was a progressive move from the term 'doctoral student', to 'doctoral candidate' to 'early career researcher' (Neumann, 2009). The view of doctoral students as early career researchers grew in the orientation programmes, the supervisor model and other efforts to strengthen departmental research climate across the faculties. The UD stressed that it was important

> to ensure that research training is not seen as part of a set of student projects and goals but is seen as a core component of the research effort of the University with doctoral researchers as co-researchers contributing to the research outputs of the University through publication and co-publication and enabling a building to the strengths within the areas of strategic priority to the University. (UD, 2006)

Thus, doctoral students were not part of the university's student body, they were part of the university's research activity and required dedicated administrative and management structures to assist their needs.

Leadership Observations and Lessons

This chapter has examined the role of senior leadership in change in doctoral education. It is first and foremost a study of leadership at the organisational level and how to lead a change process within the modern university context. As such the case study transcends national borders with relevance for organisational change and higher education leadership studies internationally. Organisational theories within the management and higher education literature have provided the framework for the research.

The specific contexts for the study are also not unique. The government policy trends are widespread with many countries embracing neoliberal education policies (Streckeisen, 2018) and while there are always national variations the trend is international. Thus, the specific context for this empirical study is doctoral education at the time of the implementation of neoliberal government policies on the funding of doctoral students in Australia. The case study university had been identified within a national study as lagging other institutions in its competitiveness for attaining government funding for doctoral students.

The appointment of a new DVCR with a strategic research vision presented a unique opportunity to examine leadership 'in situ' and a decade of significant institutional change. The period represented continuity in research management at the senior executive level. The DVCR had a strong imperative to reverse the declining quality of doctoral education and make the university more nationally competitive for the government pool of funds. The case study showed how quickly and smoothly change can be effected, when processes are participatory and seek to engage and 'bring along' the academic community to achieve longer term, meaningful and academically appropriate changes. For this case study the Bold et al. (2011, p. 41) definition of leadership is apt: '[L]eadership is a process of social influence to guide, structure, and/or facilitate behaviours, activities, and/or relationships towards the achievement of shared aims.' A combination of top-down and bottom-up ensured inclusivity of multiple views and experiences. A proactive leadership approach, strong communication and consistent story were paramount. The DVCR narrative on the managerial necessity for change imposed by the changed external policy-funding context was constantly interwoven with the academic cultural narrative. In practical terms this story straddled the collegial and NPM contexts. The deliberate and ambitious change programme produced tangible results in doctoral education and the university quickly became a national leader.

The chapter further explored the leadership and management conditions necessary to so quickly move the university's performance in doctoral education from a cottage industry with ad hoc administrative processes to a smooth managerial machine. The process and its lessons have relevance beyond the immediate institution and country. Within the higher education organisational theory framework adopted, the research showed that in this case senior leadership encompassed the multifaceted and complex nature of universities. It showed that the management conditions in the change process at times created tensions and necessitated accommodations in negotiating academic norms, aspirations and values, especially in the sensitive supervision and faculty financing areas. The DVCR successfully translated the external doctoral funding policy with its managerial subtexts into an institutional context. Existing institutional structures were replaced, new policies introduced and administrative processes formalised. Consistency of practice was strengthened with a managerial overlay. Importantly, the DVCR intertwined the managerial narrative with the narrative of shared academic and research values which enabled the embedding of new structures and policies while simultaneously bolstering the institutional and faculty research climate, especially in the non-experimental science disciplines. Yet the student-supervisor relationship*, the heart of the doctoral* *process, remained unchanged*. It was the management of the doctoral process that changed, from an ad hoc operation at the level of the individual research professor to a deliberate tactic in its institutional research strategy. *Nevertheless the private realm of doctoral supervision was made somewhat more public and open to scrutiny* (Neumann, 2009, 2010a, 2010b, 2013). With the eventual institutionalisation of the managerial perspective, the original mission faded and new modes of behaviour became the norm.

The study is pertinent at a time when market and management objectives challenge the power of the individual academic while strengthening accountability within the managerial higher education environment. The findings provide insights into university leadership, institutional doctoral education policies and national education and investment practices at a time when managerialism in the international public university sector is becoming increasingly pervasive.

That the case study would be a 'success story' or potential 'model' of good management and leadership practice was not a given from the outset—nor did it set out as such. On reflection though, it seems likely that only a confident leader, academic and researcher would set out to study and research, over such an extended time, the significant change that they were planning and to use the findings to inform the ongoing process. As such the case study could be seen as a model of a change process and leadership within universities, particularly during the era of NPM with its multiple, competing, and often contradictory, relationships.

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Part III

The Micro Level: Career Expectations and Employability of Doctoral Candidates

Views on the Usefulness of the PhD Outside Academia: What Do We Know and Need to Know?

Lynn McAlpine

Background

PhD Trajectories: The Nature of the Problem

Governments have increasingly seen PhD graduates as a non-academic labour market resource to advance the knowledge economy and international competitiveness (Hancock, Hughes, & Walsh, 2015). This view privileges the sciences which can align themselves more easily than the social sciences and humanities with entrepreneurial perspectives (e.g., patents and start-up companies). Alongside this, universities have increasingly moved to a temporary employment model (Loveday, 2018)—which likely explains why only one quarter of German PhD holders are employed in academia (Heuritsch, Waaijer, & van der Weijden, 2016), or that 6.5% of current Italian post-docs will get academic posts (Galimberti, 2018).

L. McAlpine (✉)
University of Oxford, Oxford, UK
e-mail: lynn.mcalpine@ctl.ox.ac.uk; lynn.mcalpine@mcgill.ca

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Thus, while PhDs continue to rank higher education first as to career hopes (de Grande, de Boyser, Vandevelde, & van Rossem, 2014), the reality is that more than half of graduates work outside academia (Neumann & Tan, 2011)[1]. So understanding the nature and quality of such careers is a pressing issue. In this chapter, I synthesise what is known about (a) the influence of the PhD on post-PhD careers, (b) PhD graduates' perceptions of the value of their degrees and (c) non-academic employers' views as to PhD work preparedness. In doing this, I attend particularly to the complexity of researching any social issue: addressing the interaction between a range of structuring elements and the individual as agent. Despite these challenges, I argue for a more fine-grained systematic research agenda in this area, and conclude with recommendations for future research. But, first, some background.

My Experience

This chapter is embodied in my experiences as an older white female living and working for the most part in the global north. After completing a BA (during which I worked part-time), I began my formal career working in the public sector in Canada for twenty years. During that time I completed a Master's and then an Education Doctorate, largely part-time, before becoming a Canadian academic. Initially, my research focus was teaching development, but this shifted after about fifteen years. I was intrigued by conversations I had with PhD and Master's researchers in our research team and so began studying early career researcher experience. Shortly after this research began, I also became an academic in the UK and since then have had a foot on both continents. This expansion of geographical, political and cultural experiences offered an opportunity to research PhD and post-PhD experience in a number of European countries.

The work that has influenced my stance the most was a ten-year longitudinal qualitative study that followed forty-eight individuals during the PhD and into their careers (McAlpine & Amundsen, 2016). Initially, we drew on previous research to create a synthesis of factors influential in PhD experience (McAlpine & Norton, 2006). This 'nested contexts' perspective placed the PhD researcher in the centre of interacting concentric circles: departmental, institutional, societal-global to represent how department and university PhD policies and practices are situated within societal expectations and constraints as well as international competitiveness and mobility.

Nested contexts, which synthesised the literature, represented a structural perspective on doctoral experience. That is, it paid very little attention to individual variability in PhD experience, which contrasted with our longitudinal narrative research, which attended to individual variation in agency. Still, as we followed PhD graduates into their careers, nested contexts remained useful in understanding experience. We came to realise that truly understanding PhD career trajectories meant examining the interaction between economic, political, socio-cultural and historical structuring elements and the individual as agent (McAlpine & Amundsen, 2018). This chapter builds on this thinking and the work of others to create a future research agenda, by focusing on what we know and need to know about PhD careers outside the academy.

The Structural: What Do We Mean by the PhD Labour Market?

Terms used to distinguish the structural elements are often different and not always well defined. So, for the purposes of this chapter, I use these terms.

Nature of Employment

Regardless of sector, individuals can (a) work part-time through full-time, (b) be permanent or under a contract, (c) be self-employed or a salaried employee, (d) experience a good through poor match of work demands with their education and (e) engage in serial or concurrent job changes within and across sectors.

Labour Sectors Outside Academia: The Focus of This Chapter

The *private* sector includes enterprises generating income for owners and shareholders. These organisations can vary in mission (e.g., manufacturing, retail, agriculture, transportation, services, entertainment) and size—small (49 or less[2]; perhaps a consultancy, own business) through medium (50–249) to large (250 or more; sometimes multinationals)—with larger ones better able to invest in human capital and innovation. Further, the societal context, for instance, country regulation, shapes the parameters of any business and multinationals can pick and choose the regulatory environment that suits them best. The research on PhD careers in the non-academic arena is principally in this sector.

The *public* sector represents organisations principally funded through taxation with the services perceived as government responsibilities, for instance, education, healthcare, military, police and transportation. This sector operates at multiple levels from municipal to international. Finally, the *para-public* sector represents charities, foundations, advocacy groups and professional or trade organisations. These are often funded through donations or membership fees and offer activities and services focused on enhancing specific aspects of the public good.

Within the three sectors, I distinguish two distinct employment types/roles: *professionals*, who do not have responsibility for research; and *research professionals*, whose major responsibility is research. Both positions usually lead to permanence.

Academia

The academic sector is the most researched as regards PhD careers. Funding of academic institutions varies from public, to public/private to private. Purposes incorporate, to different degrees, education, training, accreditation and research. Four posts characterise this sector: *research-teaching* (leading to permanence), *research-only* (rarely leading to permanence) or *teaching-only* (can lead to permanence), as well as an emerging category, *academic professional* (research- and/or teaching-related responsibilities, often leading to permanence). The last two positions are the ones least researched, yet growing the most quickly (McAlpine & Amundsen, 2018)—therefore worthy of more research.

This sector has experienced a number of pervasive changes, for instance, increasing emphasis on research with instrumental and commercial value (Nerad & Trzyna, 2008). As regards the PhD specifically, there is greater pressure for timely completion and training related to what is called transversal or generic skills,[3] for example, communication, project management—with the intent to better prepare graduates for the external labour market. But, who is the PhD researcher today?

The Individual: Today's PhD Researchers with Varied Pasts and Purposes

Key terms here include individual variability in *agency (intention, motivation, resilience, affect)* and *personal life course (past-present-future)*, with *past and present work experience embedded in the rest of life*. Given the legislative and economic push for greater access as well as equality of opportunity, PhD researchers have become increasingly diverse (Pearson, Cumming, Evans, Macauley, & Ryland, 2011) as regards ethnicity, race, and age and previous work and life experience.[4]

Agency represents the extent to which individuals demonstrate effortful action to achieve their goals, for instance, efforts to publish during the PhD or not. Such variation has long-term effects. Further, reasons for doing the degree may vary: some start with a clear desire to return to their previous work; others embark with no clear sense of a future career, but rather a love of research; others begin given the lack of other options; and others from encouragement by a mentor and/or a scholarship. Such varied purposes also influence the career trajectory; for instance, high research motivation influences the preference for academic careers (Roach & Sauermann, 2010).

Further, investment in their degrees and ultimately their careers is strongly influenced by their broader personal lives and life experiences (McAlpine & Amundsen, 2016). Family played a frequent role in people's lives (also noted by Valcour & Tolbert, 2003), for instance, co-locating with a partner, caring for children and supporting elderly parents. Work-life balance was similarly a concern: managing personal non-work needs alongside work, for example, eating, sleeping and exercising (noted as well by O'Meara, Lounder, & Campbell, 2014). Financial duress from long-term insecurity required full-time or part-time work alongside the degree. Life goals, more powerful than work-related ones, also emerged, for instance, desire for children, prioritising children over work. Moreover, achieving well-being was important—avoiding or reducing stress, anxiety and burnout; chronic illness; and temporary emotional upsets, such as relationship break-up. Finally, personal values played a role in the extent to which an individual's values aligned with work. In sum, even in entering a PhD programme, a range of individual factors has already created immense diversity in individuals' investment in the degree and decisions as to post-PhD careers. Of course, all these factors continued to play a role post-PhD.

How Does Success in the PhD Influence Post-PhD Outcomes?

What do we know about PhD experience, both individual and structural, that contributes to prompt completion, well-being, overall satisfaction and ultimately distinct post-PhD career prospects? Below, I highlight the most salient points drawing from a systematised review (McAlpine, Castello, & Pyhältö, in press).[5]

Entering the PhD

Previous and present experiences influence how individuals choose a PhD programme, which has long-term impacts. For instance, institutional reputation impacts job attainment (Jackson & Michelson, 2015). Further, in applying for a programme, applicants may, if flexible as regards mobility, consider such factors as (a) type of university (rural/urban; research- or teaching-focused) and (b) type of programme (e.g., traditional or industry-university collaborations); the latter can increase the possibility of permanent private sector employment (Thune, 2009). Finally, career intentions can vary; for instance, of individuals starting engineering degrees, one-third were focused on academia, one-third on the private sector and one-third had no clear intention (Mangematin, 2000).

Once accepted, interaction occurs between anticipated expectations and actual experiences, with a match enhancing satisfaction and completion (Holbrook et al., 2014). Mode of study (full-time or part-time) also has an impact on persistence, with part-time status reducing persistence during transition, but increasing it afterwards (Ampaw & Jaeger, 2012). Still, Harman (2002) reported that part-time PhD researchers are less satisfied than full-time ones on issues such as access to workspace and equipment. Funding also has a positive influence on satisfaction (Harman, 2002), as it does on completion (Jackson & Michelson, 2015).

To make this interaction between the individual and PhD programmes more concrete, two cameos are woven into this account, drawing on McAlpine and Amundsen (2016). The cameos make concrete how individual elements ([a] agency, [b] personal life on work investment, [c] past experience on the present) interact with the structuring elements of the programme and institution, an interaction that ultimately influences career trajectories. As background, Mario and Serena began their degrees before the global economic crisis and finished them during it. They did their PhDs in the same social science department in a research university in a large city with a diverse labour market, including both international private and public sectors.[6] But as you will see, each had quite different experiences.

Mario, early thirties, had worked for many years in a large city in an NGO focused on human rights, work he deeply cared about, before deciding that he wanted to do a PhD. He wanted a change and thought the degree could help him.	Serena, mid-twenties, worked a number of years in a social care agency in a small regional city as she truly loved the work she was doing. She decided to do a Master's and then a PhD since she wanted more expertise.
Since he wanted to care for his elderly parents, Mario did not consider leaving the city where he lived. He focused more on gaining entry than matching the programme to his goals.	She applied to programmes across the country, accepting one that matched her goals though far away. Given a close-knit family, she hoped to return home once finished.
He applied for and got a scholarship so felt he could manage the degree without too much financial hardship.	Completing the Master's (where she met her partner), she was invited by her supervisor to continue to a PhD (with scholarship).
Entering the programme, Mario realised he had not grasped the expectations of the PhD, so he felt fragile and anxious at times.	Serena loved doing research, and was excited to do the PhD, following up on her Master's research.

Mario's and Serena's stories demonstrate how their previous experiences, present life circumstances as well as personal goals interact with the structuring elements within their programmes. While both have fellowships which should reduce financial stress, they differ in age and previous work experience—as well as the reason for doing the PhD. Moreover, Serena chose her Master's programme for its academic appropriateness (and moved with a life desire to return home); she also continued with her Master's supervisor for her PhD. In contrast, Mario chose his programme based on its location, and experienced anxiety related to a mismatch of his expectations with reality. These factors will cumulatively influence their engagement in the degree leading to increasingly distinct graduation profiles, yet studies of PhD graduates are often inattentive to these accumulating influences.

Doing the PhD

As before, I focus on factors related to prompt completion, well-being and overall satisfaction, in relation to both individual (the PhD researcher, supervisor and their relationship) and structuring (departmental and institutional practices) elements.

PhD researcher, supervisor and their relationship: Completion, well-being and satisfaction are correlated, in the first instance, to the extent to which individuals are goal-oriented and strategic, taking ownership of the degree (O'Meara et al., 2014). Examples of such agency include (a) involvement in supervisor selection (Ives & Rowley, 2005), (b) seeking information, setting goals, sustaining motivation, job searching (McAlpine & Amundsen, 2016) and (c) developing and using personal and academic networks (Ansmann et al., 2014). Personal values also play a role; for instance, the moral stance of STEM PhDs about the 'knowledge economy' influences their research and career motivations (Hancock et al., 2015). Further, PhD STEM researchers more interested in applied research and development (R&D) than in basic research tend to consider the non-academic sector attractive (Herrera & Nieto, 2016).

These individual factors interact with structural ones as completion, well-being and satisfaction are correlated with the supervisor: (a) having expertise in the area of research (Donald, Saroyan, & Denison, 1995), (b) being available (Heath, 2002), (c) sharing responsibility with another supervisor (Pearson, 1996), (d) meeting frequently with the PhD researcher (Heath, 2002), (e) having a good working relationship with clear expectations (Woolhouse, 2002) and (f) focusing on completion (Main, 2014). How did these factors influence Mario's and Serena's experiences?

Mario had not chosen his supervisor. While she was helpful, he felt 'fragile' getting feedback. When he had troubles with the defence of his proposal, he felt she had not given the feedback he needed beforehand.	Serena found her supervisor a great mentor: he focused on her progress and completing with a good profile. She could ask him anything. When medical issues emerged, they found a way for her to have a sense of moving forward.
While Mario enjoyed the team meetings, he found them intellectually challenging.	The research team was also a great support, and she developed an important friendship with one member.
Mario had little other involvement in academic life or academic networks—other than his course work in the first year.	She worked for other professors (noting how females managed academia, her future). Joining in governance, she also learned how the university worked.

Above, we see how Mario's and Serena's personal investment and goals interacting with PhD possibilities are leading to differing trajectories. Serena's experiences reflect many of the factors that have a positive influence. She chose her supervisor and her progress and completion were a focus of their interaction. She was moreover agentive in working with other academics and engaging in governance (in each case, with a specific purpose). In contrast, Mario reported a relatively positive supervisory relationship, but it was associated with anxiety and, at a critical point, a sense that she had not provided him appropriate guidance. Further, he was minimally involved in academic life.

Departmental and institutional influences: Specific departmental through institutional practices likewise contribute to greater satisfaction, research engagement and productivity (Scaffidi & Berman, 2011). Relevant factors include career support, particularly regarding non-academic careers (O'Meara, Jaeger, et al., 2014). For instance, PhD STEM researchers engaged in technological development activities are more likely to go into the private sector than those who did not (Herrera & Nieto, 2016). Further, using career services more than triples the likelihood of employment within twelve months of graduation (Jackson & Michelson, 2015)—an important action since supervisors may not know about careers or wish to give advice (Thune et al., 2012).

Unfortunately, nearly two-thirds of PhD chemists had no systematic strategy for learning about or preparing for careers (Thiry, Laursen, & Loshbaugh, 2015).[7] Further, PhD researchers regardless of discipline often inaccurately assess the skills needed outside the academy (de Grande et al., 2014), rating communication and management skills low while employers consider them important. Not surprisingly, graduates in professional jobs wished they had had better career preparation (Kyvik & Olsen, 2012).

A positive and active intellectual climate (Pyhältö, Stubb, & Lonka, 2009) within the programme, department and faculty also contributes to satisfaction, research productivity and engagement. The same is true of institutional writing support since supervisors may not feel able to and/or have the time to provide such support (Badenhorst, Moloney, Rosales, Dyer, & Ru, 2014). Finally, robust tracking systems (Driver, 2006) document progress, time to completion and career trajectories—and thus can capture and resolve problems in the making. Interestingly, many of the departmental and institutional factors that can positively influence completion and satisfaction are absent in Mario's and Serena's experiences: lack of (a) career support, (b) robust tracking systems (note Serena's comment regarding this) and (c) institutional writing support.

Mario had little involvement in the larger life of the academy, feeling comfortable staying within his team. He did not appear to have encouragement to act otherwise.	When Serena moved cities due to her partner's job, she used social media and university visits to reduce isolation and continue work with the team and other professors in her network.
He tried publishing an article with a colleague. The negative response left him feeling injured.	She published some papers, with help from her supervisor, seeing reviewer feedback as mostly useful.
Mario learned quite late in the degree how few academic jobs there were and, moreover, came to realise that he might not be competitive.	Serena found unacceptable that the university did not follow graduate trajectories. Still, she worked hard to develop her networks and a strong academic profile.
In his last year, Mario applied three times locally for academic jobs, given his family circumstances. He had no reply and was devastated, seeing it as a personal blow.	In her last year, Serena applied for and got a competitive post-doc fellowship and began a job search in her home area (where her partner was also from), drawing on her networks there.

Here again, structuring elements interact with individual elements (personal preferences and values). While neither Mario nor Serena had institutional writing support, Serena got help from her supervisor and was actively involved in the intellectual climate of her faculty, which enhances research productivity. As well, she did not respond to reviewer feedback or job application rejections as negatively as Mario did. While neither had institutional career support, Serena had been developing her profile and had supervisory guidance so felt herself prepared for success academically (note the fellowship award). Now we turn to studies about PhD graduate perceptions of their degrees, returning to Mario's and Serena's stories later.

How Useful Is the Degree in the Non-Academic Sector? PhD Graduates' Perspectives

Twenty years of research on PhD experience has resulted in an increasingly rich representation of the interaction between individual and structural elements during that phase of the career trajectory. However, when we move to the experiences of PhD graduates outside the academy, the research is at a much earlier stage and is handicapped by examining multiple labour markets rather than one, academia. Here is some of what we know.

Structure: Influence of Historical Time and Geographical Location

Time and location strongly influence the labour market. Schwandt and van Wachter (2018) in the US reported those seeking work (not specifically PhD graduates) in adverse economic conditions are not only disadvantaged at the time but also substantially disadvantaged long-term as to health effects and family formation. Oyer (2006) also in the US reported similar results with economics PhD graduates working in the academy; the better the initial placement, the greater the long-time accumulation of benefit. A comparable result emerged for PhD humanists graduating between 2004 and 2014 in Canada; proportionally more who graduated in 2004 (before the global economic crisis) found tenure-track positions than at two later times (after the crisis) (McAlpine & Austin, 2018).

Since the labour market is historically situated, my analysis looks principally at studies published in the past decade, from early in the global economic crisis. I have also noted the country where the study took place, since region plays a role in willingness to hire PhDs (Garcia-Quevedo, Mas-Verdu, & Polo-Otero, 2012), Lastly, given disciplinary influences in the labour sector (Auriol, Misu, & Freeman, 2013), I have grouped the studies as follows: (a) all disciplines across all sectors and (b) STEM graduates in the private sector.

In each section below, I begin by summarizing the themes before providing detail.

Individual Perspectives: All Disciplines

Three themes emerged related to graduates' work experiences (departmental and institutional contexts): (a) perceived satisfaction with the PhD, (b) PhD skills related to type of work and (c) match-mismatch between PhD 'training' and the job. Notably, a sizeable proportion were research professionals (Kyvik & Olsen, 2012). Overall, graduates were relatively satisfied (e.g., Benito & Romera, 2013) and perceived the relevance of many PhD skills, but with some difference in emphasis between research professionals and professionals (labour sector not differentiated). Regardless of role, missing skills related to different aspects of communication and management (e.g., Kyvik & Olsen, 2012). A negative and long-term issue for roughly a third was job mismatch, under- and unemployment (e.g., Heuritsch et al., 2016). Aside from di Paolo and Mañé (2016), little attention is given to structural factors, such as regional economic situation, labour sector or institutional openness to hiring—some of which are considered in the later STEM studies. Here is the detail:

- *Satisfaction*: Benito and Romera (2013) reported PhD graduates working outside the academy are very or somewhat satisfied with their work in respect to contribution to society, intellectual challenge, independence, job security and responsibility, but less satisfied as to salaries, benefits and opportunities for advancement. Similar results were reported in the US by Sinche, Layton, Brandt, O'Connell, Hall & Freeman (Sinche et al., 2017).
- *Skills related to type of work (professional or research professional)*: Kyvik and Olsen (2012) in Norway reported 55% of graduates surveyed found work outside academia: with research professionals 25% of the total, and 30% professionals; 90% had a post within a year of graduation. Both groups viewed the skills learned as valued, with 'systematic and analytical thinking' and 'handling complex problems' the most important for their job, notably rated above theoretical training and methodological training. A small number suggested additional training: research management, project planning, alternative career paths and research group collaboration.

  Thune et al. (2012), also in Norway, reported 65% of graduates both in and out of academia were doing some form of research or development (innovative activities related to developing or improving services or products). The remaining 35% characterised their positions as involving consultancy or clinical tasks, with 90% reporting their employment as related to their PhDs. But 'great' relevance was attached to the PhD for those who were doing research. Respondents also suggested greater emphasis could be given to communication and management skills.

  In the US, Sinche et al. (2017) compared those in research careers in and out of the academy with those working as professionals in relation to their perception of fifteen generic skills related to the PhD. The majority of skills were considered transferrable for both careers. However, three skills were favoured in research careers: creativity/innovative thinking, career planning and awareness skills and the ability to work with people outside the organisation. Three different skills were favoured in professional careers: time management, ability to learn quickly and ability to manage a project. Again, there were skill gaps: setting a vision and goals, time management, team work, external collaboration, managing others and career planning/awareness.

- *Match-mismatch between PhD 'training' and job*: Heuritsch et al. (2016) in the Netherlands compared graduates' skills acquired during their PhDs to the ones needed in their current jobs. One-third experienced a mismatch between their training and their work. Just 65% believed they worked at the PhD level; 21% worked at the Master's level, 12% at the Professional level (including medical doctors), with 2% at the Bachelor's level. Those working at the PhD level considered the content of their job highly related to their PhD. Three clusters of skills were assessed: scientific skills, independence, and management and social skills. Management and social skills (e.g., teamwork) were particularly underdeveloped, with graduates in the private sector particularly experiencing a strong gap. Those working at the PhD level reported a lack of scientific skills, perhaps because their training had not included R&D work. Independence skills were only overdeveloped for those working at the Bachelor's level.

  In Spain, di Paolo and Mañé (2016) explored factors influencing earnings and satisfaction, looking particularly at over-education (PhD not required for job) and over-skilling (no opportunity to use PhD skills). There was a significant earnings penalty for those who were both over-educated and over-skilled. As well, being mismatched reduced job satisfaction considerably, especially for those whose skills were underutilised. This study was unusual in examining job characteristics such as economic sector and main work activity. They reported these played a fundamental and direct role in explaining 'mismatch.' PhD experiences only indirectly explained the mismatch, losing their importance once job-related characteristics were controlled for.

  An earlier study in France, Béret, Giret, and Recotillet (2003), explored the career trajectories of PhD graduates in the private and public sectors. Despite nearly half the cohort having access to research jobs in the private or public sectors, 20% remained in under-qualified jobs or recurrent unemployment—similar to results in Australia with 20% either working part-time or not working (Jackson & Michelson, 2015). Further, 10% of graduates could only access jobs which were a mismatch—ones for which they were over-qualified. As elsewhere, a relatively high percentage from STEM were in the research sector, with humanities and social science graduates more numerous in the academic sector and in recurrent unemployment.

Finally, Galimberti (2018) reported the experiences of two humanist graduates in Italian small private enterprises. Issues that emerged included negotiating entry, possible value of a PhD to the organisation and being over-skilled. These demands meant they experienced cultural re-location (McAlpine, 2012) since the underlying assumptions of the organisations were distinct from the previous academic contexts. Still, both found ways to contribute in their new jobs.

Individual Perspectives: STEM in the Private Sector

Three similar departmental-institutional themes emerged: (a) perceived value of the PhD, (b) skills used and (c) mismatch between PhD and work. These studies often incorporate structural factors, for example, time, private sector heterogeneity. Specifically, time influenced the perceived value of the PhD (Bryan & Guccione, 2017) as it did job type—with a shift over time from research professional to professional (Lee, Miozzo, & Laredo, 2010). Analytic skills and problem solving were relevant across careers, but varied in importance between professionals and research professionals—with communication and management skills lacking (Lee et al., 2010). Having done private sector work during the degree also had an effect: such graduates assessed the PhD skills needed for their job differently from those without such experience (Manathunga, Pitt, & Critchley, 2009). Finally, in the private sector, the largest PhD STEM employer, primary work responsibility varied considerably across organisations; it could be development, applied research, management or professional and other services (Turk-Bicakci, Berger, & Haxton, 2014). Here is the detail:

- *Perceived value of the PhD—and time*: Bryan and Guccione (2017) in the UK explored the perceived value of doctoral experiences for graduates across sectors (two-thirds were STEM). Value was perceived as an integration of experiences during the degree (nature of the supervisory relationship) and afterwards (accrued social connectivity from the PhD and employer valuing of the PhD). Further, there was an increase in the perceived value of the PhD over time, which the authors ascribed to having time to reflect on the value of the PhD.

- *Skills related to work and PhD experience*: In the UK, Lee et al. (2010) examined which PhD competencies were considered valuable in three different career types: (a) in the academic/public sectors conducting research (so including research professionals and research-only), (b) private sector working as research professionals (R&D, design or production) and (c) private sector working as professionals (management, consultant). They looked only at graduates in one university (to address the effect of university and region). Like the de Grange et al. study (2014), their list of skills was detailed. Graduates ranked the usefulness of (a) specialist knowledge (PhD topic), (b) general knowledge (PhD subject), (c) application of information technology and data processing, (d) general analytical skills, (e) communication skills, (f) project management skills and (g) problem solving. General analytical skills and problem solving were important in all career types, but to different degrees. For instance, general and transferable skills received higher scores from those working as professionals, lower scores by those working as research professionals and even lower scores by those in academic/public research positions.
- Manathunga et al. (2009) in Australia examined the effects of two different PhD programmes (traditional and industry-university collaborations) on skills developed during the degree in relation to their current employment—whether industry or academia (not differentiated in the study). Although both groups thought they had sufficient skills, the actual percentages varied from 75% for traditional programmes to 58% for the collaborations (which seems counter-intuitive)—perhaps due to a more complete understanding of what work was expected. Moreover, many respondents wanted more training in time management, goal setting, management and supervision of staff, commercialisation, business acumen and budgeting. (Recall that

industry-university collaborations can increase possibility of permanent private sector employment [Thune, 2009].)

- *Match-mismatch between PhD 'training,' job—and time*: In the UK, Lee et al. (2010) also tracked the first and current jobs of graduates in professional, research professional and higher education (HE) researcher posts. A shift occurred over time towards professional positions; while 91% of those initially professionals remained professional, those who were first HE researchers or research professionals migrated to professional posts over a seven- to ten- year period after graduation; so those in professional positions grew from 37% to 58%.
- In the US, Turk-Bicakci et al. (2014) focused on the distribution of post-PhD work. The private sector at 61% was the largest employer. The para-public sector employed 6–16%, and 8–17% were self-employed (variation due to demographic breakdown[8]). Primary work responsibilities were reported as follows: (a) 27% did development work (knowledge for production: design of equipment, computer applications), (b) 24% did applied research (scientific knowledge to meet recognised need)—so about half did some sort of research, (c) 19% did management (managing or supervising people), (d) 25% provided professional and other services (e.g., accounting and finance, employee relations, personnel development, sales, quality management, teaching) and (e) 5% did basic research (scientific knowledge for its own sake). Of these in the private sector, 43% reported R&D was not their primary work activity. (There were some demographic and disciplinary differences.)

Transitioning out of the PhD: Career Entry and Job Change

We continue with Mario's and Serena's stories; both were looking for positions during the global economic crisis. Both found jobs in the traditional social science sectors—and both later changed jobs—an important fact in understanding career trajectories.

Mario needed a job so he applied for a post-doc contract in another faculty which a colleague mentioned. He got it, but became totally demotivated. He was under-employed doing work that ignored his PhD abilities, rarely using his 'intellectual skills and knowledge.' 'I was very idealistic … then over time seeing things … sort of this apprenticeship of observation …you go, Holy smokes, it's not really what I had expected it to be.' His non-academic friends advised he look beyond the academy. So, Mario volunteered in NGOs for several months, re-entering the world he had left. This led to a professional job doing evaluation research. 'It brings together my academic training, professional experiences, and interest in social justice issues.'	Serena applied for the only two academic jobs available in her home area, though a bad fit; also as a research professional in a university healthcare institution. She chose this job over the fellowship (arranging an adjunct post) to ensure good benefits to start a family. 'My position is very academic … I teach, I mentor … I do research [about patient care]; … I'm fulfilled … I really value the work that I do … evidence-based practice' linked to patient care—'a bit less academic freedom, but … quite loose.' Several years later, after enhancing her academic profile, Serena got a tenure-track position in the only local university with a PhD in her area. 'Career goals can be achieved using multiple paths … and time … I decided to take … an untraditional route.'

Mario's first job post-graduation was necessary financially but demotivating. He experienced a mismatch between his training and the work, so was under-employed. His non-academic friends helpfully reminded him of his earlier work in the para-public sector. He was job hunting during the economic crisis, but he was in a large cosmopolitan city and knew the labour sector from earlier work experience. This, along with his agentive volunteer strategy after leaving his first job, likely led to his relatively quick return to paid work.

In contrast, at the same time, Serena was looking for a job in a small regional city, its economy largely driven by public funding, for example, a government, regional healthcare centre. She was seeking employment in sectors she had not worked in before so used her local network to find possibilities. Though the city has universities, only one was research intensive and her disciplinary field was not well represented, so finding an academic post was unlikely. On the other hand, the attractiveness of the healthcare job was enabled by its university links, and there were two positions available when she applied. Notably, several years later, she ended up in a tenure-track post, having strategically positioned herself through the adjunct position and publishing.

Ultimately, both individuals were influenced in their career choices by life experiences, goals and values interacting with labour market possibilities. Overall, the key point is that the interaction between individual factors and structural elements influences career trajectories and leads to increasingly varied career profiles. Their stories are also a reminder that we need to follow graduates over time to capture their career progression, including job and labour sector change.

Taking Stock: What Is Missing from Studies of PhD Graduate Careers?

There is plentiful research about PhD experience that examines the interaction between individual experiences and the structuring elements of the PhD. However, there is very little for the period afterwards about the interaction between individual elements and the structuring elements of the labour market. You may have noted above that little reference was made to geographical location, organisational features or economic climate. In our research, we were initially not sensitive to this either—which resulted in a one-sided perspective, that of the individual.

We have more recently tried to capture the interaction between individual and structural elements that influences career trajectories. Table 1 shows this interaction for Serena,[9] differentiating information related to individual elements (from the data she provided during our research) and the structuring elements post-graduation as she sought her first job. Only one of these structural factors was provided by Serena; all the rest we found post hoc in public records.

In reviewing Table 1, you may have noted that while we could find information about broader structural factors in which to situate Serena's individual intentions, actions and experiences, we lack information about the employer's perspective—which we take up in the next section.

Table 1 Intersection of individual and structural elements for Serena (adapted from McAlpine & Amundsen, 2018; see also Appendix A)

Individual elements		Structural elements	
Past experiences	∗Close-knit family; sibling challenged by school; led to Serena's 'helping' profession	*Historical time*	∗∗2006 → 2013, during and after the global economic crisis
PhD influences	∗Developed academic profile (networking, research); personal relationships remained important years after PhD	*Labour sector*	Regional market largely public sector ∗∗Only 1 university health centre ∗Only 1 university had PhD programme in her field
Values	∗places family over work; contributes to society; does applied research	*Discipline*	∗∗Social sciences—tend to find employment in public and para-public sectors
Life goals	∗Close to family, wanting children	*Government policies; societal practices*	∗Constrained as research professional and adjunct to apply for grants which limited her research resources
Career goals, institutional preference	∗On slower path than planned; took 1st post for financial security; wanted job with PhD programme in her field	*Institution structures; mission; size*	∗∗Healthcare institution, large: enhanced patient care ∗∗Universities, large: mostly teaching-focused; only one is a research university
Agency (affect, belief, action, commitment)	∗Used local non-academic network to find 1st job; negotiated contract; recrafted research to suit disciplinary structures	*Geographical location*	∗∗Small, geographically isolated city

Quality of life concerns	*Worked 9–5 to ensure time with family	*Economic climate*	** 2009, relatively poor when sought 1st job; ** 2013, economy recovering at time of 2nd position
Well-being	*Not letting work be a point of stress; time with friends and family most important	*Employer's perspective, e.g., previous hiring of PhDs, competition for post*	? actual market unknown This would require ethical consent from Serena
Family relationships	*Supportive partner and family in managing childcare, work and her intentions	*Actual work*	*My [healthcare job provides a lot of freedom and trust to be self-directed. I offer consultations on people's research activities. This past year, 50 people came to discuss and plan their research—from professors to health practitioners, to medical residents since research is now a required part of their residency.

*Stated by research participant
**Checked through public record
?Unknown

What Do Employers Think of PhD Preparedness?

Nearly all the studies related to non-academic employers are situated in the EU and principally in the private sector. The research addresses departmental and institutional contexts: work expectations, mismatches, hiring practices and the nature of the organisation. Still, other structuring elements such as geographical location or historical time are less frequently documented. The first section below does not distinguish discipline; the second focuses on STEM fields.

All Disciplines

Two themes are consistent with graduate perceptions: (a) perceived PhD value and (b) skills mismatch—here in interaction with organisation size and prior hiring of PhDs. The public and private sectors were equally low (one-fifth of employers) in their willingness to hire PhDs since graduates were not seen as adding sufficient value to be worth hiring; that is, non-PhDs could do the R&D required (e.g., Benito & Romera, 2013). Notably, employers who had previously hired PhDs were more positive and referenced different PhD skills than employers who had not (de Grande et al., 2014). Further, while employers felt work-related skills were not what was desired—they may not actually know what a PhD graduate can offer (Teelken, 2018). Lastly, size of institution influenced skills desired (e.g., de Grande et al., 2014)—also a factor in the STEM studies in the following section. Here is the detail:

- *Perceived value*: Using Organisation for Economic Cooperation and Development (OECD) data, Benito and Romera (2013) explored sector receptiveness to hiring PhD graduates as research professionals. Not surprisingly, higher education had the highest receptiveness, averaging 58.2%,[10] followed by the private (20.4%), public (21.7%) and para-public (3.9%) sectors. A majority of PhD holders worked as researchers, though, in contrast to common belief, the majority of researchers did not hold a PhD. Graduates working as professionals were distributed as follows: higher education (38.5%), private (28.1%), public (23.2%) and non-profits (6.85%).

In Norway, three-quarters of R&D private sector employers did not believe a PhD added value beyond that of a Master's degree, so only a minority sought PhDs in their job advertisements (Kyvik & Olsen, 2012). However, it was unclear if degrees may have counted in hiring decisions, or employers had actual knowledge of what PhDs could offer. Another Norwegian study (Thune et al., 2012) reported that private firms often recognise the value and relevance of PhDs but prefer to hire those with lower qualifications.

- *Skills match—and prior PhD hiring and organisation size*: de Grande et al. (2014) explored industrial employers' views as to the skills they seek in research professionals (about a third already employed PhDs). Employers who already had PhDs working as research professionals valued research skills, scientific knowledge and leadership. Those without PhDs tended to stress technical skills, independence and self-confidence. Finally, four skills differed in relation to company size, for instance, technical skills were rated 'important' by 82.4% of employers in small firms, whereas only 60.8% of employers in large firms highlight this. They also reported a mismatch between what employers expected and what PhD researchers considered important skills, with technical skills and more transferable competencies such as project management and business skills underestimated by the PhDs.

  Firm size also emerged in relation to hiring humanities graduates in the private sector (Galimberti, 2018). While previous research has largely focused on large institutions, small and medium enterprises account for the greater part of European private enterprise. In the study, small enterprise employers lacked awareness of the value of research knowledge, likely due to their greater distance from the world of research than larger firms. What appeared critical to success was the newly hired graduate demonstrating such value. He argues the need to focus more on personal contact between graduates and potential employers in understanding hiring practices.

  Finally, a study in the Netherlands (Teelken, 2018) reported the perspectives of private sector employers of social scientists. They viewed the private sector as distinct from academia with stricter deadlines, clients waiting for actual results and limited budgets. So, they expected employees to quickly transform analysis into easy to understand concise reports. In contrast, they saw PhD graduates as indecisive, eternally critical, with a slow work pace, and inexperienced in taking a broad overview—as well as lacking some key social skills. So, while they viewed graduates as very intelligent with strong analytical skills, perseverance, independence and good writing skills, they were less practically and commercially oriented than required. While their perceptions may not be accurate, these findings help explain why private sector organisations may be less willing to hire PhDs.

STEM Fields

Two themes predominate: perceived (a) institutional need and (b) PhD value—both interacting with a range of other factors. Overall, these studies highlight the diverse mix of structural factors that influence the hiring of PhD graduates: (a) prior cooperation and minimal distance between universities and firms (e.g., Heuritsch et al., 2016), (b) heterogeneous disciplinary needs of the private sector and proximity to universities (Herrera & Nieto, 2016), (c) type of innovation privileged in the organisation (Herrera & Nieto, 2013), (d) different communication needs (Beltramo, Paul, & Perret, 2001), (e) firm size and type of innovation (Adams, Mullins, & Zander, 2008) and (f) organisation size, mission, location and prior hiring of PhDs (Garcia-Quevedo et al., 2012). Here is the detail.

- *Perceived institutional need—and organisation size*: Adams et al. (2008) in Australia reported three notions of 'innovator' held by engineering employers[11] in organisations from very small to large; these views influenced their hiring of research professionals (not necessarily PhDs but knowledge workers). The 'niche adapter' required the application of specific knowledge to solve a 'problem': unique product development in response to customer requirements. The 'innovative adapter' required monitoring of products or innovations to create market advantage and the 'visionary' imaginative conceptualisations for potential future use. Interestingly, niche adapters tended to be found in smaller firms, with innovative adapters and visionaries in large organisations. Visionaries were also often employed by public and para-public organisations.

Herrera and Nieto (2013) in Spain reported wide variation in private sector firms' motivations for hiring PhDs as research professionals: (a) generate scientific knowledge, (b) access scientific knowledge, (c) address previous failures in innovation activities and (d) address difficulties in (i) finding innovation partners and (ii) access to external R&D funding. Like firm size, this range of motivations helps explain the diversity of needed skills reported in other studies.

- *Perceived PhD value—and organisation size, mission, location; prior hiring of PhDs; and university collaborations*: In Spain, Garcia-Quevedo et al. (2012)[12] surveyed private sector employers as to the perceived value of hiring PhDs. They chose a region with medium-low scientific capital (less propensity to innovate), so potentially with less capacity or interest in hiring PhDs. The results confirmed their hypothesis. While 61% of firms considered PhDs valuable or very valuable, only 10.4% preferred to hire one, and only 15.4% had actually hired one. Instead, firms were hiring non-PhDs for research, viewing PhDs as too specialised and expecting higher salaries. Still differences emerged in hiring practices; firms that appreciated the degree tended to have high and medium-high tech content, cooperate with universities and make a greater effort in R&D. Also, a tendency to hire PhDs was related to previous hiring practices, with a long-term cumulative effect. Notably, firms preferring to recruit PhDs had characteristics similar to firms that had already hired them. (Another study Cruz Castro & Sanz Menendez, 2005, again in Spain, supports these last two findings.) As well, like Adams et al. (2008) and de Grande et al. (2014), size of firm proved an influence: greater recruitment when firms were small, less when medium and more when large. A final influence was whether the R&D was done internally or outsourced: firms with a positive attitude towards temporary hiring of PhDs and firms in medium-high and high-technology sectors preferred PhDs with their thesis done in the university rather than in the technology sector. But, firms that outsourced

R&D were more likely to hire people from a technology centre or recruit workers that wanted to carry out their theses on projects related to the firm's activity.

Another Spanish study by Herrera and Nieto (2016) examined the disciplinary distribution of research professionals across manufacturing and non-manufacturing firms in the private sector, demonstrating the heterogeneity of the private sector. More PhDs were hired in non-manufacturing firms than in manufacturing firms, most often from life sciences and rarely from math and engineering sciences. In the manufacturing sector, two fields considered relevant for the industry's future, computer sciences and mathematics, represented less than 1% of PhDs hired, and the clothing sub-sector employed no PhDs. Their findings confirmed other studies (e.g., Heuritsch et al., 2016) that while some PhDs were employed in positions that did not require such degrees, this was not the case for firms hiring PhDs in the manufacturing sector—perhaps explaining the low hiring rate. As in Garcia-Quevedo et al. (2012), this study emphasised the importance of regional concentration of innovation activities and proximity to research universities for knowledge transfer.

Adams, Zander, and Mullins (2006) examined engineering employer perspectives in small through large firms. A key element in hiring knowledge workers (not necessarily PhDs) was whether the organisation wanted to make the financial and human resource investment needed to ensure employee commitment and decision to remain in the organisation. Such costs, if followed by employee departure, could help explain why organisations are hesitant to hire PhDs if they have not done so before.

An earlier study, Beltramo et al. (2001—France, Spain and the UK),[13] offers further insight into how different kinds of communication impact innovation capacity: (a) external-to-internal: drawing on and assimilating external information and (b) internal distribution: spreading and coordinating such information within the firm. The results suggest that firm structures such as R&D units can positively influence both aspects of communication. Further, each requires distinct skills, so institutional need could affect hiring practices. Finally, the surveyed employers required a divergent set of PhD skills. While they wanted employees who worked well with others, communicated well to a range of audiences and engaged in group problem solving, many also valued graduates' abilities to work in isolation, produce creative and accurate documentation and work well under pressure.

What Sense Are We to Make of This New Evidence? What Is Missing?—Suggestions for Future Research

From the studies of employer perceptions, we gain a more robust view of the organisational structuring elements that influence PhD hiring. Generally, private sector employers need convincing of the value of hiring PhDs. Factors influencing hiring include (a) institutional mission (role of innovation), size and location, (b) financial costs, that is, return on investment, (c) difficulty in seeing the added value of a PhD, (d) concern regarding PhD graduate efficiency in a time-sensitive work environment and (e) speculation rather than evidence as to PhD value in hiring decisions. Interestingly, no mention is made in any of these studies about whether potential employers actually know the skill set they are seeking—so can actually differentiate the value of someone with a PhD.

In comparing the studies on PhD perceptions with employer perceptions, both employers and graduates recognised gaps in PhD preparation, but graduates appear more positive about the relevance of the degree than employers. There is agreement though that graduates are taking positions in which they are under-employed. Since this picture is limited to the private sector, it may not be true in the public and para-public sectors. Lastly, we see a contrast between studies of PhD graduates and employers with the former studies not integrating individual and structural factors—so likely missing variation.

We also do not know (a) the actual job descriptions and job tasks of the professional and research professional roles, (b) the relationship of tasks to skills or satisfaction or (c) whether firms may hire PhD graduates on contracts for specific tasks rather than as employees. Also missing is the extent to which and why individuals change jobs over time and across geographical locations. Lastly, neither set of studies actually examines the interaction of the societal-global context with the institutional context in which PhD hiring is taking place. If we are to develop a more robust rendering of career trajectories, we need to address the interaction of all structural context issues with individual factors.

We also need a clear question(s), for instance: What does or doesn't make the PhD useful to employers and graduates in the non-academic sectors in a range of organisations?[14] In portraying the range of interacting factors, we need to attend to the diverse drivers of employers and potential employers in different organisations and labour sectors. Further, employers regardless of sector may be unwilling to commit to the research, if it is seen to impede rather than further their own goals.

A real challenge is that neither PhD graduates nor employers may be aware of societal-global influences—which means as researchers we must find ways to integrate these into our analyses. Finally, the most testing aspect of the research agenda may be finding creative ways to generate ecological inferences by integrating aggregate quantitative data and individual qualitative data since the underlying research assumptions are so distinct. The issue is whether these two can be seen as complementary, alternative or contradictory explanations (Elliott, 2005). I would argue that treating them separately fails to provide a robust image of PhD career trajectories and that integrating them can be complementary, though not straightforward (McAlpine, Skakni, & Inouye, in press).

Conclusions

In this chapter, I undertook to describe what we know of PhD graduate careers outside the academy. In the process, I argued it is a vital area for research, needing a more fine-grained systematic research agenda in order to understand the interaction of individual factors (well researched) and structural factors (less researched) in career trajectories. While this is challenging research, I hope I have convinced you of the importance of examining non-academic PhD career trajectories and highlighted areas and issues that need attention in the process.

Notes

1. Of course, PhDs have always worked outside the academy; the difference is that now it is the majority of PhDs, many of whom may not have originally intended such employment.
2. As defined by OECD.
3. Usefulness of the degree is often assessed by asking individuals to note the extent to which they use a range of generic skills, for instance, creativity and innovation, problem solving, thinking critically, teamwork, leadership, oral and written communication, project management.
4. Disciplines are becoming more balanced as to gender, with greater numbers of females in the sciences and males in traditionally female disciplines.
5. Given the focus on employment, I have set aside other outcomes that emerge from doing a PhD, such as the profound learning experience (often described as transformational) (Stevens-Long, Schapiro, & McClintock, 2012).
6. If the cameos had been two scientists, the programmatic and disciplinary practices and career outcomes would have differed somewhat but life circumstances would have similarly varied.
7. This is a concrete example of the interaction between individual agency and structuring elements in the environment.
8. Not reported here.
9. You will note more information about Serena's experiences in Table 1 than in the previous cameo.
10. There was, of course, national variation.
11. Labour sector is not named but private is inferred.
12. At no point do they refer to discipline, but their reference to technology transfer, for instance, suggests STEM.
13. I do not report the empirical evidence, given its historically situated perspective on the labour market.
14. A deeper and more policy-related question is whether countries should continue to increase PhD graduates given the evidence that non-PhDs appear to be meeting some of the present research needs.

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PhD Students' Self-Perception of Skills Acquired During Their PhD and Plans for Their Postdoctoral Careers: A Joint Analysis of Doctoral Students at Three Flagship Universities in Asia

Hugo Horta

Introduction

Doctoral education has been undergoing transformation over recent decades, although it remains mostly research-focused (Park, 2005). Currently, doctoral education worldwide is influenced by a mix of models mostly originating in Continental Europe, the UK and the US, and general academic work is becoming increasingly more collaborative and multidisciplinary (Kehm, 2006; Nerad, 2010). Doctoral students are also

This research was undertaken while on sabbatical at the Centre for Global Higher Education, Institute of Education, University College London, UK, and at the Graduate School of Education, Waseda University, Japan.

H. Horta (✉)
Faculty of Education, The University of Hong Kong, Hong Kong, Hong Kong
e-mail: horta@hku.hk

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becoming gradually more diverse and international, but are arguably less well-prepared by their previous education to engage in this type of study (Craswell, 2007). The massification of higher education, which has for years mostly affected undergraduate and (to some extent) master's degree programmes, is beginning to be felt at doctoral education levels (McAlpine & Norton, 2006). Altogether, the number of PhD students, graduates and programmes has increased steadily in recent decades, mostly in developed countries but also in developing countries as they catch up (Nerad, 2010).

The growing number of students in PhD programmes is related not only to the massification of higher education, which increases the pool of applicants, but also to increased funding for research and development to support knowledge creation in globalised economies, which includes funding for PhD students. Universities wish to attract more doctoral students, who represent a source of prestige and resources, as they ensure the university has a higher scholarly reputation. Larivière (2012) found that PhD students participated in or in some way actively contributed to two-thirds of all articles published by scholars at universities in Ontario, Canada. Increased research output, partly due to the contributions of doctoral students, pleases government funding agencies and contributes to maintaining or improving a university's position in global university rankings (Bloch & Mitterle, 2017). This process, associated with the non-sustainable funding of PhD students by governmental agencies, has created in some countries an imbalance between supply and demand for PhDs, as a growing number of PhD holders face stagnant academic labour markets (Stephan, Franzoni, & Scellato, 2016).

For recent PhD holders, the challenge is not unemployment but rather being unable to meet the career expectations associated with the degree, namely, obtaining a tenure-track position (McAlpine & Emmioglu, 2015). PhD holders in most countries tend to enter postdoctoral programmes after concluding the doctorate, and experience unstable careers and 'forced' mobility, which affects their professional, family and social life, leading to states of high anxiety and stress (Chen, McAlpine, & Amundsen, 2015). In such a scenario, a 'skill-push' agenda has been formulated and promoted by policymakers and university administrators, which aims to complement the traditional skills acquired during doctoral studies with ones suitable to non-academic jobs, whether or not they are related to research (Peters, 2007). This has led to the creation of new PhD programmes with a more professional flavour (e.g., Kitagawa, 2014), and a transformation of traditional PhD programmes (Bao, Kehm, & Ma, 2016). These professional-oriented programmes include seminars, courses and training to foster skills that PhD students supposedly lack (soft, generic and transferable skills; see Platow, 2012) that are considered important for landing a job outside academia or in non-research-related professions (Pablo-Hurtado, 2015).

There have been no studies of how the perceived skills acquired during doctoral studies are associated with students' preferred career paths, except for a single study by Jackson and Michelson (2015). The present study fills this knowledge gap by associating the self-perceived skill set of students with their career preferences during their doctoral studies. It focuses on doctoral students engaged in both the Science, Technology, Engineering and Math (STEM) disciplines and the non-STEM disciplines, as career opportunities for these groups can be very different (Bloch, Graversen, & Pedersen, 2015). The analysis draws on a representative sample of students from three Asian flagship universities: the University of Hong Kong, Singapore National University and Seoul National University. The objective is not to compare these universities but to use the data from them (appropriately controlled by university dummies in the analytical model) to answer the research question: how do students' self-perceived skill sets influence their career choices? This is a particularly important question from the perspective of careers outside academia versus those in academia. This study also contributes to the literature by focusing on doctoral students at Asian universities, as most studies have focused on Europe and North America.

This chapter is organised as follows: the next two sections present a brief literature review and an account of the data and methodological procedures. The following section presents the results of the analysis and the final section concludes the chapter by suggesting future avenues of research and offering policy implications relevant for managing doctoral programmes.

Literature Review

The 'skill-push' agenda was introduced to equip PhD students with competencies, skills and dispositions to make them more employable in non-academic sectors, which traditional PhD programmes were not providing (Peters, 2007). Teaching these skills has so far been problematic. Aside from the known challenges of teaching non-academic skills, on which there is an extensive literature (e.g., Gilbert, Balatti, Turner, & Whitehouse, 2004, Metcalfe & Gray, 2005), there are still unresolved key conceptual issues. The debate about which skills really matter and which skills doctoral programmes should provide continues unabated, and so far no compromise has been reached (Mowbray & Halse, 2010). It is agreed that the traditional PhD nurtures skills related to personality traits such as determination, creativity, perseverance, resilience and dedication, which are related to the multidimensionality of a doctoral programme (Pearson, Evans, & Macauley, 2008). Some authors argue that the introduction of soft, transferable, generic skills jeopardises the acquisition of these skills related to these personality traits because of the limited duration of the degree (see Lovitts, 2008).[1] Other authors discuss the feasibility and appropriateness of learning all the skills ideally needed, and conclude that having them all as learning outcomes is doubtful at best and detrimental at worst (Platow, 2012).

In addition, academics may not be prepared to train PhDs in non-academic skills,[2] especially because even in the same non-academic sector of activity, the skills that matter may differ substantially, as Herrera and Nieto (2016) have shown using the case of the manufacturing industry in Spain. In addition, learning generic, soft, transferable skills may be disconnected from the central focus of the PhD. They may distract from the identity and socialisation process that characterises doctoral study, which involves interaction with supervisors, other academics and peers and is rooted in the routines and results of the research process itself (Mantai, 2017). PhD supervisors may have a critical role, transferring their own skills and advising their supervisees on their career paths (Craswell, 2007; Manathunga, Pitt, & Critchley, 2009; Platow, 2012). This role is particularly important as PhD students may not have formulated their career perspectives clearly, although there are PhD students who have a clear view from the start as to why they are doing a PhD (McAlpine & Amundsen, 2015).

The theory of planned behaviour, a validated social and cognitive model of human behaviour, is an appropriate analytical model for this topic because it relies on individual motivational factors determining the likelihood of a specific behaviour (Ajzen, 1991). Its main premise is that the best predictor of behaviour is the intention to engage in that behaviour (Ajzen, 2005). Behavioural intention is thus determined by one's attitude towards the behaviour and the socially normative perceptions that frame it. In this process, individual and environmental characteristics are important. First, attitudes towards a behaviour are linked to beliefs about the consequences of engaging in it. Second, an individual subjective norm (also known as an injunctive norm) is related to the extent to which important referents (in this case, supervisors) approve or disapprove of a specific behaviour. Third, perceived control relates to perceptions of factors that make it easier or harder to adopt a specific behaviour and individuals' control over their ability to engage in a behaviour (see Ajzen, 1991; Sutter & Paulson, 2017).

Methods

Data

The data for this study come from a single questionnaire designed jointly by project teams from the University of Hong Kong (HKU; Hong Kong SAR, China), the National University of Singapore (NUS; Singapore) and Seoul National University (SNU; South Korea). After pre-testing the questionnaire with a small number of PhD students, each team proposed to collect around 500 complete surveys from PhD students in different fields—based on a stratified random sampling strategy that considered the population of students (including the proportion of male and female students) per faculty at each university—in a way that broadly represented the doctoral student body at each university. The following data were collected: 490 questionnaires from HKU, 310 from NUS and 516 from SNU, for a total of 1316 observations. The collection took place in 2016.

Variables and Procedure

Dependent Variables

The dependent variables were built focusing on the preference of the PhD students among five careers outside the academic sector in relation to the baseline, a career in academia. The five careers outside academia were as follows: (1) in the business sector; (2) in the business sector (but engaged in research, such as in an industrial laboratory); (3) in the government; (4) in the government (but engaged in research, in a government think-tank or laboratory) and (5) as an entrepreneur (i.e., self-employment). The students gave their preferences among these five career options, plus one in academia, using a Likert scale ranging from 1 (extremely uninterested) to 7 (extremely interested). The dependent variables result from subtracting the responses given to each question about a non-academic career from the responses given about pursuing a career in academia. For example, if a student marks 1 for becoming an entrepreneur and 6 for working in academia, then the dependent variable 'self-employment' for this student would be –5. This results in a continuum between –6 (maximum preference for work in academia) and 6 (maximum preference for working as an entrepreneur); a highly negative number means that a given student leans strongly towards working in academia. As predicted in the literature (e.g., Chen et al., 2015), PhD students have an overall intention of pursuing a career in the academic sector, rather than in business (–0.85), business involving R&D (–0.39), government (–0.66) or self-employment (–1.71). The exception is a preference for work in the government involving R&D (0.33). Although a preference for working in academia is evident, it is relatively weak except when balancing options between academia and self-employment, where the preference is moderately strong towards a career in the academic sector.

Explanatory Variables

The explanatory variables are based on twelve basic skills that encompass skill sets associated with traditional PhD programmes (e.g., methodology) and soft, generic and transferable skills (e.g., project management). As with the dependent variables, for each basic skill the students were asked to state their perception of their ability for each skill using a 7-item Likert scale. An explanation of each skill was provided to ensure better comprehension (see Table 1). The structure of the questions was benchmarked from the Organisation for Economic Co-operation and Development (OECD) 'Careers of Doctorate Holders' survey, and the same structure was used (Auriol, 2010). From these twelve basic skills, two types of explanatory variables were created:

1. *Aggregate skills* are a simple average of the students' self-perception of having acquired these skills, which tended to be high (4.64, on a scale from 1 to 7). This variable is significant, because if one departs from a human capital theory lens, one could argue that the broader the skill

Table 1 Meaning of the basic skills

	How do you assess your current knowledge and attributes acquired during your PhD? (7-point Likert scale ranging from 1 [low end] to 7 [high end], N/A option available)
1	**Methodology** (e.g., appropriate application of methodologies, tools and research techniques)
2	**Innovation** (e.g., development of new ideas, embedded in your research)
3	**Critical thinking** (e.g., critical analysis of findings and results)
4	**Problem solving** (e.g., formulating and applying solutions to problems)
5	**Communicating effectively** (e.g., communicating knowledge to audiences)
6	**Creativity** (e.g., ability to be creative, think outside the box)
7	**Flexibility** (e.g., quick adaptation to challenges and new situations)
8	**Responsibility** (e.g., working independently, assuming responsibility for actions)
9	**Networking** (e.g., development and use of networks and collaboration)
10	**Project management** (e.g., planning, management of projects)
11	**Pedagogy** (e.g., knowing how to teach others)
12	**Teamwork** (e.g., developing work with colleagues)

Adapted from OECD's Career in Doctorate Holders questionnaire set of a PhD student, the more 'available' the student is to face a wide range of careers, including those outside academia (Kim et al., 2014). The premise that a 'jack-of-all-trades' skill set is suitable for a wider range of jobs underlies the 'skill-push' agenda. This is an assumption worth testing.

2. *A set of specialised skills*: These explanatory variables are associated with the argument that specialised skills mean that a PhD student will move to a sector of activity where those skills are perceived to be valued (see Roach & Sauermann, 2010). The idea is that individuals with specialised skills look for occupations where those skills can be optimally used (e.g., students who are better at mathematics in high school seek out STEM occupations; see Eccles & Wang, 2016).

Specialised skills were identified following an empirical procedure, because there were no relevant conceptual guidelines. The procedure was based on a two-stage strategy. First, data reduction was performed through an Exploratory Factor Analysis (EFA) to identify the scale's latent components. The EFA used the twelve basic variables as inputs, with Varimax rotation. The resulting Kaiser-Meyer-Olkin Measure of Sampling Adequacy was deemed very good, with a value of 0.906. Two factors were extracted based on the Kaiser rule (> 1 Eigenvalues), explaining a cumulative variance of 54.87%. The two factors were co-substantiated by a scree plot. The factor loadings are reported in Table 2. The result of this first step then fed a cluster analysis that used a TwoStep Cluster Algorithm, which generated a preliminary cluster structure and then subjected it to classical hierarchical agglomerative clustering (using log-likelihood rather than Euclidean distance), where the units of analysis were pre-clusters rather than individual subjects (see Horta, 2018). The TwoStep Cluster Algorithm optimally calculates a number of clusters using Schwarz's Bayesian Inference Criterion (BIC), instead of relying on subjective interpretations. For a more complete description of this method see Chiu, Fang, Chen, Wang, and Jeris (2001).

Based on these results, factor 1 was designated 'research-oriented skills,' because the stronger basic skills evidenced there are creativity, innovation, critical thinking, problem solving, flexibility and methodology. All of these skills are considered core for excelling in research (Polanyi,

Table 2 Factor analysis results

	Component	
Basic Skill	1	2
Innovation	**0.820**	0.131
Creativity	**0.791**	0.147
Critical thinking	**0.741**	0.237
Problem solving	**0.680**	0.376
Flexibility	**0.617**	0.356
Methodology	**0.583**	0.296
Communicating effectively	0.510	0.494
Teamwork	0.133	**0.786**
Project management	0.220	**0.752**
Networks	0.240	**0.727**
Responsibility	0.413	**0.530**
Pedagogy	0.204	**0.519**

Note: Rotated components matrix; extraction method: principal component analysis; rotation method: Varimax with Kaiser normalisation; rotation converged in three iterations.

1958). Factor 2 was named 'managerial-oriented skills,' due to the strong basic skills of teamwork, pedagogy, project manager, networks and responsibility, which are considered key skills for managers (Kerzner, 2017; Thompson, 2014). Both factors share similar values in terms of communicating effectively.

The two factors were used as input variables in the TwoStep Cluster analysis, leading to the identification of five clusters, which are referred to as specialised skills in the analysis (Table 3; see also Fig. 1): (1) solo researcher (6.8% of the sample), referring to PhD students who believe they have very strong research-oriented skills, but very poor management-oriented skills; (2) solo manager (23.1% of the sample), referring to PhD students who believe they have very strong management-oriented skills, but very poor research-oriented skills; (3) more researcher than manager (30.6% of the sample—and also the largest group), referring to PhD students who believe they have substantially better research-oriented skills than management-oriented skills; (4) capable as both (17.7% of the sample), referring to PhD students who feel they have equally good research- and managerial-oriented skills and (5) neither manager nor researcher (21.7% of the sample), referring to PhD students who do not feel confident of their abilities in either skill set. The latter group is used in the analyses as the baseline.

Table 3 Results of the TwoStep Clustering process based on results of the factor analysis

	Management Skills	Researcher Skills	Number (%)
Solo researcher	−1.63	1.50	87 (6.8%)
Solo manager	0.79	−0.75	297 (23.1%)
More researcher than manager	−0.24	0.48	393 (30.6%)
Capable as both	1.07	0.76	227 (17.7%)
Neither manager nor researcher	−0.86	−0.96	279 (21.7%)

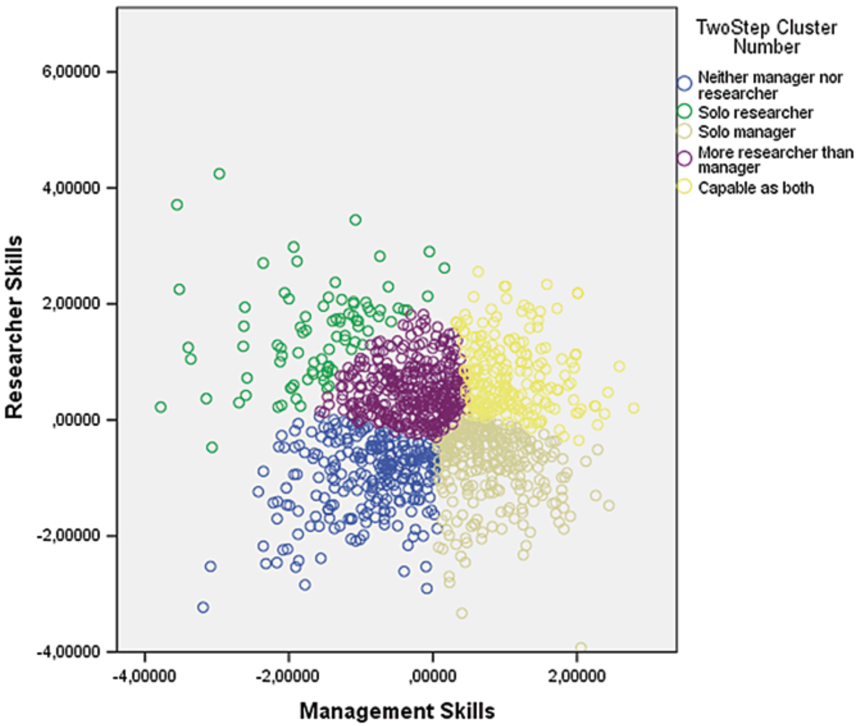

Fig. 1 Visualisation of the results of the TwoStep Clustering process based on the results of the factor analysis

Control Variables

The control variables are organised according to the three explanatory dimensions of the theory of planned behaviour: attitudes, subjective norm and perceived control. The descriptive statistics, however, start with individual characteristics: 48% of the students were female, the mean age was 30 years old, 36% were international students, 34% did a bachelor's degree abroad, 67% had obtained both a bachelor's and a master's degree (vs. only a bachelor's degree) and the parents of 14% were academics.

The attitude dimension includes the perception of skill sets, in terms of both aggregate and specialised skills, and these have been described already. However, variables related to attitude also relate to motivations to start a PhD and perceived activities of importance for a career after the conclusion of the PhD. The set of variables related to motivations to start a PhD show that becoming an academic was the strongest reason (5.16 on a 7-point Likert scale), followed by benefitting others through PhD research (4.78), desire for a higher salary (4.48) and, finally, as a minor motivation, a lack of employment prospects (2.62). Among the set of control variables associated with activities of importance for a career after the conclusion of the PhD (all of them 7-point Likert scales), publishing in international journals was considered by far the most important (5.99), followed by quality of the dissertation (5.30), publishing in national journals (4.34) and engaging in non-R&D-related activities (4.10). Students placed only moderate stress on employability after the conclusion of the PhD (4.46), as they generally planned to do a postdoc (4.33).

The subjective norm dimension refers to the characteristics and role of the supervisor, which may influence students' career intentions. In terms of supervisor characteristics, it was reported that 62% were national citizens and 79% had obtained a doctorate from a foreign university. Of the supervisors who were national citizens, 79% had a PhD from a foreign university, a figure that aligns with the findings of Yonezawa, Horta, and Osawa (2016) concerning the training of academics in East and Southeast Asia. The students reported a better professional than personal relationship with their supervisor (5.21 vs. 4.52), but still with values above the median on the Likert scale (i.e., 4). The students felt that, on average, their supervisors provided career advice (4.30).

For the final dimension of the theory of planned behaviour, perceived control, the set of control variables relates to the conditions and constraints posed by the doctoral programme. Students reported that on average the programme emphasised international publications (4.89) and allowed them to express their interests (4.68), and that the programmes were moderately conducive to free discussion with academics (4.13). The students felt to a substantially lesser extent that academics were more concerned with furthering their own careers than showing concern for students (3.64), and that the programme encouraged students to compete for resources (3.51). As a whole, these results show that the experience of students at the three universities was mostly positive. Among the students, 65% were in STEM fields (of these, 48% were female) and 22% were in professional doctorate programmes; 21% were first-year students, 27% were second-year students, 21% were third-year students, another 21% were fourth-year students and 10% were in their fifth year or above. Finally, 39% of the students in the sample were doing their PhD at SNU, 37% at HKU and 24% at NUS.

Procedure

Ordinary-least-squares (OLS) regression analysis tested the extent to which skills influence the intentions of PhD students to pursue careers outside academia in relation to a career in academia. The OLS regressions use robust standard errors to account for heteroskedasticity (Cribari-Neto & Lima, 2014). Potential multicollinearity concerns can be dismissed because the average variance inflation factor (VIF) score was 1.59 and only two variables were above 2.5 (NUS with 3.26 and HKU with 3.24), but below the usual cut-offs of 5 and 10 (see Kock & Lynn, 2012) used to indicate the presence of multicollinearity.

Results

Table 4 shows that students with self-perceived skill sets in the 'solo researcher' and 'capable in both' clusters did not show different preferences when considering working in careers in or out of academia after concluding the PhD in relation to the baseline cluster (i.e., 'neither manager nor researcher'). Students with self-perceived skill sets in the clusters 'solo manager' and 'more researcher than manager' felt more driven to opt for a career outside academia than the baseline group. Both clusters preferred to work in the government (in a research-related or non-research-related position) than in academia, although students belonging to the 'solo manager' cluster had a stronger leaning towards a career in government than in academia than students in the 'more researcher than manager' cluster. The students in the cluster 'solo manager' were the only ones who showed a greater leaning towards a career in business than in academia, but only if this career involved engagement in research. This finding indicates overall that the self-perceived level of skills acquired during the PhD is associated with career preferences after the PhD, but it is not a given. That is, only a few self-perceived skill sets lead students to consider careers outside academia straight after graduation, meaning that specialised skill sets are relevant, but probably less relevant than policy-makers and managers engaged in 'skill-push' reforms assume. If some specialised skill sets lead students to consider careers outside academia, the same is not found for a strong self-perception of a broad set of skills. Table 5 shows that a strong self-perception of a broad set of skills is not a predictor of career choice. These two results together contradict the emphasis on skills as a critical dimension leading PhD students to seek career options outside academia, and suggest that the 'skill-push' effort is questionable, notwithstanding that some specialised skill sets play a role in making students more open to a career outside academia. One clear conclusion from these findings is that training PhD students in as broad a set of skills as possible is not only impractical during doctoral studies (as argued by Platow, 2012) but may not be impactful in terms of leading students to focus on careers outside academia.

Table 4 Skill clusters and preferences for careers outside versus inside academia

Variables	Business vs. academia	Business (R&D) vs. academia	Government vs. academia	Government (R&D) vs. academia	Self-employed vs. academia
Solo researcher	0.190 (0.317)	0.156 (0.313)	0.178 (0.286)	0.332 (0.276)	−0.149 (0.257)
Solo manager	0.340 (0.211)	0.374** (0.186)	0.461** (0.182)	0.364** (0.173)	0.083 (0.188)
More researcher than manager	0.214 (0.208)	0.266 (0.181)	0.339* (0.180)	0.314* (0.169)	−0.006 (0.175)
Capable as both	−0.049 (0.249)	0.356 (0.222)	0.307 (0.207)	0.206 (0.196)	−0.053 (0.222)
Female	−0.026 (0.152)	−0.204 (0.134)	0.130 (0.127)	−0.027 (0.122)	0.028 (0.127)
Age	−0.012 (0.023)	0.004 (0.022)	0.024 (0.021)	−0.009 (0.019)	0.020 (0.020)
Motivation to start PhD: Higher salary	0.084* (0.050)	0.102** (0.048)	0.0613 (0.045)	0.082* (0.043)	−0.006 (0.049)
Motivation to start PhD: Benefit others	0.008 (0.056)	0.033 (0.051)	−0.009 (0.047)	−0.002 (0.045)	0.077 (0.047)
Motivation to start PhD: Become an academic	−0.384*** (0.062)	−0.331*** (0.056)	−0.178*** (0.051)	−0.175*** (0.048)	−0.357*** (0.053)
Motivation to start PhD: Lacking employment prospects	0.031 (0.051)	−0.024 (0.045)	0.052 (0.042)	0.001 (0.039)	−0.015 (0.044)
Did bachelor's or master's abroad	0.088 (0.227)	−0.209 (0.184)	−0.209 (0.178)	−0.070 (0.167)	0.230 (0.195)
Bachelor's + master's degree	−0.389** (0.185)	−0.401** (0.160)	−0.267* (0.146)	−0.206 (0.137)	−0.068 (0.148)
International student	−0.205 (0.230)	−0.277 (0.195)	−0.818*** (0.186)	−0.368** (0.168)	0.176 (0.206)
PhD year 2	0.155 (0.208)	0.264 (0.191)	0.252 (0.181)	0.154 (0.170)	0.072 (0.178)

(*continued*)

Table 4 (continued)

Variables	Business vs. academia	Business (R&D) vs. academia	Government vs. academia	Government (R&D) vs. academia	Self-employed vs. academia
PhD year 3	−0.205 (0.236)	−0.219 (0.220)	−0.045 (0.199)	−0.206 (0.194)	−0.010 (0.197)
PhD year 4	−0.183 (0.237)	−0.109 (0.222)	−0.214 (0.195)	−0.331* (0.191)	0.109 (0.207)
PhD year 5 or above	−0.062 (0.301)	−0.213 (0.270)	−0.389 (0.246)	−0.168 (0.255)	−0.263 (0.237)
Professional doctorate	−0.076 (0.188)	−0.166 (0.159)	−0.255* (0.148)	−0.053 (0.143)	−0.054 (0.164)
Supervisor: Professional relation	0.091 (0.079)	0.035 (0.070)	0.040 (0.070)	0.069 (0.062)	0.019 (0.073)
Supervisor: Personal relation	−0.201*** (0.061)	−0.186*** (0.056)	−0.159*** (0.054)	−0.110** (0.051)	−0.102** (0.052)
Supervisor: Gives career advice	0.021 (0.054)	0.035 (0.049)	0.039 (0.045)	0.017 (0.042)	0.003 (0.047)
Supervisor: National	−0.189 (0.198)	−0.036 (0.176)	0.084 (0.165)	−0.230 (0.156)	0.029 (0.190)
Supervisor: PhD abroad	−0.108 (0.176)	0.109 (0.160)	−0.046 (0.150)	0.064 (0.147)	−0.067 (0.149)
PhD programme: Focus on international publications	0.071 (0.055)	−0.030 (0.051)	0.059 (0.046)	0.015 (0.045)	−0.015 (0.046)
PhD programme: Students free to register in any class	−0.020 (0.054)	0.023 (0.050)	0.034 (0.048)	0.003 (0.044)	−0.034 (0.047)
PhD programme: Open discussion with academics	0.127** (0.0641)	0.114** (0.0567)	0.004 (0.054)	−0.005 (0.048)	0.143*** (0.053)

(*continued*)

Table 4 (continued)

Variables	Business vs. academia	Business (R&D) vs. academia	Government vs. academia	Government (R&D) vs. academia	Self-employed vs. academia
PhD programme: Students compete for resources	0.049 (0.050)	0.027 (0.043)	0.068 (0.043)	−0.059 (0.037)	0.004 (0.042)
PhD programme: Academics more concerned about their careers	−0.035 (0.049)	0.014 (0.045)	0.014 (0.043)	0.023 (0.041)	0.109** (0.045)
Career importance: National publications	−0.074 (0.050)	−0.091** (0.043)	−0.036 (0.041)	−0.033 (0.038)	−0.084** (0.041)
Career importance: International publications	−0.124 (0.077)	0.016 (0.069)	−0.092 (0.063)	0.043 (0.060)	−0.107 (0.068)
Career importance: Quality of dissertation	0.109* (0.063)	0.064 (0.059)	0.026 (0.057)	0.016 (0.051)	0.080 (0.054)
Career importance: Involvement in non-R&D activities	0.074 (0.050)	−0.049 (0.045)	0.006 (0.042)	−0.082** (0.039)	0.029 (0.043)
Career importance: Concern about employment	−0.016 (0.044)	0.024 (0.040)	0.107*** (0.039)	0.034 (0.036)	−0.068* (0.040)
Considering doing postdoc	−0.169*** (0.048)	−0.080* (0.044)	−0.068 (0.042)	−0.046 (0.041)	−0.115*** (0.043)

(*continued*)

Table 4 (continued)

Variables	Business vs. academia	Business (R&D) vs. academia	Government vs. academia	Government (R&D) vs. academia	Self-employed vs. academia
Parents are academics	−0.160	−0.267*	−0.460***	−0.307**	−0.140
	(0.181)	(0.157)	(0.145)	(0.149)	(0.159)
NUS	−0.406	−0.161	0.071	−0.321	0.219
	(0.322)	(0.286)	(0.262)	(0.239)	(0.296)
HKU	−0.716**	−0.536**	−0.577**	−0.610***	−0.102
	(0.281)	(0.241)	(0.230)	(0.219)	(0.243)
STEM programme	1.819***	1.452***	1.054***	0.982***	1.414***
	(0.183)	(0.169)	(0.161)	(0.158)	(0.167)
Constant	1.099	0.547	−1.016	1.363*	−0.912
	(1.027)	(0.918)	(0.899)	(0.793)	(0.865)
F-statistics	13.41***	10.09***	7.96***	5.27***	9.42***
Root MSE	2.34	2.09	1.98	1.88	2.01
Observations	1071	1077	1077	1077	1078
R-squared	0.29	0.26	0.20	0.16	0.24

Robust standard errors in parentheses; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Other variables give further insights into what is associated with the career choices of PhD students. Variables associated with motivation to start a PhD are particularly relevant. Students who entered a PhD programme to earn higher salaries are more interested in working in the business sector (whether or not it is research-related) and in government (but only in positions involving research). In contrast, the stronger the initial idea of doing a PhD to become an academic, the stronger the desire to pursue a career in academia upon graduation. Other motivations to start a PhD (benefitting others through doctoral research and lack of employment prospects) do not seem to be associated with any career choice. However, the initial motivations to do a PhD assume even greater importance, because in general students in different years think similarly in terms of career choice, which suggests that their initial motivations remain constant throughout their doctoral studies, despite their training, courses and experience.

Although gender[3] and age do not seem to influence students' expected career choices after graduation, students who obtained a master's degree are more driven to work in academia than those who only completed a

Table 5 Self-perceived aggregate skills and preferences for careers outside versus inside academia

Variables	Business vs. academia	Business (R&D) vs. academia	Government vs. academia	Government (R&D) vs. academia	Self-employed vs. academia
Aggregate skills	0.067 (0.105)	0.074 (0.098)	0.071 (0.090)	0.133 (0.086)	−0.015 (0.097)
Female	−0.031 (0.152)	−0.207 (0.134)	0.125 (0.127)	−0.033 (0.122)	0.031 (0.127)
Age	−0.015 (0.023)	0.003 (0.022)	0.022 (0.021)	−0.011 (0.019)	0.019 (0.020)
Motivation to start PhD: Higher salary	0.088* (0.050)	0.107** (0.048)	0.067 (0.045)	0.084* (0.043)	−0.004 (0.048)
Motivation to start PhD: Benefit others	0.001 (0.055)	0.034 (0.051)	−0.009 (0.047)	−0.010 (0.044)	0.077* (0.047)
Motivation to start PhD: Become an academic	−0.388*** (0.062)	−0.331*** (0.056)	−0.179*** (0.051)	−0.177*** (0.048)	−0.358*** (0.053)
Motivation to start PhD: Lacking employment prospects	0.024 (0.051)	−0.024 (0.044)	0.050 (0.042)	−0.004 (0.039)	−0.016 (0.044)
Did bachelor's or master's abroad	0.093 (0.228)	−0.216 (0.184)	−0.215 (0.178)	−0.066 (0.167)	0.228 (0.195)
Bachelor's + master's degree	−0.376** (0.185)	−0.394** (0.160)	−0.254* (0.146)	−0.202 (0.137)	−0.059 (0.149)
International student	−0.218 (0.231)	−0.292 (0.197)	−0.840*** (0.190)	−0.372** (0.169)	0.160 (0.205)
PhD year 2	0.155 (0.207)	0.257 (0.192)	0.246 (0.182)	0.146 (0.170)	0.077 (0.178)
PhD year 3	−0.189 (0.234)	−0.206 (0.218)	−0.021 (0.199)	−0.198 (0.194)	−0.004 (0.197)
PhD year 4	−0.179 (0.236)	−0.099 (0.221)	−0.197 (0.197)	−0.331* (0.192)	0.109 (0.207)
PhD year 5 or above	−0.063 (0.299)	−0.187 (0.267)	−0.358 (0.244)	−0.166 (0.254)	−0.256 (0.235)

(*continued*)

Table 5 (continued)

Variables	Business vs. academia	Business (R&D) vs. academia	Government vs. academia	Government (R&D) vs. academia	Self-employed vs. academia
Professional doctorate	−0.062 (0.189)	−0.163 (0.160)	−0.249* (0.149)	−0.039 (0.144)	−0.058 (0.163)
Supervisor: Professional relation	0.088 (0.081)	0.041 (0.071)	0.047 (0.071)	0.068 (0.062)	0.016 (0.075)
Supervisor: Personal relation	−0.201*** (0.062)	−0.181*** (0.055)	−0.153*** (0.055)	−0.111** (0.050)	−0.097* (0.051)
Supervisor: Gives career advice	0.014 (0.054)	0.035 (0.049)	0.037 (0.045)	0.012 (0.042)	0.001 (0.047)
Supervisor: National	−0.179 (0.198)	−0.033 (0.176)	0.089 (0.166)	−0.224 (0.156)	0.028 (0.189)
Supervisor: PhD abroad	−0.092 (0.176)	0.118 (0.158)	−0.032 (0.151)	0.070 (0.146)	−0.058 (0.149)
PhD programme: Focus on international publications	0.067 (0.056)	−0.025 (0.051)	0.063 (0.046)	0.012 (0.045)	−0.014 (0.046)
PhD programme: Students free to register in any class	−0.021 (0.054)	0.022 (0.050)	0.032 (0.048)	0.001 (0.045)	−0.034 (0.047)
PhD programme: Open discussion with academics	0.124* (0.064)	0.114** (0.057)	0.003 (0.054)	−0.005 (0.048)	0.140*** (0.053)
PhD programme: Students compete for resources	0.048 (0.050)	0.023 (0.043)	0.065 (0.043)	−0.061* (0.037)	0.004 (0.042)

(*continued*)

Table 5 (continued)

Variables	Business vs. academia	Business (R&D) vs. academia	Government vs. academia	Government (R&D) vs. academia	Self-employed vs. academia
PhD programme: Academics more concerned about their careers	−0.037 (0.049)	0.015 (0.046)	0.015 (0.043)	0.022 (0.041)	0.108∗∗ (0.045)
Career importance: National publications	−0.073 (0.050)	−0.088∗∗ (0.042)	−0.032 (0.040)	−0.033 (0.038)	−0.081∗∗ (0.040)
Career importance: International publications	−0.117 (0.077)	0.022 (0.069)	−0.084 (0.063)	0.048 (0.060)	−0.104 (0.067)
Career importance: Quality of dissertation	0.102 (0.063)	0.061 (0.059)	0.020 (0.057)	0.012 (0.051)	0.076 (0.054)
Career importance: Involvement in non-R&D activities	0.067 (0.050)	−0.047 (0.045)	0.007 (0.042)	−0.088∗∗ (0.039)	0.030 (0.043)
Career importance: Concern about employment	−0.010 (0.044)	0.026 (0.040)	0.110∗∗∗ (0.039)	0.040 (0.036)	−0.067∗ (0.040)
Considering doing postdoc	−0.173∗∗∗ (0.049)	−0.079∗ (0.044)	−0.067 (0.042)	−0.050 (0.041)	−0.115∗∗∗ (0.043)
Parents are academics	−0.153 (0.181)	−0.258 (0.157)	−0.449∗∗∗ (0.144)	−0.301∗∗ (0.147)	−0.136 (0.159)
NUS	−0.410 (0.322)	−0.160 (0.286)	0.069 (0.263)	−0.330 (0.239)	0.222 (0.296)
HKU	−0.743∗∗∗ (0.280)	−0.550∗∗ (0.241)	−0.601∗∗∗ (0.229)	−0.638∗∗∗ (0.218)	−0.102 (0.241)

(*continued*)

Table 5 (continued)

Variables	Business vs. academia	Business (R&D) vs. academia	Government vs. academia	Government (R&D) vs. academia	Self-employed vs. academia
STEM programme	1.804***	1.458***	1.061***	0.964***	1.422***
	(0.185)	(0.169)	(0.161)	(0.158)	(0.167)
Constant	1.189	0.328	−1.143	1.195	−0.837
	(1.006)	(0.905)	(0.885)	(0.790)	(0.823)
F-statistics	14.65***	10.82***	8.41***	5.60***	10.20***
MSE root	2.34	2.09	1.98	1.88	2.01
Observations	1071	1077	1077	1077	1078
R-squared	0.29	0.25	0.20	0.16	0.24

Robust standard errors in parentheses; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

bachelor's degree (internationalisation at the bachelor's and master's level does not predict career preference). There are two possible explanations for this finding. By earning a master's degree, students show an intellectual interest in continuing their studies after the bachelor's degree (and several students do a master's degree because they are not satisfied with what they learned in the bachelor's degree). In addition, while doing a master's degree, students usually write a dissertation that requires them to do research, which may lead them to acquire the taste for it (as occurs with bachelor students that get involved in research; see Hunter, Laursen, & Seymour, 2007). International students prefer to work in academia rather than in government, while not showing any preference between working in academia and business or becoming self-employed. This is an expected finding, because international students are aware that to work for the Hong Kong, South Korea or Singapore governments, they need citizenship. Another interesting finding is that students enrolled in professional doctorate programmes do not have different professional aspirations from those in mainstream PhD programmes, and even prefer an academic job rather than working in the government when compared to the latter students. There are two possible explanations for this result: first, universities create professional doctorate programmes but run them basically as traditional PhD programmes (Neumann, 2005; Schildkraut & Stafford, 2015); second, students in these programmes may have been unable to enrol in the traditional programmes and preferred to enrol in a professional doctorate to gain the prestige of obtaining an advanced research degree at a well-recognised university (which provides access to more resources and can lead to better employment; see Headworth & Freese, 2016).

Supervisor characteristics do not seem to influence students' career choices. The same is true for the professional relationship with the supervisor, and for whether the supervisor gives them career advice; however, a better personal relationship with the supervisor makes students keener to pursue careers in academia. Although this finding would be unusual for scholars outside Asia, in the Asian cultural context it is somewhat expected. Students in Asia look to supervisors as role models, not only for their professional ability but as persons, citizens and (most importantly) paternal/maternal figures. Supervisors are expected to motivate students in their work and guide their social and personal lives to the extent that the students become dependent on them (almost like family members), and this behaviour is also expected by students (thus merging the professional with the personal in defining students' aspirations; Sidhu, Kaur, Fook, & Yunus, 2014). In terms of variables associated with the programme, the more confident students are that they can express their views, openly comment and exchange ideas with their professors, the more they lean towards a career in the business sector (doing research or not) and self-employment (self-confidence is a determinant of entering in entrepreneurship activities; see Koellinger, Minniti, & Schade, 2007). Students who feel more disappointed with academia (associated with less supervision experience) also lean towards being self-employed rather than working in academia upon completion of the degree.

Publishing during the PhD seems to have little bearing on career choice, except for publishing in national journals in relation to pursuing careers in business and self-employment. This finding is surprising considering the importance that publications have for a career dedicated to research (Horta & Santos, 2016) and for competing at the entrance stage of the academic labour market; prior research has shown that even early stage researchers have a mix of intrinsic and extrinsic pressures to publish (Waaijer, Teelken, Wouters, & van der Weijden, 2017). The perceived quality of the PhD also seems to have little effect, except for a minor association with leaning towards a non-research-related career in the business sector. The same is true for engagement in non-research-related activities during the PhD, which only leads students to prefer to work in academia rather than in the government as a researcher. Students' increased concern about their career after the conclusion of their PhD seems to lead to retrenchment towards a safe plan B: preferring to work in the government (as a civil servant, which is a safe bet) and increasingly preferring to work in academia rather than engaging in self-employment (a risky bet). The more students consider doing a postdoc, the more they lean towards working in academia, and those with parents working in academia also prefer to work in academia over other professional paths (underlining the importance of paternal/maternal figure role models, as is typical of Confucian societies; Cheng et al., 2014; Jung, 2018).

Finally, doctoral students at the University of Hong Kong have a greater inclination towards careers in academia (except self-employment) than those at Seoul National University. No significant statistical differences were found in terms of career preference after completing the PhD between students at the National University of Singapore and Seoul National University. These findings are explained by the economic structure influencing students' perceptions of careers: Hong Kong's economy relies mostly on high-end services and basically no industry, whereas Singapore and South Korea have strong high-tech industries. Students in STEM fields are also more predisposed to work outside academia than non-STEM students, a finding related to the potential job market outside academia in relation to non-STEM students.

The analysis for PhD students enrolled in STEM fields in terms of skill clusters shows that the 'solo manager' and 'more researcher than manager' clusters tend to lean most towards careers outside academia upon conclusion of the PhD (Table 6). This is true for careers outside academia in government (in research or not) and also in business but only if it involves research. Students in the 'capable in both' cluster prefer a career in business, but one involving research. Students in the 'solo researcher' cluster do not show statistically significant differences in relation to career paths from the 'neither manager nor researcher' cluster. No skill cluster shows a preference for business sector careers not involving research or for self-employment in relation to a career in academia. This suggests that

Table 6 Skill clusters and preferences for careers outside versus inside academia for students in STEM fields

Variables	Business vs. academia	Business (R&D) vs. academia	Government vs. academia	Government (R&D) vs. academia	Self-employed vs. academia
Solo researcher	0.228 (0.478)	0.339 (0.434)	−0.358 (0.386)	0.132 (0.368)	−0.032 (0.378)
Solo manager	0.345 (0.279)	0.485** (0.238)	0.546** (0.223)	0.635*** (0.209)	0.108 (0.235)
More researcher than manager	0.253 (0.274)	0.469** (0.223)	0.360* (0.216)	0.448** (0.209)	0.029 (0.221)
Capable as both	−0.053 (0.323)	0.537* (0.279)	0.276 (0.246)	0.324 (0.238)	−0.003 (0.278)
Female	−0.055 (0.210)	−0.060 (0.172)	0.272* (0.159)	0.028 (0.151)	−0.088 (0.165)
Age	−0.008 (0.036)	−0.012 (0.028)	0.023 (0.023)	−0.003 (0.022)	0.015 (0.028)
Motivation to start PhD: Higher salary	0.126* (0.0743)	0.106* (0.0644)	−0.008 (0.055)	0.001 (0.057)	0.004 (0.069)
Motivation to start PhD: Benefit others	−0.014 (0.075)	0.003 (0.066)	−0.025 (0.056)	−0.021 (0.055)	0.067 (0.062)
Motivation to start PhD: Become an academic	−0.381*** (0.079)	−0.258*** (0.068)	−0.070 (0.059)	−0.107* (0.060)	−0.340*** (0.063)
Motivation to start PhD: Lacking employment prospects	−0.039 (0.071)	−0.059 (0.056)	0.022 (0.050)	−0.026 (0.046)	−0.068 (0.057)
Did bachelor's or master's abroad	0.115 (0.296)	−0.317 (0.221)	−0.295 (0.212)	0.015 (0.186)	0.202 (0.232)
Bachelor's + master's degree	−0.369* (0.212)	−0.479*** (0.172)	−0.282* (0.153)	−0.220 (0.144)	−0.021 (0.166)
International student	−0.425 (0.322)	−0.640*** (0.241)	−1.092*** (0.233)	−0.567*** (0.202)	−0.126 (0.255)
PhD year 2	0.204 (0.286)	0.326 (0.250)	0.207 (0.224)	0.373* (0.206)	0.064 (0.226)

(*continued*)

Table 6 (continued)

Variables	Business vs. academia	Business (R&D) vs. academia	Government vs. academia	Government (R&D) vs. academia	Self-employed vs. academia
PhD year 3	−0.027 (0.311)	−0.046 (0.280)	0.429* (0.237)	−0.008 (0.229)	0.167 (0.246)
PhD year 4	−0.033 (0.335)	0.094 (0.287)	0.022 (0.249)	−0.120 (0.234)	0.182 (0.268)
PhD year 5 or above	0.165 (0.416)	−0.115 (0.355)	−0.233 (0.303)	−0.084 (0.321)	−0.220 (0.299)
Professional doctorate	0.037 (0.235)	−0.301 (0.191)	−0.298* (0.175)	−0.010 (0.165)	−0.105 (0.188)
Supervisor: Professional relation	0.164 (0.108)	0.139 (0.0916)	0.110 (0.0855)	0.106 (0.0802)	−0.013 (0.098)
Supervisor: Personal relation	−0.261*** (0.080)	−0.259*** (0.070)	−0.217*** (0.065)	−0.188*** (0.058)	−0.112* (0.064)
Supervisor: Gives career advice	0.003 (0.075)	0.077 (0.063)	0.088 (0.056)	0.083* (0.050)	0.008 (0.059)
Supervisor: National	−0.065 (0.264)	0.032 (0.220)	0.147 (0.201)	−0.140 (0.183)	0.022 (0.244)
Supervisor: PhD abroad	−0.256 (0.232)	−0.043 (0.203)	−0.268 (0.182)	−0.177 (0.174)	−0.144 (0.194)
PhD programme: Focus on international publications	0.079 (0.084)	−0.036 (0.071)	0.028 (0.058)	−0.040 (0.059)	0.021 (0.062)
PhD programme: Students free to register in any class	−0.033 (0.073)	0.015 (0.065)	0.085 (0.058)	−0.002 (0.054)	−0.064 (0.062)
PhD programme: Open discussion with academics	0.138 (0.085)	0.130* (0.070)	0.039 (0.066)	0.062 (0.058)	0.170** (0.066)

(*continued*)

Table 6 (continued)

Variables	Business vs. academia	Business (R&D) vs. academia	Government vs. academia	Government (R&D) vs. academia	Self-employed vs. academia
PhD programme: Students compete for resources	0.089 (0.070)	−0.002 (0.056)	0.091* (0.052)	−0.041 (0.045)	0.008 (0.054)
PhD programme: Academics more concerned about their careers	−0.078 (0.066)	0.022 (0.057)	0.019 (0.053)	0.050 (0.051)	0.084 (0.056)
Career importance: National publications	−0.032 (0.063)	−0.069 (0.052)	−0.026 (0.049)	−0.024 (0.043)	−0.022 (0.049)
Career importance: International publications	−0.078 (0.098)	0.011 (0.084)	−0.040 (0.073)	0.079 (0.072)	−0.075 (0.086)
Career importance: Quality of dissertation	0.047 (0.078)	0.044 (0.070)	−0.011 (0.067)	−0.024 (0.058)	0.032 (0.065)
Career importance: Involvement in non-R&D activities	0.114* (0.069)	−0.046 (0.058)	0.011 (0.051)	−0.060 (0.049)	0.005 (0.057)
Career importance: Concern about employment	−0.036 (0.061)	0.044 (0.052)	0.098** (0.048)	0.074* (0.044)	−0.070 (0.051)
Considering doing postdoc	−0.171*** (0.066)	−0.149** (0.058)	−0.160*** (0.051)	−0.111** (0.049)	−0.150*** (0.055)

(*continued*)

Table 6 (continued)

Variables	Business vs. academia	Business (R&D) vs. academia	Government vs. academia	Government (R&D) vs. academia	Self-employed vs. academia
Parents are academics	−0.163	−0.358*	−0.588***	−0.324*	−0.164
	(0.235)	(0.198)	(0.169)	(0.176)	(0.201)
NUS	0.067	0.293	0.627**	−0.097	0.646*
	(0.439)	(0.357)	(0.317)	(0.289)	(0.372)
HKU	−0.704*	−0.640**	−0.719***	−0.923***	−0.187
	(0.363)	(0.297)	(0.267)	(0.260)	(0.287)
Constant	2.492*	2.141*	−0.340	2.076**	0.924
	(1.370)	(1.107)	(0.964)	(0.920)	(1.101)
F-statistics	3.55***	3.69***	4.59***	2.77***	2.70***
MSE root	2.49	2.09	1.88	1.79	2.03
Observations	705	705	704	706	706
R-squared	0.16	0.16	0.19	0.13	0.14

Robust standard errors in parentheses; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

doctoral students in STEM fields have much less interest in entrepreneurial routes than expected, despite universities' efforts to push for greater involvement of students and academics in academically rooted entrepreneurship in technology-oriented fields (Walsh, Hargreaves, Hillemann-Delaney, & Li, 2015). The skill clusters' relevance concerning career plans is different for students enrolled in non-STEM fields at the doctoral level (Table 8). For these students, association with one skill cluster or another does not seem to make a difference in terms of a preference for careers outside versus inside academia. The exception is that the 'solo researcher' cluster tends to be more willing than the 'neither manager nor researcher' cluster to opt for a career in the government (not involving research). The differences in terms of skill self-perception and its effects on career preferences between students enrolled in doctoral programmes in STEM and non-STEM fields highlight the complexity of understanding how skill clusters influence students to opt for careers outside academia, because this influence is largely dictated by field characteristics and context. It also suggests that uniformly promoting the 'skill-push' to all PhD students may not only be ineffective but potentially detrimental to students in non-STEM fields, for whom a different perception of their specialised skill set does not seem to influence their career choices (except for the solo researcher). Similar to the main analysis, for students in STEM or non-STEM fields the self-perception of a broad number of basic skills does not predict a leaning towards careers outside academia (see Tables 7 and 9), once again showing that specialised self-perceived skill sets are more relevant than self-perceived ability in a broad set of skills.

The other variables show further interesting findings. Age and gender in general are not predictors of career choice, except that older students in non-STEM fields lean towards working in self-employment and female students in STEM fields prefer government work not involving research.[4] The relevant motivations to start the PhD are the same as in the main analysis: wanting to become an academic and desire for a higher salary. However, the greater the desire to earn a higher salary, the more students in STEM fields desire a career in the business sector (research-related or not), whereas students in non-STEM fields focus on government work (research-related or not). Thus PhD students in STEM and non-STEM fields are well aware of where their knowledge can be best rewarded, disproving the idea that they are unaware of the job market upon graduation (note that the sample is well balanced among students in all years of doctoral studies). Only students in non-STEM fields who started the PhD due to lacking employment prospects seem to find working in business and government (not involved in research in either sectors) more appealing than working in academia. The motivations to start a PhD continue to be key drivers of career choice, and as in the main analysis (Tables 4 and 5), students in different years of study think similarly.

In terms of previous educational path, having a bachelor's and master's degree only seems to drive students in STEM fields to opt for academia, but has no effect on students in non-STEM fields. International students' findings are also generally aligned with the previous results, although students in STEM fields prefer to work in academia rather than in the business sector in research-related professions. Supervisor influence seems to be basically insignificant for non-STEM students' choice of careers, but the better the personal relationship between supervisee and supervisor in STEM fields the greater the students' desire to work in academia (super-

Table 7 Self-perceived aggregate skills and preferences for careers outside versus inside academia for students in STEM fields

Variables	Business vs. academia	Business (R&D) vs. academia	Government vs. academia	Government (R&D) vs. academia	Self-employed vs. academia
Aggregate skills	0.131 (0.151)	0.193 (0.132)	0.080 (0.114)	0.145 (0.110)	0.046 (0.129)
Female	−0.064 (0.208)	−0.068 (0.170)	0.278* (0.156)	0.018 (0.150)	−0.084 (0.164)
Age	−0.011 (0.035)	−0.013 (0.028)	0.016 (0.023)	−0.008 (0.022)	0.014 (0.027)
Motivation to start PhD: Higher salary	0.131* (0.073)	0.108* (0.064)	0.001 (0.056)	0.008 (0.057)	0.006 (0.068)
Motivation to start PhD: Benefit others	−0.025 (0.074)	0.001 (0.065)	−0.021 (0.057)	−0.022 (0.055)	0.064 (0.061)
Motivation to start PhD: Become an academic	−0.388*** (0.079)	−0.260*** (0.068)	−0.0757 (0.059)	−0.113* (0.060)	−0.342*** (0.063)
Motivation to start PhD: Lacking employment prospects	−0.047 (0.071)	−0.058 (0.056)	0.023 (0.051)	−0.028 (0.046)	−0.070 (0.057)
Did bachelor's or master's abroad	0.116 (0.297)	−0.322 (0.221)	−0.310 (0.213)	0.003 (0.185)	0.201 (0.232)
Bachelor's + master's degree	−0.361* (0.213)	−0.472*** (0.173)	−0.252 (0.153)	−0.199 (0.144)	−0.018 (0.167)
International student	−0.439 (0.322)	−0.663*** (0.244)	−1.161*** (0.243)	−0.612*** (0.206)	−0.134 (0.257)
PhD year 2	0.181 (0.285)	0.295 (0.250)	0.175 (0.225)	0.339 (0.207)	0.059 (0.224)
PhD year 3	−0.025 (0.310)	−0.045 (0.278)	0.431* (0.236)	−0.002 (0.231)	0.165 (0.246)
PhD year 4	−0.046 (0.333)	0.094 (0.287)	0.023 (0.250)	−0.122 (0.236)	0.172 (0.268)
PhD year 5 or above	0.157 (0.413)	−0.100 (0.351)	−0.201 (0.298)	−0.065 (0.318)	−0.225 (0.298)

(*continued*)

Table 7 (continued)

Variables	Business vs. academia	Business (R&D) vs. academia	Government vs. academia	Government (R&D) vs. academia	Self-employed vs. academia
Professional doctorate	0.052 (0.236)	−0.289 (0.192)	−0.310* (0.175)	−0.003 (0.168)	−0.106 (0.186)
Supervisor: Professional relation	0.151 (0.110)	0.138 (0.092)	0.100 (0.088)	0.099 (0.080)	−0.020 (0.101)
Supervisor: Personal relation	−0.266*** (0.080)	−0.256*** (0.069)	−0.198*** (0.065)	−0.180*** (0.057)	−0.110* (0.064)
Supervisor: Gives career advice	−0.005 (0.075)	0.074 (0.063)	0.078 (0.056)	0.074 (0.050)	0.005 (0.058)
Supervisor: National	−0.057 (0.264)	0.031 (0.219)	0.147 (0.202)	−0.136 (0.182)	0.025 (0.243)
Supervisor: PhD abroad	−0.232 (0.229)	−0.039 (0.200)	−0.246 (0.181)	−0.149 (0.173)	−0.139 (0.193)
PhD programme: Focus on international publications	0.072 (0.085)	−0.035 (0.072)	0.029 (0.059)	−0.040 (0.060)	0.019 (0.062)
PhD programme: Students free to register in any class	−0.037 (0.074)	0.010 (0.065)	0.078 (0.059)	−0.008 (0.054)	−0.065 (0.062)
PhD programme: Open discussion with academics	0.136 (0.085)	0.132* (0.069)	0.032 (0.066)	0.060 (0.058)	0.167** (0.066)
PhD programme: Students compete for resources	0.084 (0.069)	−0.008 (0.056)	0.086 (0.053)	−0.048 (0.045)	0.006 (0.053)

(continued)

Table 7 (continued)

Variables	Business vs. academia	Business (R&D) vs. academia	Government vs. academia	Government (R&D) vs. academia	Self-employed vs. academia
PhD programme: Academics more concerned about their careers	−0.091 (0.066)	0.018 (0.057)	0.011 (0.054)	0.040 (0.051)	0.080 (0.057)
Career importance: National publications	−0.033 (0.063)	−0.070 (0.051)	−0.024 (0.049)	−0.022 (0.043)	−0.022 (0.048)
Career importance: International publications	−0.076 (0.098)	0.019 (0.084)	−0.026 (0.073)	0.090 (0.072)	−0.074 (0.085)
Career importance: Quality of dissertation	0.042 (0.078)	0.045 (0.070)	−0.016 (0.067)	−0.029 (0.058)	0.029 (0.064)
Career importance: Involvement in non-R&D activities	0.097 (0.069)	−0.051 (0.058)	0.008 (0.052)	−0.068 (0.049)	0.001 (0.057)
Career importance: Concern about employment	−0.027 (0.060)	0.049 (0.051)	0.104** (0.048)	0.083* (0.043)	−0.065 (0.050)
Considering doing postdoc	−0.175*** (0.066)	−0.150*** (0.058)	−0.160*** (0.052)	−0.112** (0.049)	−0.151*** (0.055)
Parents are academics	−0.156 (0.234)	−0.345* (0.196)	−0.545*** (0.169)	−0.295* (0.173)	−0.158 (0.200)
NUS	0.070 (0.439)	0.298 (0.358)	0.637** (0.322)	−0.087 (0.292)	0.649* (0.372)
HKU	−0.737** (0.364)	−0.675** (0.297)	−0.749*** (0.267)	−0.963*** (0.260)	−0.193 (0.286)

(*continued*)

Table 7 (continued)

Variables	Business vs. academia	Business (R&D) vs. academia	Government vs. academia	Government (R&D) vs. academia	Self-employed vs. academia
Constant	2.514*	1.708	−0.270	1.965**	0.910
	(1.336)	(1.082)	(0.918)	(0.909)	(1.043)
F-statistics	3.79***	3.86***	4.91***	2.84***	2.97***
MSE root	2.49	2.09	1.89	1.80	2.02
Observations	705	705	704	706	706
R-squared	0.15	0.16	0.18	0.11	0.14

Robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

visors who provide more advice also lead students to consider a government career in research). The greater influence of supervisors on STEM students' career choice (in comparison to that of the non-STEM fields) may be because in STEM fields they tend to work together in a laboratory (which suggests greater interaction; see Lechuga, 2011). Supervisor characteristics, as in the main analysis, are not influential on students' career choices in STEM and non-STEM fields (except for supervisors who did their PhD abroad, who influence students in non-STEM fields towards working in the government in research rather than academia).

PhD programme characteristics also have relatively low influence on students' choice of careers. This is especially the case for students in non-STEM fields, but for both STEM and non-STEM students their ability to express opinions and engage in open discussion with professors seems most influential.[5] In terms of what the students believe matters for their professional path, publishing is not relevant for the career choice of students in STEM fields, but a focus on publishing in national publications is an important determinant leading students in non-STEM fields to opt for careers in academia over careers in business (whether or not research-related) and self-employment. Students who emphasise the quality of the dissertation feel more oriented towards careers in business in positions not involving research (for students in both STEM and non-STEM fields) and self-employment (for students in non-STEM fields). Concern over employability (which mainly refers to employability in academia) does not seem to influence the career choices of non-STEM students but

Table 8 Skill clusters and preferences for careers outside versus inside academia for students in non-STEM fields

Variables	Business vs. academia	Business (R&D) vs. academia	Government vs. academia	Government (R&D) vs. academia	Self-employed vs. academia
Solo researcher	0.044 (0.439)	−0.022 (0.486)	0.837** (0.409)	0.472 (0.428)	−0.404 (0.386)
Solo manager	0.418 (0.321)	0.280 (0.308)	0.418 (0.307)	0.030 (0.309)	0.062 (0.321)
More researcher than manager	0.294 (0.316)	0.082 (0.329)	0.500 (0.330)	0.113 (0.316)	−0.001 (0.319)
Capable as both	0.109 (0.382)	0.262 (0.369)	0.546 (0.388)	0.048 (0.367)	0.027 (0.387)
Female	−0.015 (0.228)	−0.317 (0.238)	−0.134 (0.223)	−0.114 (0.218)	0.265 (0.222)
Age	0.001 (0.031)	0.034 (0.034)	0.041 (0.037)	−0.016 (0.033)	0.053* (0.031)
Motivation to start PhD: Higher salary	0.019 (0.070)	0.105 (0.070)	0.160** (0.071)	0.184*** (0.070)	−0.006 (0.070)
Motivation to start PhD: Benefit others	0.038 (0.084)	0.026 (0.084)	−0.043 (0.080)	0.008 (0.074)	0.081 (0.073)
Motivation to start PhD: Become an academic	−0.365*** (0.099)	−0.398*** (0.100)	−0.306*** (0.090)	−0.301*** (0.080)	−0.383*** (0.096)
Motivation to start PhD: Lacking employment prospects	0.145** (0.073)	0.023 (0.075)	0.125* (0.071)	0.025 (0.073)	0.059 (0.072)
Did bachelor's or master's abroad	0.251 (0.359)	−0.014 (0.351)	−0.287 (0.342)	−0.321 (0.358)	0.429 (0.390)
Bachelor's + master's degree	−0.712 (0.473)	−0.379 (0.530)	−0.647 (0.418)	−0.396 (0.426)	−0.520 (0.422)
International student	0.045 (0.340)	0.074 (0.316)	−0.757*** (0.290)	−0.163 (0.289)	0.473 (0.336)
PhD year 2	0.062 (0.310)	0.268 (0.316)	0.465 (0.308)	0.019 (0.302)	0.206 (0.325)

(*continued*)

Table 8 (continued)

Variables	Business vs. academia	Business (R&D) vs. academia	Government vs. academia	Government (R&D) vs. academia	Self-employed vs. academia
PhD year 3	−0.388 (0.365)	−0.155 (0.371)	−0.671* (0.386)	−0.201 (0.365)	−0.199 (0.366)
PhD year 4	−0.446 (0.349)	−0.270 (0.375)	−0.432 (0.330)	−0.593* (0.320)	0.021 (0.362)
PhD year 5 or above	−0.396 (0.426)	−0.343 (0.432)	−0.449 (0.407)	−0.165 (0.415)	−0.437 (0.425)
Professional doctorate	−0.308 (0.292)	0.225 (0.283)	−0.095 (0.284)	−0.080 (0.279)	0.009 (0.337)
Supervisor: Professional relation	−0.041 (0.110)	−0.144 (0.108)	−0.051 (0.113)	0.001 (0.103)	0.082 (0.110)
Supervisor: Personal relation	−0.100 (0.096)	−0.041 (0.092)	−0.110 (0.091)	0.008 (0.098)	−0.104 (0.095)
Supervisor: Gives career advice	0.0475 (0.080)	−0.026 (0.081)	−0.022 (0.077)	−0.075 (0.079)	−0.007 (0.086)
Supervisor: National	−0.068 (0.325)	0.029 (0.324)	0.183 (0.295)	−0.164 (0.311)	0.279 (0.338)
Supervisor: PhD abroad	0.178 (0.281)	0.367 (0.269)	0.385 (0.260)	0.501* (0.270)	0.0935 (0.258)
PhD programme: Focus on international publications	0.054 (0.073)	−0.046 (0.076)	0.069 (0.076)	0.049 (0.073)	−0.091 (0.072)
PhD programme: Students free to register in any class	0.031 (0.082)	0.071 (0.083)	−0.018 (0.085)	0.051 (0.081)	0.014 (0.072)
PhD programme: Open discussion with academics	0.099 (0.094)	0.007 (0.099)	−0.109 (0.095)	−0.180** (0.087)	0.089 (0.089)

(*continued*)

Table 8 (continued)

Variables	Business vs. academia	Business (R&D) vs. academia	Government vs. academia	Government (R&D) vs. academia	Self-employed vs. academia
PhD programme: Students compete for resources	0.014 (0.078)	0.103 (0.073)	0.086 (0.076)	−0.034 (0.068)	0.062 (0.075)
PhD programme: Academics more concerned about their careers	0.044 (0.073)	−0.006 (0.078)	0.011 (0.079)	−0.013 (0.075)	0.162** (0.076)
Career importance: National publications	−0.224** (0.089)	−0.177** (0.086)	−0.114 (0.076)	−0.032 (0.085)	−0.251*** (0.092)
Career importance: International publications	−0.192 (0.133)	0.001 (0.122)	−0.151 (0.109)	−0.020 (0.109)	−0.175 (0.120)
Career importance: Quality of dissertation	0.223** (0.105)	0.165 (0.104)	0.102 (0.100)	0.106 (0.102)	0.241** (0.106)
Career importance: Involvement in non-R&D activities	−0.006 (0.078)	−0.052 (0.079)	0.044 (0.071)	−0.087 (0.073)	0.047 (0.072)
Career importance: Concern about employment	0.011 (0.069)	−0.018 (0.068)	0.082 (0.070)	−0.062 (0.068)	−0.065 (0.068)
Considering doing postdoc	−0.145** (0.074)	0.050 (0.073)	0.071 (0.073)	0.044 (0.077)	−0.031 (0.078)

(*continued*)

Table 8 (continued)

Variables	Business vs. academia	Business (R&D) vs. academia	Government vs. academia	Government (R&D) vs. academia	Self-employed vs. academia
Parents are academics	0.078	0.119	−0.139	−0.071	0.251
	(0.299)	(0.287)	(0.291)	(0.293)	(0.292)
NUS	−1.243**	−0.738	−0.798*	−0.613	−0.266
	(0.521)	(0.517)	(0.448)	(0.438)	(0.537)
HKU	−0.488	−0.082	−0.003	0.107	0.348
	(0.483)	(0.467)	(0.457)	(0.447)	(0.512)
Constant	1.024	−0.248	−0.477	2.255	−2.662*
	(1.563)	(1.643)	(1.708)	(1.505)	(1.502)
F-statistics	2.38***	1.69***	3.44***	1.61***	2.82***
MSE root	2.07	2.12	2.05	1.99	2.02
Observations	374	380	381	379	380
R-squared	0.20	0.14	0.21	0.13	0.20

Robust standard errors in parentheses; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

influences students in STEM fields to consider careers in government (in both research and non-research positions) over a career in academia.

The different variables affecting career choice for students in STEM and non-STEM fields extend to the intention to do a postdoc after graduating. Intending to pursue a postdoc does not seem to influence the career choices of students in non-STEM fields but is a strong predictor of students in STEM fields opting for a career in academia over other career alternatives. Having academic parents also does not seem to influence the career choice of students in non-STEM fields, but does so for students in STEM fields, leading them to prefer careers in academia rather than the government (in research and non-research positions) and business (in research positions). Between the universities, there are almost no significant differences in terms of career choice among students in non-STEM fields (except that students at the National University of Singapore are keener to follow a career path in academia than in business and government—both in non-research positions—than students at Seoul National University). In STEM fields, students at the University of Hong Kong strongly prefer working in academia over government and business compared to those at Seoul National University, whereas those at the National

Table 9 Self-perceived aggregate skills and preferences for careers outside academia versus career in academia for students in non-STEM fields

Variables	Business vs. academia	Business (R&D) vs. academia	Government vs. academia	Government (R&D) vs. academia	Self-employed vs. academia
Aggregate skills	0.079 (0.137)	0.038 (0.143)	0.244 (0.151)	0.197 (0.149)	−0.013 (0.153)
Female	0.006 (0.227)	−0.314 (0.236)	−0.144 (0.224)	−0.128 (0.217)	0.278 (0.221)
Age	−0.003 (0.030)	0.033 (0.034)	0.041 (0.037)	−0.015 (0.033)	0.052* (0.031)
Motivation to start PhD: Higher salary	0.021 (0.071)	0.110 (0.071)	0.160** (0.071)	0.178** (0.070)	−0.005 (0.070)
Motivation to start PhD: Benefit others	0.030 (0.084)	0.028 (0.084)	−0.054 (0.080)	−0.007 (0.072)	0.084 (0.074)
Motivation to start PhD: Become an academic	−0.372*** (0.099)	−0.398*** (0.099)	−0.308*** (0.089)	−0.303*** (0.080)	−0.383*** (0.095)
Motivation to start PhD: Lacking employment prospects	0.140* (0.072)	0.026 (0.074)	0.114* (0.069)	0.021 (0.071)	0.064 (0.071)
Did bachelor's or master's abroad	0.254 (0.362)	−0.018 (0.353)	−0.285 (0.336)	−0.314 (0.350)	0.426 (0.392)
Bachelor's + master's degree	−0.681 (0.468)	−0.360 (0.523)	−0.696* (0.422)	−0.423 (0.422)	−0.490 (0.412)
International student	0.028 (0.342)	0.060 (0.318)	−0.710** (0.286)	−0.129 (0.280)	0.441 (0.333)
PhD year 2	0.107 (0.307)	0.282 (0.314)	0.429 (0.302)	−0.023 (0.301)	0.237 (0.323)
PhD year 3	−0.357 (0.362)	−0.153 (0.365)	−0.688* (0.385)	−0.272 (0.375)	−0.189 (0.363)
PhD year 4	−0.433 (0.346)	−0.259 (0.371)	−0.451 (0.332)	−0.652** (0.322)	0.030 (0.363)
PhD year 5 or above	−0.375 (0.423)	−0.306 (0.426)	−0.478 (0.406)	−0.243 (0.411)	−0.395 (0.419)

(*continued*)

Table 9 (continued)

Variables	Business vs. academia	Business (R&D) vs. academia	Government vs. academia	Government (R&D) vs. academia	Self-employed vs. academia
Professional doctorate	−0.306 (0.293)	0.233 (0.281)	−0.084 (0.286)	−0.074 (0.279)	−0.003 (0.335)
Supervisor: Professional relation	−0.041 (0.110)	−0.139 (0.107)	−0.041 (0.113)	−0.011 (0.100)	0.076 (0.110)
Supervisor: Personal relation	−0.087 (0.095)	−0.036 (0.091)	−0.114 (0.093)	−0.001 (0.098)	−0.095 (0.093)
Supervisor: Gives career advice	0.042 (0.080)	−0.019 (0.081)	−0.030 (0.078)	−0.090 (0.077)	−0.005 (0.085)
Supervisor: National	−0.060 (0.322)	0.018 (0.326)	0.241 (0.298)	−0.141 (0.309)	0.242 (0.329)
Supervisor: PhD abroad	0.189 (0.277)	0.389 (0.264)	0.370 (0.257)	0.482* (0.266)	0.109 (0.255)
PhD programme: Focus on international publications	0.053 (0.073)	−0.041 (0.076)	0.057 (0.076)	0.031 (0.072)	−0.084 (0.073)
PhD programme: Students free to register in any class	0.034 (0.083)	0.074 (0.083)	−0.025 (0.084)	0.043 (0.079)	0.018 (0.073)
PhD programme: Open discussion with academics	0.092 (0.094)	0.003 (0.099)	−0.108 (0.097)	−0.185** (0.086)	0.084 (0.089)
PhD programme: Students compete for resources	0.019 (0.077)	0.100 (0.072)	0.080 (0.077)	−0.035 (0.067)	0.065 (0.075)

(*continued*)

Table 9 (continued)

Variables	Business vs. academia	Business (R&D) vs. academia	Government vs. academia	Government (R&D) vs. academia	Self-employed vs. academia
PhD programme: Academics more concerned about their careers	0.051 (0.073)	−0.006 (0.078)	0.027 (0.079)	0.002 (0.075)	0.157** (0.076)
Career importance: National publications	−0.212** (0.090)	−0.171** (0.087)	−0.117 (0.076)	−0.042 (0.086)	−0.242*** (0.090)
Career importance: International publications	−0.191 (0.135)	−0.001 (0.122)	−0.149 (0.110)	−0.015 (0.110)	−0.177 (0.120)
Career importance: Quality of dissertation	0.205* (0.105)	0.153 (0.105)	0.110 (0.099)	0.112 (0.100)	0.223** (0.103)
Career importance: Involvement in non-R&D activities	−0.001 (0.075)	−0.049 (0.078)	0.031 (0.070)	−0.101 (0.072)	0.057 (0.070)
Career importance: Concern about employment	0.013 (0.069)	−0.019 (0.068)	0.093 (0.070)	−0.051 (0.069)	−0.068 (0.069)
Considering doing postdoc	−0.149** (0.074)	0.053 (0.073)	0.063 (0.074)	0.031 (0.076)	−0.027 (0.079)
Parents are academics	0.0956 (0.297)	0.103 (0.279)	−0.110 (0.278)	−0.060 (0.277)	0.243 (0.282)
NUS	−1.202** (0.517)	−0.733 (0.514)	−0.817* (0.449)	−0.647 (0.432)	−0.244 (0.531)
HKU	−0.476 (0.483)	−0.100 (0.470)	0.018 (0.458)	0.131 (0.442)	0.348 (0.513)

(*continued*)

Table 9 (continued)

Variables	Business vs. academia	Business (R&D) vs. academia	Government vs. academia	Government (R&D) vs. academia	Self-employed vs. academia
Constant	0.937	−0.401	−0.999	1.895	−2.663*
	(1.516)	(1.648)	(1.732)	(1.494)	(1.483)
F-statistics	2.57***	1.81***	3.55***	1.82***	2.95***
MSE root	2.06	2.11	2.05	1.99	2.01
Observations	374	380	381	379	380
R-squared	0.19	0.14	0.20	0.13	0.20

Robust standard errors in parentheses; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

University of Singapore prefer to work in government (not in research) or be self-employed rather than work in academia, relative to students at Seoul National University.

Conclusion

This study advances the literature by making several contributions regarding the association between the skills learned by doctoral students and their plans for careers in or out of academia. First, the assumption that a broader skill set ensures that PhD students are open to a broader set of employment choices (including those outside academia) has been shown to be doubtful. The findings show no statistically significant association between the self-perception of having a broad set of skills and different career choices. Second, evidence that a specialised set of skills will drive PhD students to a sector of activity where these skills are perceived as valued (as suggested in Roach & Sauermann, 2010) is somewhat mixed and arguable. Although some specialisation of perceived skill sets seems to influence students to consider careers outside academia (the 'solo manager' skill set in particular), other skill sets do not seem to be influential at all. These results underline the need to be careful when considering the relevance of skills in doctoral education and their ability to influence PhD students to consider career venues outside the traditional academic job market. Most importantly, the differing relevance of specialised sets of skills for students in STEM and non-STEM fields should alert graduate schools and PhD programme directors and managers not to adopt a one-size-fits-all plan for students in different fields. The findings show that even the specialised skill sets of students in non-STEM fields have little influence on their career choices. Promoting such skills forcefully to these students may not only be a waste of resources for everyone involved (students, teachers and universities) but also be detrimental to the quality of these students' research, as they must divert time and energy to skill-enhancing courses that may not have the intended results (i.e., leading students to be more receptive towards jobs outside the higher education sector).

The self-perception of skills, however, is part of the attitude dimension of the theory of planned behaviour, which has been found to define the career behaviours of students. However, other sets of variables within this dimension may have a stronger influence and demand closer scrutiny. The initial motivations to start a PhD, particularly the motivation to become an academic and the desire to earn a higher salary, are strongly associated with expected career paths: the former is strongly associated with a desire to work in academia, and the latter is associated with certain careers in sectors outside higher education. Attention should be given to initial motivations, because the results indirectly suggest that they may remain constant throughout doctoral studies: students in different years of their PhD indicated similar career choices. This suggests that their ideas about where to work do not vary substantially and that their career goal of obtaining a PhD is strongly entrenched from the start. If university managers want to enrol PhD students with the expectation that they will work outside academia (which would be especially relevant for those enrolled in professional doctorates) then it is important to ask about their motivations for entering the programme. The findings show that students enrolled in professional doctorate programmes think similarly to other PhD students concerning their career prospects in or out of academia. The findings concerning professional doctorate programmes suggest that they may differ little from traditional PhD programmes, or that students enter them not because they are particularly interested in doing a professional doctorate, but rather because they want to obtain credentials from a prestigious Asian university.

The importance of engaging in specific activities for career purposes as part of the attitudinal dimension of the theory of planned behaviour also presents interesting findings: publishing matters, but mainly publications in national journals, which reinforces the importance of national journals and associations, and how students perceive their utility for obtaining a job, rather than international publications, which have no statistical significance at all, even for students in STEM fields (being in PhD programmes focusing on international publications also does not have any association with students' career preferences). The quality of the PhD moderately influences career choices, but somewhat surprisingly, engaging in non-research activities (which could be associated with experience that could eventually be rewarded by non-academic employers) does not seem relevant to career choices. This reveals that students are interested from the start in research and intellectual pursuits, rather than forming their career ideas as they experience the socialisation of the PhD programme. Intending to obtain a postdoc is an indicator of students' preference for jobs in academia, but seems particularly relevant for students in STEM fields. These factors underline the need to monitor student preferences to better design courses or seminars to help them achieve their career goals, and alert them to the benefits, difficulties and issues associated with their chosen careers and what these careers entail. A finding of major interest is that growing levels of anxiety about employability do not lead students to opt for entrepreneurial paths (as some policymakers desire), but, rather, students turn to the prospect of a government job as a safe plan 'B' in case the academic job route fails, instead of riskier self-employment.

Aside from the variables in the attitude dimension, the variables in the perceived control dimension of the theory of planned behaviour were also found to be relevant. An environment that stimulates open debate and exchange of ideas between students and professors seems to stimulate students' confidence and broadens their career choices. This finding is interesting, as it means that an effort to change the mentalities of students and supervisors is required at this education level. In hierarchical Confucian social models, students expect their supervisors to possess most of the knowledge and to convey it unilaterally, and supervisors expect little debate or interaction and instead expect students to follow their directions (among other issues; see Hu, van Veen, & Corda, 2016).

Students' perceptions of academia are also influential, and a negative supervisorial experience (associated with the idea that academics are more concerned with their own careers and themselves than with students) is associated with students considering non-academic careers. However, of all motives for finding a professional future outside academia, this one is probably the least desirable one for universities, policymakers, academics and students. Giving students freedom to register in any course, emphasising publishing in international journals and requiring students to compete for resources may benefit some learning outcomes, but do not seem to influence career choices. The final major dimension of the theory of planned behaviour, subjective norm, as measured through the influence of the supervisor, is also relevant to students' career choices, but mainly the personal relation between student and supervisor, and mostly for students in STEM fields. This is explained by both the specific cultural and the social framework of the supervisor-supervisee relationship in Asia, but also highlights the relevance of proximity and interaction (which is more evident for students in STEM fields).

This study's findings will be of interest to an international audience, and specifically relevant to policymakers, university managers and graduate school or PhD programme directors in the Asian region. Several analytical limitations also need to be taken into account, however. The first is that this study is correlational, and no causality is claimed. The analysis is also based on a cross-sectional data set, and it shows the self-perceptions of students at these universities at one point in time. A longitudinal study would be beneficial for understanding how students' perspectives and ideas remain set or change throughout their doctoral studies. It is also important to extend this study to other universities in Asia and elsewhere to better comprehend the phenomenon assessed here. Finally, as in any survey research, the answers obtained are based on self-reported data. Respondent bias may thus be an issue, especially regarding socially desirable responses (McDonald, 2008), which represent an inherent limitation of this method. There is the possibility that students felt compelled to place an emphasis on the academic route for fear of not being taken seriously by their supervisors (see Nerad, 2015), although this bias is unlikely, because they were directly contacted about participating in the study without their supervisors even knowing about it.

Notes

1. The introduction of some of these skills may be more consensual such as training in communication and teamwork at a time when the projection of future work in academia and elsewhere will increasingly require project work and collaboration. Besides, these are skills that are important for doctoral students if they become academics due to these skills' importance for teaching activities (Moore, 2016; Muukkonen, Lakkala, Toom, & Ilomaki, 2017).
2. An example of this relates to entrepreneurship education where most of the times academics teach at most theories related to entrepreneurship but not the practical side of entrepreneurship. This is so because these academics either do not have an expertise on entrepreneurship or have never started a company themselves, or do not have practical experience on how a business is run, or all of the above (see Anderseck, 2004; Weiming, Chunyan, & Xiaohua, 2016).
3. Additional analyses were run interacting the variable female with the explanatory variable. All the interactions resulted in statistically insignificant associations between these variables. The results of these interactions are not shown in this chapter but can be requested directly from the author.
4. Older students in non-STEM fields leaning towards working in self-employment rather than in academia may be related to the understanding that they will face greater difficulties in entering an academic career and progressing in it, something that is perceived as a growing issue in East Asia (some academic positions in mainland China are stipulating a maximum of thirty-five years old as an application criteria) but also elsewhere (see Granleese & Sayer, 2006; Hansmann & Schroter, 2018). At the same time, older students in non-STEM fields may have previous working experience that can make them sufficiently confident to work as self-employed. Female students in STEM may prefer to work in the government rather than in academia because they may perceive greater barriers to professional development and progression in the latter when compared to the former (Baker, 2016; Szelenyi, Bresonis, & Mars, 2016).
5. Particularly concerning regarding the preferences of students in STEM fields to work in the business sector involving research and self-employment and students in non-STEM fields to work in the government sector involving research.

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Diversifying the Missions and Expectations of Doctoral Education: Are We Losing the Distinctive 'Added Value' of the PhD?

Corina Balaban

> [The ideal PhD fellow] should be … an excellent researcher, an excellent teacher, know how to integrate their research and their teaching together, be able to work across disciplines … and have … a global perspective. That's a lot to ask … [laughs] so it's a utopia. (former NSF officer)

From a desire to boost employability beyond academia, 'future-oriented' doctoral programmes are now aiming to achieve many things at the same time: create great researchers but also great entrepreneurs, create experts able to work across many different disciplines, build the in-depth knowledge of a research degree, and also develop a breadth of generic 'transferable' skills. However, in this chapter, I am arguing that by trying to achieve so much within a very limited time frame, this new kind of

C. Balaban (✉)
Alliance Manchester Business School, The University of Manchester, Manchester, UK
e-mail: corina.balaban@manchester.ac.uk

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PhD risks failing to excel in any of the above; moreover, it risks losing its distinctiveness (i.e. whatever makes it different from other—lower—degrees, or what constitutes the added value that it can bring to society and the labour market). By 'added value' I mean the specialised skills, knowledge, and expertise that only a few years of in-depth study can develop. I argue that this 'added value' is worth keeping because society and the labour market need knowledgeable researchers who have benefitted from spending a considerable amount of time focused on their respective area of expertise. By aiming to achieve so many things at the same time, the creators of these programmes often struggle to clearly articulate their goals without depicting a utopia, as in the quote above. Furthermore, due to unclear objectives and/or ways of achieving them, the programmes are also hard to institutionalise in practice.

The chapter is structured as follows: first, it briefly outlines the background for this study; second, it introduces the Initial Training Network (ITN) and the Integrative Graduate Education Research Traineeship (IGERT)—the two main doctoral programmes that the study focuses on; third, it explains the methodological choices and design; fourth, it discusses the two main features of these programmes—interdisciplinarity and cross-sectoral collaborations—as ways of achieving employability; and finally, it suggests possible ways forward.

Background for the Study

The last decade has witnessed intensified efforts from national governments, as well as powerful transnational organisations such as the World Bank and the Organisation for Economic Co-operation and Development (OECD), to frame higher education—and especially doctoral education—as the key provider of knowledge and human capital for the so-called knowledge economy. On the backdrop of wider transformations sweeping higher education, doctoral education has received special attention. As the key producer of knowledge, research, and human capital for the knowledge economy, it has become the central focus of policy discussions. As a result, the number of PhD positions increased all over the world (Nerad, 2010; Nerad, Trzyna, & Heggelund, 2008) so that more

PhD-educated graduates went into industry and thus made the (national/regional) economy more competitive. However, concerns with ‘employability’ (beyond academia) have led to a much deeper ‘rethinking’ of doctoral education (Borkowski, 2006; Nerad, 2011) to suit a wide range of purposes. It has thus been proposed that the mission of doctoral education today is not just that of forming a community of scholars, but also that of creating intellectual elite able to function well in a highly globalised economy (Boud & Lee, 2009; Nerad et al., 2008). It was thought that employability beyond academia could be achieved by working across disciplines and sectors; so, in other words, by focusing on meta-aspects or skills (such as flexibility and adaptability) rather than developing further content-specific expertise, or, what may be called, ‘specialised’ skills (discipline and sector-specific).

As part of their strategies to compete in the global knowledge economy, nations and transnational organisations have designed doctoral programmes that, in their view, reflect some of these new, twenty-first-century visions. The European Commission (EC) is one such entity that has come up with a doctoral programme called Initial Training Network (ITN), later renamed Innovative Training Network. Similarly, the US government agency called the National Science Foundation (NSF) has designed its own vision of doctoral education, reflected in their flagship programme called Integrative Graduate Education Research Traineeship (IGERT), and to some extent also reflected in its most recent successor, the National Research Traineeship (NRT).

The EU and the US

This study focuses on the above-mentioned PhD programmes: the ITN and the IGERT. They are ‘flagship’ models of doctoral education, which means that, although they are not representative in terms of numbers, they are important because they were set up as examples to be followed more widely, and were offered generous funding from influential (trans) national bodies (the EC and the NSF). For this reason, the chapter does not treat them as ‘alternatives’ to more ‘traditional’ PhD programmes, but as programmes that are meant to ‘lead the way’ in doctoral education and show what ‘future-oriented’ programmes ought to be like. What is special about the ITN and the IGERT is that they both aim to diversify the missions of doctoral education by incorporating broader notions of employability beyond academia.

The Innovative Training Network (ITN)

The ITN was designed as a network of universities and non-academic actors, where institutions across Europe collaborated on an interdisciplinary programme. According to the official website, ‘ITNs bring together universities, research centres and companies from different countries worldwide to train a new generation of researchers’ (EC ITN official website). The ITN labels itself as ‘high quality doctoral-level training in and outside academia’ (EC ITN official website), and its description includes keywords such as ‘excellence’, ‘business innovation’, and ‘entrepreneurship’. What is clear from the website is that the focus on business is undoubtedly at the forefront of the ITN.

Applications to ITNs were open to ‘organisations such as universities, research centres or companies that propose a research training network’ (EC ITN official website). Geographical mobility was one of its core features, as it required fellows to relocate to a different country when taking up their position. This meant that individuals could only apply to become enrolled at an institution in the network, if this was located in a country where they had not lived for more than twelve months in the last three years. Because of its consortium structure, the fellows and supervisors were not all based in one campus but spread across different countries in Europe.

The Integrative Graduate Education Research Traineeship (IGERT)

The IGERT was designed as an interdisciplinary initiative bringing together researchers from different areas on one site to look at thematic issues from multiple angles. Similarly to the ITN, the IGERT was intended to catalyse a ‘cultural change in graduate education’ by establishing 'innovative new models for graduate education and training' (IGERT official website). The programme was inspired by the COSEMPUP report from 1995 (Committee on Science, Engineering, Medicine, and Public Policy), which was chartered by the Academies to address 'the concerns and requests of the President's Science Advisor, the Director of the National Science Foundation, the Chair of the National Science Board, and heads of other federal research and development departments and agencies, and the Chairs of key science and technology-related committees of the Congress' (National Academies website). In 1998, the IGERT was born as the product of the National Science Foundation (NSF), 'an independent agency created by Congress in 1950 to promote the progress of science, to advance the national health, prosperity, and welfare; [and] to secure the national defence' (NSF official website).

The IGERT was the product of the NSF in the same way that the ITN was the product of the European Commission. However, there is one significant difference between the two cases. On the one hand, the IGERT was presented as the product of a single agency, the only acknowledged influence being that of the COSEMPUP report (1995). On the other hand, the ITN was presented as the result of collective thinking between various stakeholders, who engaged in active discussions with the European Commission prior to the birth of the ITN. A function that both programmes shared, nonetheless, was their role as 'flagship' models for doctoral education worldwide and especially in their respective regions.

Methodology/Research Design

This chapter is part of a larger study conducted throughout 2013–2017, where data was collected from two ITNs and two IGERT programmes, in the form of interviews with PhD fellows (marked as 'FEL' in the table below), and their supervisors ('SUP')/principal investigators ('PI'). In addition, interviews were conducted with the main organisations that created the programmes (the European Commission and the National Science Foundation), as well as other stakeholders involved in doctoral education policy. Table 1 illustrates the span of the interviews, using pseudonyms and a unique descriptor for each interviewee, which will be used throughout the rest of this chapter.

Table 1 Participants in the study

Region/country	Affiliation	Interviewees
Europe	Policy level	European Commission rep (EC)
		European Commission former official (former EC)
		European students' union rep (ESU)
		European University Association—Council for Doctoral Education rep (EUA-CDE)
	ITN MED	Eva (ITN MED, PI)
		Oscar (ITN MED SUP)
		Kristine (ITB MED FEL1)
		Lauren (ITN MED FEL2)
		Chris (ITN MED FEL3)
		Lisa (ITN MED FEL4)
		Caroline (ITN MED FEL5)
	ITN TECH	Charlotte (ITN TECH ADMIN)
		Carla (ITN TECH SUP)
		Lena (ITN TECH FEL1)
		Monica (ITN TECH FEL2)
		Anna (ITN TECH FEL3)
United States of America	Policy level	Council of Graduate Schools rep (CGS)
		National Science Foundation former employee (former NSF)
		National Science Foundation rep (NSF1)
		National Science Foundation rep (NSF2)
		National Science Foundation rep (NSF3)
	IGERT COMP	Nick (IGERT COMP ADMIN)
		Richard (IGERT COMP SUP1)
		Brian (IGERT COMP SUP2)
		Nicolas (IGERT COMP SUP3)
		Martin (IGERT COMP FEL1)
		Oliver (IGERT COMP FEL2)
		Daniel (IGERT COMP FEL3)
		Maya (IGERT COMP FEL4)
	IGERT ENV	James (IGERT ENV PI)
		Simon (IGERT ENV SUP)
		Joana (IGERT ENV FEL1)
		Emily (IGERT ENV FEL2)
		Mathew (IGERT ENV FEL3)
		Penny (IGERT ENV FEL4)

The first ITN programme that I investigated was a collaboration between universities, companies, and governmental authorities, with twelve PhD fellows and two postdoctoral fellows located across seven countries. The two sites from which I selected my interviewees from this programmes were a Nordic country and a Western European country. As an indication of the disciplines involved, the thematic focus of the project was at the intersection of Medical and Biological Sciences. This is why, for the purpose of this chapter, it is referred to as 'ITN MED'.

The second ITN that I investigated was a collaboration between nine European research laboratories and two companies, spanning eight countries. The project included ten PhD fellows and three postdoctoral fellows, who were all spread across the eight different countries. The two sites in this programme from which I recruited my participants were located one in a Nordic and one in a Southern European country. Similarly to the first, the thematic focus of this second ITN was at the intersection of Biology, Health, and Technology. To distinguish it from the first ITN, this programme is referred to as 'ITN TECH'.

The reason that both ITNs that I investigated were in a similar field is because life science was also one of the most funded disciplines through the ITN, alongside engineering (private correspondence with EC official).

In the case of IGERT, I used my academic connections at universities in the US to obtain access to two IGERT programmes that were ongoing at the time of my stay in the US. In addition, I used my three-month secondment at an American University as my base during the fieldwork period, which involved two trips to two university campuses on the West Coast. The particular organisation and disciplinary makeup of these programmes will be discussed in more detail in the following section, which focuses on the ways in which interdisciplinarity was linked to employability in the IGERT.

The semi-structured interviews were conducted in an open, flexible manner, aiming to understand how individuals made sense of the transformations going on in doctoral education, and more specifically, what they thought of and/or how they experienced the emblematic features of these two programmes. For example, open-ended questions were asked about interdisciplinarity, entrepreneurship, and many other programme features, in order to understand what the respondents thought of them.

In addition, I also asked broader, more open-ended questions about the perceived purpose/mission of doctoral education, hoping to understand the extent to which ideas embedded in the programmes matched the respondents' own understandings of what a PhD ought to be about and what it meant to be a doctoral researcher.

The approach used in analysing the data was, therefore, both deductive and inductive. On the one hand, I broadly structured the analysis around the main features of the two programmes, as well as their implications for doctoral education, as perceived and negotiated by different actors. At the same time, within this loose structure, I have allowed themes to emerge from my data, by conducting an inductive thematic analysis of the interview transcripts. Most themes revolved around the purpose of the doctorate, the fellows' motivations to pursue a PhD and, ultimately, the question of 'employability'—within and outside academia. In addition, critical discourse analysis has been used to identify instances of negotiation, acceptance, and/or contestation in relation to transformations occurring in doctoral education. For reasons of anonymity and confidentiality, the chapter does not include the names of the individual programmes and the institutions that housed them. From similar considerations, the names of the respondents have been replaced by pseudonyms.

Rather than aiming to offer an exhaustive account of all the themes that emerged in the interviews, this chapter showcases some of the thoughts that many interviewees have expressed as way of giving a voice to early career researchers, as well as agency, which goes through their perceptions of their own employability. Employability in itself is an interesting concept as it refers not to one's actual job status but the one's imagined capacity to obtain a job (Boden & Nedeva, 2010); it is a concept that refers to form rather than content, centred around skills.

The following section discusses the findings of the study, organised by programme goals, and including a comparative dimension between the ITN and the IGERT. The main programme goals—interdisciplinarity and cross-sectoral collaborations—are analysed as ways to achieve employability beyond academia.

Employability Through Interdisciplinarity

One way of achieving employability beyond academia was through interdisciplinary research. Interdisciplinarity was a feature of both the ITN and the IGERT; however, it was institutionalised quite differently in the two programmes. The ITN operationalised interdisciplinarity in a relatively narrow sense; in other words, the disciplines grouped in one programme normally belonged to the same vast area of inquiry (e.g. Biology and Health). The IGERT projects, on the other hand, employed a much more radical idea of interdisciplinarity, where the thematic focus of one programme would span across vastly different disciplines, such as Anthropology, Computer Science, and Engineering. For this reason, this section focuses on the IGERT.

The IGERT

> The broad goals are largely set forward by the NSF … the overarching goals: We wanna train a group of students that are able to work across disciplines … in groups; and that's a means for an end which is to work in places outside of the university. (Simon, IGERT ENV SUP)

As stated on the IGERT official website, the programme labelled itself as an interdisciplinary initiative that went 'beyond' what disciplinary undertakings could achieve. 'Collaborative research that transcends traditional disciplinary boundaries', announces the website, is 'the future' (IGERT official website). The IGERT programme was designed as an interdisciplinary initiative bringing together scientists from different areas on one site to look at thematic issues from multiple angles. The idea behind it was that each person would be a specialist in their own discipline but work as part of an interdisciplinary team to address the issue at hand. As IGERTs were normally topic-based, rather than discipline-based, fellows were recruited from sometimes vastly different disciplinary backgrounds. The first IGERT that I investigated, for example, combined seven disciplines, ranging from Computer Science and Engineering, to Biology, Geography, and Sociology. This IGERT was based at a relatively prestigious public university in the US; the second IGERT that I investigated was based at a less prestigious public university. The subjects combined in this IGERT included Engineering, Environment, Health, Urban Studies and Sociology. It is also important to add here that a special feature of the IGERT was the fact that it accepted several cohorts of PhD fellows on the same programme, over a longer period of time, as opposed to the ITN, which only included one cohort of fellows, working simultaneously on three-year PhDs.

Intellectual Relocation as Detrimental to One's Employability/Career Path

Despite the quote above from the NSF, some of the fellows whom I interviewed thought that their interdisciplinary training actually made them less employable. They believed that interdisciplinarity was limiting their opportunities, for both academia and other sectors, and therefore represented a disadvantage on the labour market. This finding also mirrors an academic study done in 2013, which discussed the difficulties of obtaining employment when having an interdisciplinary background (Bridle, Vrieling, Cardillo, & Araya, 2013). Many of my respondents believed that the breadth of their programme did not give them a deep enough knowledge of any subject in particular, and that made them less competent in almost any given job. It was the specialisation of the PhD, not the generic skills and the breadth that they thought would give them an advantage of the labour market. In the example below, which shows a fellow's perceived prospects for a job in academia, interdisciplinarity was seen as a limitation for pursuing an academic career because, as Mathew (IGERT ENV FEL3) argued, well-established departments generally liked to consider applicants with more experience in their own discipline when hiring. The impediment, here, therefore, was the organisational structure of the university.

> I know that I can't fit in a traditional department somewhere, so I can't apply for … I can't fit into a traditional Sociology department, or Political Science department … because of the interdisciplinarity in my background, I wouldn't be as competitive against a pure Sociologist. (Mathew, IGERT ENV FEL3)

McAlpine (2010) has already explored how switching back and forth between disciplines requires intellectual relocation that can disrupt the intellectual strand of junior researchers' identity-trajectories as academics. An interdisciplinary track was also proven to have negative consequences for employment and tenure by Jacobs and Frickel (2009). Oliver (IGERT COMP FEL2), a fellow who wanted to get a job in industry, was equally doubtful whether his interdisciplinary background would work to his advantage:

> All that IGERT stuff seems like departing from the traditional Engineering background so it's like … am I gonna have trouble finding a job, after this, doing Engineering […] If I was gonna just go straight into working for an Engineering firm or something, I would probably want better background of that, but … I think after the fellowship is done I'll probably just go back to Engineering and go deeper in that. (Oliver, IGERT COMP FEL2)

Employability Through Cross-Sectoral Collaborations

As mentioned earlier, the ITN was designed as a collaboration between universities and non-academic partners, in an attempt to design a more 'modern' model of doctoral education, 'subject to multiple accountabilities', as Novotny et al. (2003, p. 179) would say. Collaborations with non-academic partners were, therefore, designed to add a somewhat contemporary, innovative feel to the so-called traditional doctorate. The collaborators could be partners from industry, non-governmental organisations (NGOs), or government organisations, and their role was to participate in the process of research, alongside the universities involved; some of them also hosted fellows at their institutions for secondments.

The collaborations with non-academic partners were set up primarily to enhance the fellows' employability, by expanding the range of skills that would qualify them for a job in industry or other non-academic sectors. The widespread preoccupation with employability arose from an acknowledgement that the number of academic positions in higher education was significantly lower than the number of doctoral degree holders (Kehm & Teichler, 2016). Furthermore, a so-called traditional PhD education was framed in policy documents to be unsuccessful in preparing fellows for a job outside academia. Following this thread, Nerad (2004) and Kehm (2007) have aptly summarised the critiques of 'traditional' doctoral education, which mainly amount to fellows being trained too narrowly, lacking professional skills, teamwork skills, and, among many others, being ill-informed about employment outside academia.

This preoccupation with employability was, therefore, also a pressing concern among the fellows, who, understandingly, seemed intently preoccupied with their survival in a competitive labour market. Most of them showed an awareness of very limited opportunities available in academia, and subsequently expressed concerns regarding their suitability to occupy jobs in other sectors. As one of the fellows put it, 'I hear a lot of my colleagues, whether they are postdocs or PhDs, thinking—I don't know what my transferable skills are … if I were to shift to industry or government and I only know how to process genetic data […] would somebody hire me?—And certainly those are relevant concerns' (Lauren, ITN MED FEL2); 'because …', as another fellow put it, 'we all know that we'll finish the PhD and not everybody will continue an academic career' (Caroline, ITN MED FEL5).

Innovation Seminars

The focus on employability and the pressures to produce 'employable' graduates prompted universities to introduce courses and seminars to equip students with skills for the business world. This trend was also taken up by an innovation seminar organised at IGERT COMP.

> The idea of the innovation seminar was to see how you can apply your research in real life, or how you could take research outside of a lab, make it useful. But, a lot of the speakers who came to talk were people who basically work in industry and … talked about how to turn specifically Engineering or Computer Science research into a business. Which is not really what I am interested in, so that gives me the impression there seems

> to be a focus on business. Or even if you are in academia, sort of … how do you still make your research into some kind of business, into some kind of profit. (Daniel, IGERT COMP FEL3)

The image of the entrepreneur articulated here appears in opposition to Daniel's own idea about his role as an early career researcher and is refuted as something that he was 'not really interested in'. According to the fellows, the organisation of the seminar had been promised in the application to the NSF, at a time when the PI was preoccupied with designing a programme that the NSF would approve of. However, based on Daniel's account, not all the fellows were interested in transforming their research into products, and in fact many of them felt alienated by it. Maya (IGERT COMP FEL4) was another fellow who openly declared that she had not been interested in this seminar, yet she still had to attend, as she was 'highly encouraged' to do so: 'If you are not interested, it will drive you crazy, you know. … Please don't tell me how to start a business again. I am really not that interested' (Maya, IGERT COMP FEL4). Of course, while the IGERT did advertise its promotion of cross-sectoral collaborations, what Maya found was that none of these seminars focused on collaborations with NGOs, government, or any other stakeholders that might have been of interest to the social scientists, beyond private businesses. Daniel (IGERT COMP FEL3) further explained how he was 'turned off' by all the 'focus on money':

> I'm listening to these presentations, I'm hearing these people, and it's great that they took their research and made a company and that they're making lots of money, but it kind of turns me off and makes me think that maybe that's not for me. Maybe that's not what I want to do with my life. (Daniel, IGERT COMP FEL3)

Oliver (IGERT COMP FEL2) was another fellow who did not seem interested in business and sounded quite sceptical of the whole set up: 'just a bunch of entrepreneurs who came in and talked about innovation'—is how he described the seminar; a focus on 'Get out there and start a business! Have an idea!' (Oliver, IGERT COMP FEL2). It is interesting to note Oliver's phrasing—'just' entrepreneurs—which stands in stark contrast with the language used by some policy-makers in my interviews, who talked about academics as 'just' academics. This clearly shows a difference across groups about who is to be held in the highest regard: entrepreneurs or academics. Going back to Oliver's statement, entrepreneurialism and making money seemed to be pushing people away from academia.

The reason that many of the fellows had chosen to be in an academic environment was, for many, precisely because of how different it was from industry—because it was a space where the focus was not on producing money, but on pursuing higher intellectual ideals. The transition to a more marketable training model had ruined that experience for many, who now found academia unappealing because of its business features and the kind of environment that it was creating.

> I think one of the good things the IGERT has done is actually push me to think about … maybe it's time to leave the academy … or distance myself from it a little more, just being exposed to some of these … alliances with businesses and business perspectives … [the academy] is such a competitive environment, it's such a masculine environment, I think it's also for my own personal well-being and how I like to just be with people and in the world … academia might not be the place where I can do that. (Martin, IGERT COMP FEL1)

This is an interesting perspective suggesting that academia was an attractive place to many precisely because of its difference from industry, and that the increasing marketisation of higher education had taken away that distinctive academic mark.

Focusing on Acquiring Breadth Rather Than Depth: The Case of the IGERT

It is widely assumed that doctoral education is about doing research, yet the COSEMPUP report (1995) claims that 'traditional PhD programmes *overemphasise* research' (as cited in Graybill et al., 2006, p. 758; my emphasis), implying that doctoral education should not centrally be concerned with acquiring 'depth', but rather—breadth; of course, this means 'spreading oneself just a little thinner' and 'giving less' (respondents in Gardner et al. study, 2012, p. 384), which, arguably, may not be the way to achieve 'breakthrough research'—also one of the goals of the IGERT.

The idea behind increasing the number of PhDs globally was so that more PhD-educated graduates went into industry and thus made the national economy more competitive. Because academia could not absorb all PhD graduates anymore, the PhD had to be re-shaped to suit industry needs. However, this study suggests that this may have led to a PhD that was trying to achieve too many things at the same time. 'You know, [the IGERT PhD fellows] need to be broadly trained professionals, not just scientists or engineers' (NSF2). This quote brings into focus the debate on depth versus breadth and whether it was realistic of anyone to expect a PhD to achieve both. Of course, the NSF argued that 'the additional training [was] not additional training … it [was] integrated into the programme' (NSF2), through the way in which the IGERT was designed and structured. However, as it will be shown later, the fellows overwhelmingly thought that the IGERT training did feel like additional training and that it was very hard for them to juggle and negotiate the multiple responsibilities that they had been assigned. One of the most challenging issues was navigating different disciplines at the same time. However, more importantly still, was fulfilling the expectations that they should be both top researches and commercially minded entrepreneurs; because, despite claims for breadth, 'in the end, the thing that NSF [was] looking for [was] breakthrough research' (NSF1). The issue arose from the fact that it was not explained how someone could achieve all these things within the given time frame—and the given structure. As one NSF officer explained:

> We gave people extra money to help them invite someone to train them in how to think more entrepreneurial. […] Everything is so competitive now, I don't see how anyone can survive if they're not a little more entrepreneurial. […] Well, I suppose if you're doing very basic research and you're brilliant you deserve some time and space. (NSF1)

It was not clear, therefore, *where* this kind of 'blue skies' research could be done, and the confusion seemed to emerge precisely from the fact that the IGERT was designed as a programme preparing fellows for two very different career paths. Yet, regardless of the career that they ended up pursuing, everyone had to undertake the same IGERT training, with the risk of not being suitably qualified for either of the career paths. This was in fact reflected in some of the interviews with the fellows, who were concerned about their employability for both academia and industry.

Labour Market Outside Academia Not Ready to Fully Utilise PhD Knowledge and Expertise

The employability issue also gave rise to a discussion about the value of a PhD for a non-academic job market. Besides being appreciated as an additional credential, a PhD was also claimed to be largely unnecessary for a non-academic position. One supervisor, in particular, expressed strong scepticism:

> You are in the same place [as someone with a Master's degree]. Most likely, when you are a Master's graduate you are younger and more energetic. … People look differently when you start at the company. Whereas when you do a PhD, it's four years later. You are more mature, they expect more from you, you don't have the same room for mistakes … but you are on the same level, same place. […] Whereas people who went directly from … when I graduated … they're directors now. […] So, that's just to show, I mean, that's a difference, right? (Oscar, ITN MED SUP)

According to Oscar, unless one had a research position (in any sector), there would be no perceived benefits of working in industry with a PhD—on the contrary. One would be starting at the same place as someone with a Master's degree, only four years later in life. While the policy focus has been on how to make PhD holders 'qualified' to enter a wider labour market, there has been little work done to ensure that industry is prepared to take on PhD holders—prepared to offer them jobs in which they could effectively use their higher level of expertise.

Similar concerns were expressed by fellows:

> I recently talked to people about Sociology and how you can maybe manage people and how a PhD in Social Sciences can help you in that. But, I kind of wonder, if that is really your end goal job, do you really need six years of a PhD in Sociology or do you only do that if you are really interested in the academic part? (Daniel, IGERT COMP FEL3)

Because of the increased focus on entrepreneurship and innovation in the detriment of other (academic) pursuits, the fellows who wanted to pursue a career in teaching felt at a disadvantage. Arguably, a fellow enrolled in a so-called traditional PhD programme might also feel at a disadvantage for not having been offered opportunities outside academia; this was, therefore, also a case of unclear communication of goals and expectations. However, the reality of the programme was that the stress on performativity, which had replaced the 'professional culture of open intellectual inquiry and debate' (Olssen & Peters, 2005, p. 313) had (unintended) implications for teaching (Naidoo, 2003), as some of the fellows explained.

> For me, the purpose of doctoral studies is generally to do research, to get deeper understanding of the field you are interested in and also partly, depending on why you are getting a PhD, if you are going to work in academia, then also there would be a teaching component to it, developing the skills to transmit information. […] But coming at Computer Science I see that there is definitely a group of people who put more emphasis not on teaching but rather … yes, being able to do research and then go off into industry, founding companies or whatever. That's what I mean by 'if'. That also leads to very different population at Computer Science, where they probably have people who are really just there to eventually get a job. And they don't really focus on teaching at all. (Daniel, IGERT COMP FEL3)

This quote is another example of fellows trying to negotiate and reconcile competing ideas about the doctorate: ideally, the IGERT wanted to prepare fellows for multiple career paths; however, in practice, too big an emphasis on an entrepreneurial path neglected the needs of those who wanted to pursue a career in academia. While this approach seemed to work for some disciplines (as in the example above with the computer scientists), this was not the case with the social sciences. What Daniel was explaining is indicative of a wider phenomenon, namely the redefinition of the relationships between academia and industry (Lauder, Young, Daniels, Balarin, & Lowe, 2012), which is affecting the educational and professional experience they were receiving during a PhD.

Conclusion and Possible Ways Forward

This chapter has explored some of the consequences of the diversification of the goals of doctoral programmes as experienced by fellows enrolled in ITN and IGERT programmes. It argued that by being too ambitious—that is conducting high-level research but also developing fellows' generic skills fit for a career in industry—these programmes risked failing to accomplish their goals. On the one hand, in my respondents' perceptions, industry was not well prepared to absorb or did not value these highly qualified individuals, and on the other hand fellows aiming at pursuing an academic career were being diverted from their interests by the focus on entrepreneurship.

In policy terms, the ITN and the IGERT were trying to diversify the career paths of the fellows by giving them the skills—and therefore, the option—to pursue a career in non-academic sectors if needed/desired. In practice, however, this meant that fellows had to spread themselves thin. For this reason, many of the fellows felt alienated and cheated, arguing that a career in business was not why they had chosen to pursue a PhD; while this could have been presented to them as an option, some argued, it should not have limited the experience of those who wanted to stay in academia. Some of the additional programme commitments were, therefore, distracting to some, indifferent to others, and outright upsetting for many, who had chosen to do a PhD precisely to occupy an alternative space to that created by the world of business.

Arguably, the relative success or failure of this type of programmes is dependent on how well the goals are being communicated, how the programmes are institutionalised, and to what extent they are able to attract fellows whose motivations to do a PhD are aligned to the programme goals. Of course, some may argue that programmes like the ITN and the IGERT aim to attract people who have different interests than 'traditional' PhD fellows and some of my respondents were perhaps not the right target audience for these kinds of programmes. Yet the ITN and the IGERT were not set up as 'alternative' programmes, neither were they designed as 'professional' PhDs; they were set up as models to be taken up more widely by 'mainstream' doctoral education. Therefore, what this chapter has shown is how it would be problematic if *all* PhD programmes looked like the ITN and the IGERT. Going back to the question posed in the title, the chapter suggests that by diversifying the purposes of the PhD (beyond the scope of professional doctorates), we risk losing its distinctive 'added value'—that of creating specialised 'experts' in a given field, which requires extended intellectual immersion.

Policy Recommendations

On the basis of this study, my recommendation would be to manage expectations in regard to different types of doctorates suited to different purposes, and not aim to transform all PhDs into professional doctorates as the only way forward. In order to reap most benefits from what a PhD could offer (to society/the economy), the doctorate could strengthen its distinctiveness: in-depth knowledge of a specific subject, specific skills. Of course, it also needs to adapt and be responsive to a changing labour market, but the best way for the PhD to contribute is exactly through the characteristics that give its added value. Possible ways forward would be to engage industry in a discussion about how PhD trained individuals could best contribute based on their in-depth expertise; having an academic PhD track and an industry track/applied PhD for people who wish to have a career in industry; keep objectives of each type of doctorate realistic and explicit so that there is no mismatch of motivations and expectations; create more synergies with NGOs and public sector instead of focusing so much on business/industry.

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Building Bridges Between Industry and Academia: What Is the Profile of an Industrial Doctorate Student?

Orlanda Tavares, Cristina Sin, and Diana Soares

Introduction

The knowledge society and economy has implied transformations in the relationship between governments, universities and industry, the three pillars representing the triple helix[1] driving innovation in the contempo-

O. Tavares (✉) • C. Sin
Agency for Assessment and Accreditation of Higher Education (A3ES), Lisbon, Portugal

Centre for Research in Higher Education Policies (CIPES), Matosinhos, Portugal
e-mail: orlanda.tavares@a3es.pt; cristina.sin@a3es.pt

D. Soares
Centre for Research in Higher Education Policies (CIPES), Matosinhos, Portugal

Research Centre for Human Development – Universidade Católica Portuguesa, Porto, Portugal
e-mail: dsoares@porto.ucp.pt

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rary world, as theorised by Etzkowitz and Leydesdorff (2000). This relationship raises implications for the relevance of higher education to the outside world, requiring institutions to follow closely the tendencies beyond its walls. Higher education is increasingly viewed as instrumental in the contribution it can make both to society and to economy (Slaughter & Rhoades, 2004). This resulted in a broadening of its missions to include, beyond teaching and research, the 'third mission'. The third mission presupposes that the produced knowledge contributes to social and economic development (Santos, 2016; Pinheiro, Langa, & Pausits, 2015) and one of the consequences has been the reorganisation of the operations of the university as an 'entrepreneurial university' (Clark, 1998) in many institutions in developed countries (Ashraf et al., 2018).

Higher education is called upon to respond to nowadays social, cultural and economic challenges, which requires opening up and paying more attention to the interests of employers, the demands of policy-makers and the needs of students. To meet these expectations, higher value has been attributed to knowledge with potential for application in the real world, triggering a shift in knowledge production from Mode 1 to Mode 2 knowledge (Gibbons et al., 1994) and even, very recently, to Mode 3 knowledge (Carayannis, Campbell, & Rehman, 2016). Mode 2 knowledge often entails transdisciplinarity and collaborations among diverse actors (Bienkowska & Klofsten, 2012). The changes in knowledge production have had implications for the research activities carried out in higher education institutions and, consequently, for research training. This has become evident in the criticisms often addressed to doctoral education for not being relevant outside academia, where relevance is understood as preparing doctoral students capable of working in other sectors of society and industry (De Grande, De Boyser, Vandevelde, & Van Rossem, 2014; Kyvik & Olsen, 2012; Roberts, 2018). De Grande et al. (2014) also argue for a mind-set change among doctoral researchers and supervisors in order to turn them more receptive to employment outside academia.

In this context, a new type of doctoral degrees has emerged which involves the collaboration with industry, often designated in the literature as industrial or collaborative doctorates (Borrell-Damian et al., 2010; see Kehm's chapter in this book for a typology of doctoral programmes). According to a report by the European University Association (EUA), collaborative doctorates imply that doctoral theses are 'carried out with interaction between a university, a company and a doctoral candidate. A distinctive characteristic is that industry experts take part in the supervisory committee, officially or informally. Industry can play several roles, but being in the supervisory committee is what effectively reflects the specific nature of the collaborative doctoral project' (Borrell-Damian, Morais, & Smith, 2015). In several European countries governments have set up policy schemes to support collaborations in doctoral training by committing resources through public funding programmes (European Commission, 2011).

Industrial doctorates aim to ensure broader career prospects and the diversification of labour market outcomes for doctorate holders, since the capacity of academia to absorb growing numbers of doctorate graduates is limited (Roberts, 2018; Thune, 2010; Wardenaar, Belder, Goede, Horlings, & Besselaar, 2014). This kind of doctoral education is a reflection of the triple helix model as it emphasises an entrepreneurial mind-set and competencies needed for knowledge commercialisation, exposure to 'real life problems' and collaboration with industry or government during the development of doctorate programmes (Thune, 2010). Collaborative doctoral programmes expose students to both academia and industry. According to Kihlander, Nilsson, Lund, Ritzén, and Bergendahl (2011), being an industrial doctorate student means that the research is closely linked to the company, but the student is also affiliated to a research department at a university; hence, he/she is exposed to a dual culture. Despite the benefits of this exposure, some authors are critical of the limitations to academic freedom and autonomy and the implications for the progress of science (Henkel, 2007; Santiago, Carvalho, & Ferreira, 2015).

Doctoral students are significant producers of knowledge in collaborative research projects, important channels for knowledge transfer and vital in network configurations between firms and universities (Thune, 2009). It is therefore worth understanding what kind of characteristics are needed for a student to be able to fulfil these roles as bridge builders (Borrell-Damian et al., 2010), not only as students but also after graduation. Some of those characteristics put forward in the literature include transdisciplinary competencies and 'team science' skills and attitudes (Nash, 2008), the ability of integrating knowledge from different disciplines and sectors to find or improve existing solutions and transferable skills (such as communication, leadership, ability and willingness to change and creativity) (Borrell-Damian et al., 2010).

This chapter studies the perceptions of students enrolled in Portuguese industrial doctorates about what sets them apart from other doctoral students. Analysing this topic through the lens of students' perceptions contributes to knowledge on the profile of the industrial doctorate student—what motivates them, who they are and who they become. Starting from the premise that students in industrial doctorates act as bridge builders between industry and academia, the aim of this chapter is to analyse whether students' profile reflects the dual culture. The effectiveness of the bridge is partly dependent on students' assimilation of the hybrid nature which research training in an industry context entails. Drawing on focus groups discussions, the following aspects are analysed: motivations and expectations behind their enrolment, the personality traits perceived to be in tune with the demands of industrial doctorates and the skills and competences acquired during the programme. Although the importance of doctoral students in university-industry relationships is acknowledged in the literature, research focusing on students themselves is limited (Thune, 2010). For example, gaps are identified in relation to expectations, motivations and acquired competences (Roberts, 2018; Thune, 2010). The lack of studies is even more evident in Portugal, where industrial doctorates are quite recent (Santos, 2017).

The European and Portuguese Context of Industrial Doctorates

In Europe, universities have been intensifying research collaboration with industry, including at the level of daily exchange of knowledge with firms, involving scholars and students (e.g. spinout companies, science parks, incubator units) (Borrell-Damian et al., 2010). The estimates point to the fact that more than half of doctoral candidates find employment outside academia. This has encouraged the establishment of industrial doctorates, which are funded by industry or government programmes that involve industrial participation. The financial contribution of industry varies between 25% and 80% of the costs (Borrell-Damian et al., 2015). France, Denmark, the UK, Italy, Finland, Sweden or Estonia has promoted such collaboration through government-led schemes (Borrell-Damian et al., 2010; Cardoso, Tavares, & Sin, 2019). Such collaborations in doctoral programmes do not emerge only as top-down initiatives stimulated by the government, but also as bottom-up endeavours of institutions or companies. However, it is recognised that public support is essential, consisting not necessarily of funding only, but also of adequate policies and legislation to foster university-business partnerships in doctoral education (Borrell-Damian et al., 2010). Geographical proximity between companies and universities is a key factor which facilitates the development of collaborative doctorates (Borrell-Damian et al., 2015). There are differences in the legal status of candidates in industrial doctorates: employed part- or full time by the company, employed by the university or candidates funded by scholarships from a public research body (Borrell-Damian et al., 2015).

The Portuguese context of industrial doctorates is characterised by a high level of public support and encouraged by a top-down government-led scheme. This, in fact, applies to all doctoral education in Portugal, which, until the mid-1980s, was very scarce in Portugal. At the time of the 1974 democratic revolution, Portuguese higher education institutions awarded a very limited number of doctoral degrees because of the elitist nature of the higher education system. The majority of PhD holders had the degree awarded abroad. Once Portuguese institutions developed capacity to train PhD students, public policies started to foster the advanced training of human resources in the country, by means of scholarships (Heitor, Horta, & Mendonça, 2014). The fast expansion of higher education following the revolution was also reflected in the increasing number of awarded PhDs (from 292 in the 1970s to 3823 in the 1990s). The number of PhDs awarded after 2000 was 35 times higher than the number of those awarded in the 1970s, and more than 8 times the number of those awarded in the 1980s (Tavares, Cardoso, Carvalho, Sousa, & Santiago, 2015). This expansion occurred partly because of new legislation in 2006 which stipulated the percentages of PhD holders among academics teaching in the different higher education qualifications (first degree, master and PhD) and also in 2009 which made the PhD a pre-condition for entry into a permanent academic career. Before 2009, the PhD was only necessary for career progression and academics could enter the academic profession without this qualification (Carvalho, 2012).

In Portugal, doctoral degrees can only be awarded in universities, 24 in all, out of which 14 are public and 10 are private.[2] The majority of doctoral programmes are traditional research doctorates. A doctoral candidate has a student status and pays doctoral tuition fees, except when scholarships are granted. The main funding body is the Foundation for Science and Technology (FCT), which supports doctoral education through two funding strands: doctoral programmes and individual doctoral scholarships. The doctoral programmes can be national, industrial and international (FCT, 2018).

So far, 96 doctoral programmes have been funded in a competitive scheme and 7 of these are industrial doctoral programmes (FCT, 2018). However, according to the Portuguese accreditation agency database, only six are in operation. These six industrial doctorates are offered in universities located in urban areas with dynamic economic activity, which reinforces the importance of geographic proximity between universities and companies. Industrial doctoral programmes are funded both by the Foundation and by industry (respectively 75% and 25%) and aim to foster the development of research activities in a business environment. The responsibility for these doctoral programmes is jointly shared by at least one university or a Portuguese university institute, a Portuguese R&D unit recognised by the FCT and a company with significant R&D activity (FCT, 2018). Industrial doctorates have the same duration as research doctorates (three or four academic years). Supervision can be conducted jointly between an academic supervisor(s) and an industry representative. This collaboration requires compromise because of the different objectives underlying their engagement with knowledge. When academic knowledge assumes a great importance, industry supervisors seem to accept a minor role in supervision (Salminen-Karlsson & Wallgren, 2008). However, collaboration with industry can happen in other aspects such as the selection of doctoral candidates, the choice of research topics, curriculum development and teaching and assessment of doctoral work and thesis (Cardoso et al., 2019).

One of the motivations driving the creation of industrial doctorates is related to extending graduates' employability in sectors beyond the academia and supporting innovation in the industry. In Portugal, the private sector is made up mainly of small and medium companies, which attach low importance to human capital and innovation and, as a result, the demand for highly qualified resources is limited. Thus, Portugal is one of the Organisation for Economic Co-operation and Development (OECD) countries with the highest proportions of doctorate holders working in the higher education sector (83.2%) and a lower presence in the private industry sector (Santos, 2017).

Profile of the Industrial Doctorate Students

Contemporary doctoral students are far more different from the traditional ones, as they are more in number, more diversified, have different starting conditions, motivations or expectations. Doctoral students no longer have the traditional and delimited profile, which corresponded to a student studying full time, on campus and pursuing an academic career. Nowadays, it is possible to find a rich diversity of student profiles, either full or part-time, both on campus and at a distance, single or married, with or without children (Offerman, 2011), pursuing academic and other sector careers. Additionally, doctoral students are under higher pressure to develop a broader range of skills that will enhance their marketability to a variety of users on graduation (Wardenaar et al., 2014).

Doctoral education also had to readjust to these variety of profiles in order to respond to their different ambitions and expectations. A new emphasis on the integration of the graduate experience with outside work combined with a move away from the more traditional disciplinary-based research training model in the sciences gave rise to industrial doctorates (Harman, 2004). Industrial doctorates tend to attract a different type of doctoral students, preferentially those who are able to adapt to the broader goals of the programme and are open to different types of collaborations, who are proactive and open-minded (Briscoe, Hall, & DeMuth, 2006; Seibert, Crant, & Kraimer, 1999). Industrial doctorates are more likely to develop dissemination and translation skills (boundaryless mind-set, multidisciplinary approach, stakeholder involvement, society-oriented outlook) and transferable skills (Wardenaar et al., 2014).

Drivers and Motivations

Students enrol in doctoral programmes for several reasons and are driven by different motivations, which are often generally classified in the literature as intrinsic and extrinsic. While intrinsically motivated students choose an activity for its own sake, for the enjoyment it provides, the learning it allows or the feelings of accomplishment it evokes, extrinsically motivated students try to obtain some reward that is external to the activity itself, such as grades, social approval, parents' expectations or employability (Lepper, 1988; Tavares & Ferreira, 2012). According to Celis and Duque (2016), intrinsically motivated doctoral students tend to have a preference for science, for basic and purely academic research undertaken in traditional research doctorates, whereas extrinsically motivated doctoral students tend to have a preference for commercialisation and for applied research capable of producing innovation in an industrial context. Therefore, contrary to students who prefer science, whose ambitions are to create, share and disseminate knowledge considered essential for the development of science and the improvement of society, students who are driven by the preference for commercialisation pursue projects targeting the production and commercialisation of innovation-based products. For this reason, these latter are interested in funds availability, resources and cutting-edge technology and equipment (Celis & Duque, 2016). Hence, extrinsically motivated students would arguably be more inclined to enrol in an industrial doctorate (Fritsch & Krabel, 2012).

According to Hancock, Hughes, and Walsh (2017), doctoral students hold four moral positions towards their acceptance/rejection of the knowledge economy: scientific purists, social idealists, pragmatists and third-order capitalists. While the former two respectively favour academic science and the improvement of society through scientific research, the latter two are prone to see science as instrumental for economic development. Purists and social idealists are interested in an academic career, while pragmatist have flexible career prospects (both in academia or in industry) and third-order capitalists reject academic careers, seeing themselves employed in non-academic labour markets (Hancock et al., 2017). Based on these characteristics, it is likely that students in industrial doctorates hold moral positions somewhere between pragmatists and third-order capitalists.

Industrial doctorate students are also driven by employability, career ambitions (preferred employment sector) and career prospects (easiness to find a relevant job) (Roberts, 2018; Thune, 2009). According to Roberts (2018), students of industrial doctoral programmes seek the opportunity to develop and update their skills through professional experience and to gain awareness of multiple employment sectors. While similar career ambitions can be found among doctoral students collaborating with industry and non-collaborating students (Thune, 2009), in what regards career prospects students in collaboration with industry appear more optimistic than non-collaborating students, as the former believe that it will be easier for them to find relevant work after graduation (Thune, 2009). The ability to find employment more easily is ensured by skill development through teamwork environments (Kyvik & Olsen, 2012; Roberts, 2018). With a career in industry in mind, interacting with industry offers students competencies, access to data and research material that are seen as vital for future research careers both inside and outside the university (Thune, 2010).

Therefore, carrying out research in collaborative projects and developing a broader set of skills influences the career trajectories of students in industrial doctorates and has long-term impact on career patterns (Manathunga et al., 2012; Thune, 2009, 2010; Wardenaar et al., 2014). Evidence from a literature review (Thune, 2010) suggests that graduates who collaborate with industry during the doctorate have better labour market prospects and are more frequently employed in the private sector than students who do not collaborate with industry. Manathunga et al. (2012) similarly argue that there is a higher tendency for these students to gain employment in industry and in public sector research organisations. A more recent report by the European University Association (Borrell-Damian et al., 2015) confirms this trend. A study conducted in 13 European countries found that universities, companies and doctoral candidates all consider that graduates of collaborative doctorates had more job opportunities in the non-academic sector than doctorate holders who graduated from a traditional programme. According to the authors, the ability to be 'bilingual', bridging the academic and business sectors and the acquired transferable skills were highlighted as the main reasons accounting for the collaborative doctorate holders' enhanced employment prospects outside academia.

Competences

Thus, one of the aims behind the transformation of doctoral education has been to prepare a new generation of researchers able to embark not only on a career in academia, but who also possess ties to and competencies relevant for other sectors and professions (Borrell-Damian et al., 2010). This requires a different set of skills, beyond the academic skills acquired in a traditional doctorate. According to De Grande et al. (2014), employers seem to encounter deficits in transferable skills, such as being able to work with others, and having general management skills such as project management and business skills.

A literature review on doctoral students' experience of the interaction with industry (Thune, 2009) revealed that those students who are involved in collaborative arrangements have a markedly different training experience than non-collaborative students. In turn, this leads to differences in the skills and competences they develop (Lee & Miozzo, 2015; Wardenaar et al., 2014), which, in the case of industrial doctorates tend to be broader and more aligned with industrial activities of commercialisation and application of knowledge. According to Roberts (2018, p. 1), this encourages a rethinking of the professional identity of these doctoral students, who 'acquire an interdependent suite of skills from a range of contexts and set goals in multiple working environments', thus being more versatile than their traditional counterparts. For example, Lee, Miozzo, and Laredo (2010) refer to researchers employed in public organisations who see themselves as project managers. They also mention the very different business environment characterised by precise end goals and tight deadlines, where teamwork is critical and scientists are simultaneously involved in several projects.

Research literature highlights a number of specific competences among industrial doctorate students/graduates which make them fit for a career outside academia. The research objectives of doctoral students carrying out industrial projects are targeted at solving firm-specific technical problems or developing firm prototypes or specifications. These are also benefiting from the close interaction with industry through meetings and presentations during their doctoral training (Lee & Miozzo, 2015). Thus, they have the opportunity to get familiar with the industrial environment and working practices, which in turn facilitates their transition to a career in industry (Lee & Miozzo, 2015). According to Wardenaar et al. (2014), the involvement of heterogeneous partners enriches students' knowledge and confronts them with a diversity of values, incentives and practices. This increases their ability to adapt to boundary-crossing research. Roach and Sauermann (2010) additionally emphasise industrial doctorate students' entrepreneurial knowledge and skills, their ability to build connections with the scientific community and integrate knowledge networks valuable for businesses. Although not at the level of doctoral education, Smith, Mackay, Holt, and Challis (2008) argue that industry-based learning allows students to understand organisation cultures, work ethic, standards and expectations of industrial sectors. Similarly, a literature review by Lee (2008) found that industry-based experiential learning facilitates the acquisition of negotiation skills, management and leadership skills, financial management and the ability to take initiative and to socialise with other professionals.

Comparing doctoral students in collaborative multi-actor projects with students in traditional trajectories in the UK and the Netherlands, Wardenaar et al. (2014) concluded that being involved in multi-actor research projects (MARPs) appears, indeed, to have a positive effect on skills development, resulting in a broader skillset. They found that the academic research skills and academic communication skills of students in MARPs do not suffer as a result of exposure to the hybrid environment; additionally, these students report higher non-academic skills (such as translation and dissemination skills and transferable skills) than students in traditional trajectories. Doctoral students in multi-actor projects also score higher on 'boundaryless mindset', associated with working across organisational boundaries.

Methodology

Participants

Focus groups (FG) were conducted with 30 industrial doctorate students, organised in six groups, having between three and six participants (Table 1). Groups were organised by doctoral programme and each comprised students enrolled in different years, therefore in different stages of their doctoral trajectory. Participants came from the six doctoral programmes in partnership with industry funded by the FCT, as mentioned above. These programmes belong primarily to two disciplinary areas: Engineering (Refining, Petrochemical and Chemical Engineering, Advanced Engineering Systems and Biomedical Engineering) and Health and Medical Sciences (Animal Science, Health Sciences and Pharmaceutical Sciences). Each group comprised between three and six participants (see Table 1 for additional participant details). Almost all were full-time students (96.7%) and had previous professional experience (70%). In order to apply, students had to meet the competitive criteria established by the FCT for entering doctoral programmes. Additionally, the selection involved interviews by the coordinator in order to assess students' suitability and motivation for this kind of collaborative programme. Admitted students have the same scholarships as other doctoral students who were awarded funding from the FCT to undertake research-based PhDs.

All doctorates were attached to companies, which ranged from big international/national firms small and medium enterprises, some of them spin-offs of the research labs of the university. Each programme had at least one major company as a partner. Supervision was shared between university and industry representatives in most cases, with an academic and an industrial supervisor. In two doctoral programmes only, academics supervised the doctoral thesis, while company representatives acted as business coordinators or as 'problem owners', responsible for supporting students in the company.

Table 1 Participant characteristics

Participant characteristics	FG 1 (n = 6)	FG 2 (n = 4)	FG 3 (n = 6)	FG 4 (n = 6)	FG 5 (n = 3)	FG 6 (n = 5)	All (n = 30)
Gender							
Male	4	1	3	3	1	3	15 (50%)
Female	2	3	3	3	2	2	15 (50%)
Mean age (years) (range)	28 (25–31)	30 (27–34)	29 (26–35)	26 (25–38)	29 (27–30)	30 (28–35)	28.7 (25–38)
Disciplinary area	Engineering (Advanced Engineering Systems)	Health and Medical Sciences (Pharmaceutical Sciences)	Health and Medical Sciences (Animal Science)	Engineering (Biomedical Engineering)	Engineering (Refining, Petrochemical and Chemical Engineering)	Health and Medical Sciences (Health Sciences)	
Full-time student	6	4	5	6	3	5	29 (96.7%)
Previous professional experience	6	4	4	2	2	3	21 (70%)

Procedure

At the beginning of each focus group, written informed consent was obtained. Students were also asked to fill in a sociodemographic questionnaire. After their consent, the focus groups were audio recorded and transcribed. Focus groups were conducted between February and June 2018, and lasted between 45 and 60 minutes. The focus groups were facilitated by two researchers and approached a wide range of topics about students' experiences and challenges, from the moment of application up to the point where they found themselves at the time of the interview. In this chapter, the focus lies on two broad areas: (i) reasons, motivations and expectations of an industrial PhD; and (ii) specific competences (personal attributes and acquired skills).

Data Analysis

A content analysis of each focus group was carried out using the MAXQDA software (version 12). Data were analysed using both a deductive approach, based on the literature review, and through an inductive analysis approach (Braun & Clarke, 2006; Hennink, 2013). Each transcription was read and coded, line by line, to identify themes that were acknowledged in the literature review as key dimensions of an industrial doctorate student profile. New themes were also added, according to new insights that emerged from the transcripts. Themes were categorised under two key dimensions of the industrial doctorate student profile: (1) drivers and student motivations, and (2) competences.

Findings and Discussion

This section is organised according to the two above-mentioned dimensions that structured the analysis and presents the key findings which allow the definition of the profile of Portuguese doctoral students enrolled in industrial doctorates.

Reasons and Expectations for Choosing an Industrial Doctorate

The following reasons and expectations emerged during the discussions: link between industry and academia, applied research and employability and career prospects. First, participants emphasised the *link between industry and academia* as one of the main drivers for choosing an industrial doctorate. Both worlds (academia and industry) could be tied together through this doctorate, offering students the opportunity to develop research within industrial contexts. Theoretical expertise becomes practical and applied to 'real' problems:

I always wanted to do a PhD but I did not want to do one which would stay in the drawer, I wanted something applied, which had an economic context and feasibility. This idea of joining both worlds, industry, which has real needs, and the university, which has the scientific part. (…) So I think it was a good opportunity. This was the main reason. (FG2)

To develop a doctorate with an industrial applicability was also mentioned by the students as one of their motivations. As stressed by Celis and Duque (2016), this *applied research*, capable of producing innovation within an industrial setting, is considered one goal for students' enrolment in an industrial doctorate. Being more extrinsically motivated (Fritsch & Krabel, 2012), industrial doctorate students are driven not only by basic and purely academic research development but also by the ambition of producing and commercialising innovation-based products (Celis & Duque, 2016). The following transcripts are representative of this kind of motivation:

> I always wanted to do a doctorate, but I wanted something that was applicable and that has an economic impact (…) my research needs to be an idea with viability. (FG3)

> I am a very practical person and I like to see things happen. I like to see people using what I am doing. (FG6)

> There is a greater opportunity to achieve something tangible and visible. It is also expected that the company has some output that could be commercialised. (FG2)

An equally important reason for choosing an industrial doctorate was the perception of greater *employability and career prospects*. Students stated that an industrial doctorate not only offered a degree, but also enabled them to gain work experience in industrial contexts. As corroborated by Roberts (2018), students of industrial doctoral programmes sought the opportunity to develop and update their skills through professional experience. Hence, interacting with industry offers students competencies that go beyond the specificity of each disciplinary area (Kyvik & Olsen, 2012; Roberts, 2018). Competences such as teamwork, flexibility or interpersonal communication are perceived as key dimensions for their future employability, both inside and outside the university (Thune, 2010).

> I enrolled in this PhD because I think it was the only opportunity to work in this area in Portugal. After my 4-year PhD, I can even stay in the company. It was an opportunity to start a career in the field. (FG1)

> I think it is a way to have more than a solution for the future, more than just one possibility: to have an academic career or to have an industrial career. (FG6)

This 'unique' combination of experiences of the dual culture—academia and industry—works as a differentiation factor, benefiting those who already have an involvement in industrial contexts (Thune, 2009). This positive perspective regarding career prospects was invoked by participants, as they believed that it would be easier for them to find a relevant job after graduation.

> It could be an added value: at the end of my PhD I could stand out from the other colleagues who may want to apply for the same position. (FG5)

Despite being optimistic, students did not put job opportunities in academia and industry at the same level. Some students acknowledged the added value of being familiar with the dual culture, which enabled them to be employable in both those worlds. However, when referring to academia, the prospects were not very appealing, because they did not imagine themselves as professors but as scholarship holders, which is, in Portugal, a precarious status to undertake research. The following transcript is representative of this expectation:

> We are a bit more open minded, we can apply for a post-doc scholarship but we can also get a job in a company. (FG3)

Therefore, students considered that job opportunities would come mainly from industry, where employers would recognise their value.

> I think companies will no longer look at us as academics, as those people who have only been in the laboratory and ignore what is done in the company. They will look at us in a different way. (FG4)

Better career prospects in industry do not necessarily mean that students expect to be employed in the partner company where their research is being developed. Whereas some students developed that expectation, others recognised that as the partner company is a *start-up*, it would be difficult to get employed there. The following two transcripts are illustrative of these two perceptions:

> I would like to stay in the company where I am developing the project. The companies that hire us to do these jobs think that we are suitable to work there, because we will spend 4 years developing a project for that company. They see us as if we were workers. Of course, many of those who enter may not want to stay, may want to go abroad or the company may also say "I provide you with the training, but we won't hire more doctoral students because we are already full". This does not mean that it cannot open the door to another type of company, because companies know each other and therefore we improve our employability. (FG5)

> I think the problem is that usually *start-ups* are small companies, which do not have much funding to hire new people every year. (FG6)

The perspective of the company regarding scientific research and academia is mentioned as a potential challenge because the integration in an industrial context depends on how the company assesses the relevance of scientific research.

> Not all companies have this vision, or the ability to realize the importance of day-to-day research on a company and how it can evolve with it. (…) In Portuguese companies I think that this business vision of the importance of research is still lacking. (FG6)

Personal Attributes and Acquired Competences

During the focus group discussions, the students referred both to personal attributes, which they thought were necessary for a student enrolled in an industrial doctorate, as well as to competences that they acquired during their doctoral studies and which set them apart from students in traditional trajectories.

Regarding personal attributes, *flexibility* stood out as the most frequently mentioned characteristic. Flexibility is necessary for these students because they develop their research in multiple environments and have to adapt and respond to diverse needs and interests coming from academic supervisors and the partner company. Students described themselves as polyvalent since they do not only have to conduct research but they must also be able to tune in a different mind-set typical of an industrial environment, as the following transcript shows:

> For example, I think that a doctoral student at both academic and industry level has to possess some characteristics in order to know how to do the job, to have that ability to adapt, to get to work on the tools and to take these tools and adapt them to the type of work you are doing. For example, in my case, I did data processing, did optimization, programming, I'm working with several tools that are not only applied to my project, but can also be adapted to another type of company, another type of industry and I have this ability to use the tools and adapt them to various situations and use them to solve business problems. (FG5)

Another personal attribute that was mentioned by students, although with less emphasis, was *resilience*. This is understood as a fundamental attribute when dealing with the many challenges and difficulties posed by the company's presence as an actor with a stake in the research. The students referred to the inaccessibility and lack of time of industry representatives and felt persistence was necessary to get the information and input they needed. The hosting and integration process in the companies is described as a complex task and the most challenging and the main limitation of an industrial PhD.

They also spoke of a different rhythm as far as research was concerned in an industry context.

> We also talked about persistence … (…), we also have to have a lot of persistence, because it will be a solitary job, always knocking on the door of the company, for them to help us, and give us the data that we need. (…) For this [doctoral programme], in particular, it has to be the persistence, which has to begin early in the first year. The question is to overcome the difficulties that arise in a company in the context of research. And we know things have their normal rhythm there, don't they? It's almost like setting an aircraft carrier in motion. It takes a little while to start moving. (FG1)

Resilience and flexibility are also necessary because the definition of the research topic and the research plan is perceived as a complex negotiation between students' own research interests and the interests and expectations of the company.

> We have freedom, but it is a conditional freedom. In a traditional doctorate you have your interest and the interests of your supervisor and you discuss with him how to put it into practice. In an industrial PhD, we must always take into account the business and the interests of the company. (FG3)

The different expectations of academia and industry also appear to lead to uncertainty regarding research outputs. In some cases, students do not know what is expected to achieve by the end of the research: a traditional thesis or a patent or a collection of scientific articles.

> If the results were already defined … but they are not. It gave us a little more security, we already knew what they expected from us. (…) This is not written at all and we do not know. (FG2)

Other characteristics which were underlined, with less weight than the previous ones but in an equal measure between them, were proactivity (taking initiative), learning autonomy (capacity to search for relevant knowledge) and an entrepreneurial mind-set (related to being business- and output-oriented, aware of costs and benefits and the real-world context). This last characteristic is indicative of the industry culture which students are exposed to.

In fact, gaining knowledge of the *industry culture* emerged as the most important acquired competence during this kind of doctorate. Multiple dimensions of this culture were highlighted, but the greatest emphasis lay on the focus on commercialisation through the application of knowledge in order to create a product/service and learning about what this entails (patents, copyright, certifications, market research, etc.).

> I think this type of programme allows people to have some sensitivity, maybe some more than others, depending on the project you are doing. You start to have some idea of the value of things and how you can introduce new technologies, which may be discovered in the laboratory, into the market. (FG6)

Industry culture also implied learning about the dynamics and the organisation of a private company, becoming more aware of the costs and benefits of every activity and feeling the need to develop their research so as to be oriented towards objectives and towards solving the problems raised by the companies.

> For me it was a very vast learning. I think it is very complete. I could understand not only the whole manufacturing process, which has a lot of interest, but also the way the business fabric is organised, the various departments, and I think that's a plus. First because it does not limit our knowledge as we here have a way of working that is the proper form of research. We know how things work at the level of the university, the laboratories in particular, and we manage at the same time to adapt, or to learn what the reality is, let's say so. It turns out to be our intention to do something here that can be transposed. (FG3)

Besides the knowledge of the industry culture, the second most important acquired set of skills and abilities referred to by students were the *transferable skills*, which could be applied to a wide range of different jobs and industries. These skills include, in descending order of relevance, networking (a wide range of contacts both in academia and in industry), communication (to sell and to justify their ideas and the outcomes of their research), negotiation (the ability to reconcile different and, in some cases, conflicting interests), team work (through which students develop conflict resolution skills) and, with less emphasis, flexibility, writing skills and autonomy. These skills are fully aligned with those described in the literature and which are related to the business environment and its precise end goals, tight deadlines, teamwork and multi-tasking required by the involvement in several projects (Lee et al., 2010). Indeed, these skills are, as Wardenaar et al. (2014) argued, broader and more aligned with industrial activities of commercialisation and application of knowledge. The following transcript illustrates the importance attached to networking:

> The advantage ends up being that of working with other entities, which allows us to gain knowledge. We end up having more than one working group, not only here in the University, but also in another working group. Being in collaboration with Zurich, I have not only my supervisor, but also the working group that he guides. And we all contribute to the same work. I'm not just in touch with my supervisor. I have other people, we are always collaborating. Getting to know people from different worlds, and from different areas, to see how it works, I think this is quite beneficial. The company level also turns out to be the same thing … contact with the company. (FG 4)

Although not emerging in focus group discussions as prominently as the two previous competences—gaining knowledge of the industry culture and transferable skills—*entrepreneurship*, which had already been mentioned as a personal attribute, was also a competence that students deemed to develop within this type of doctorate.

> For me it was a novelty reaching a stage of development of the *start-up* and selling it. I had no idea that this was common in other countries. For example, in the US, people develop the idea, work on it for a while, and then go to a big company and say they have that idea and they want to sell it. This is one of the things that we learned here and which I found interesting. (FG6)

Other students, while recognising the importance of gaining knowledge of the industry culture, did not forget the relevance of the academic environment, highlighting the meaning of gaining knowledge of the *dual culture* (academia and industry).

> I did a doctorate, but I'm not theoretical person, because I did a doctorate in industry. So I keep on having the perspective of research and of the academic career because it is still a doctorate after all. Additionally, I have the perspective of industry because I did a doctorate in the industry and I'm not as theoretical as the other doctorates at the university. And that's a big gain. (FG4)

Although professional experience did not emerge with much weight in the focus group discussions on the criteria for admission to industrial doctorates (alongside knowledge of the English language and the relevance of the discipline), the fact is that 70% of the participants in these discussions had some previous professional experience. In this sense, having previous knowledge of the business environment can be a factor that influences the choice of this type of doctorate and increases the possibility of getting accepted on the programme.

Conclusion

The aim of this study has been to explore the perceptions of Portuguese students enrolled in industrial doctorates in order to analyse their profile regarding what motivates them, what they expect, who they are and who they intend to become.

Indeed, students enrolled in these doctorates seem to be mainly extrinsically motivated, which means that they perceive their research as a product with potential to be commercialised. Students enrolled in industrial doctorates think that they benefit from having contact with the dual culture, which tends to broaden their career prospects, turning them more promising than those of their colleagues enrolled in traditional doctorates. The degree is therefore perceived in an instrumental way, since its value is understood according to the opportunities it fosters.

However, opportunities appeared to students as more feasible in industry rather than in academia, where jobs are very scarce and where their competences are not as valued as in industry. Students believe that some of these competences define who they are and determine a successful completion of the doctorate: flexibility, resilience and proactivity are perceived as key personal attributes to enrol and to achieve the goals of an industrial doctorate. Besides these competences, students also believe that, through these kind of doctorates, they develop an additional set of competences that set them apart from other doctoral students: the knowledge of the industry culture (dynamics, problem-solving or commercialisation), transferable skills (networking, communication or negotiation) and entrepreneurship (such as start-up development). Students therefore believe that they will become both employable and potential entrepreneurs.

The profile of Portuguese industrial doctorate students has therefore a great potential to act as bridge builders between two apparently distant worlds, such as academia and industry. Students develop a more *pragmatic* profile focused on combining synergies, taking advantage of academic research tools to solve real-world problems. This profile supports and gives robustness to the bridge between academia and industry which they represent and points to the emergence of a different professional identity than the one typically associated with PhD holders. For this reason, this study suggests that industrial doctorates are a means of contributing to the development of a multifaceted researcher capable of and willing to perform research in industry (De Grande et al., 2014).

Notes

1. Currently, authors talk about a quintuple helix (see Carayannis, Barth, & Campbell, 2012) and even about an N-tuple helix (see Park, 2014).
2. Very recent legislation allows polytechnics to award doctorates under very restricted conditions (the capacity of the institution to carry out R&D activities and to have at least 75% of the human resources integrated into research units). A minimum evaluation of 'Very Good' by the Foundation for Science and Technology (FCT) is also required.

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Conclusion: The Transformations in Doctoral Education—A Comprehensive and Critical Approach

Teresa Carvalho and Sónia Cardoso

Introduction

It is widely acknowledged in the literature that there are a number of global and convergent factors leading to changes in doctoral education (Jones & Gopaul, 2012; Lee, Brennan, & Green, 2009; Metcalfe, 2006;

T. Carvalho (✉)
Department of Social, Political and Territorial Sciences, University of Aveiro, Aveiro, Portugal

Centre for Research in Higher Education Policies (CIPES), Matosinhos, Portugal
e-mail: teresa.carvalho@ua.pt

S. Cardoso
Agency for Assessment and Accreditation of Higher Education (A3ES), Lisbon, Portugal

Centre for Research in Higher Education Policies (CIPES), Matosinhos, Portugal
e-mail: sonia.cardoso@a3es.pt

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Shin, Kehm, & Jones, 2018). Among the most preponderant factors is the assumption of doctoral education as a strategic resource for the knowledge society, as well as its shaping by public higher education policies and initiatives promoted by national and supranational actors (Bao, Kehm, & Ma, 2016; Bartelse & Huisman, 2008; Bernstein et al., 2014; Bitusikova et al., 2010; Fortes, Kehm, & Mayekiso, 2014; Lee, Brennan, & Green, 2009; Nerad & Trzyna, 2008). Perceived as a way for countries to reinforce research and knowledge production capacity and thus gain a competitive advantage in the global knowledge society and economy, doctoral education has ceased to be a purely academic matter and has become a matter of supranational, national and institutional intervention (Bartelse & Huisman, 2008; Kehm, 2006, 2011; Nerad, 2014; Kehm's chapter in this book). The knowledge society, and its requirement for improving human resource qualifications, has paved the way for deep transformations in doctoral education, which has become the target of diverse initiatives and reforms aimed at aligning it with the demands of society, policymakers and a growing and more diverse student body.

This book has addressed these transformations across diverse national contexts and higher education systems, assessed by the authors from different approaches—macro, meso and micro. Based on the authors' contributions, it is now time to reflect critically on how such transformations are meeting, or not, the expectations not only of society and policymakers but also of doctoral students. Furthermore, it is also time to discuss the direction doctoral education is headed as well as where it may go in the future.

This concluding chapter begins by pointing out the structural and institutional transformations occurring in doctoral education, as described by the authors of the book, while discussing how these transformations seem to be responding to social, political and student expectations. Then, it critically reflects on the direction(s) in which doctoral education may go. Are changes in doctoral education effectively responding to social, political and student expectations? Should doctoral education indeed meet such expectations? What can be expected in the future for doctoral education?—are some of the questions the chapter seeks to address. This critical assessment is expected to be useful not only for the next generation of doctoral candidates and their supervisors but also for policymakers, institutional leaders as well as potential employers, both inside and outside academia.

Where Is Doctoral Education Going: The (Mis) Alignment with Social, Political and Student Expectations

Throughout the three parts of the book, the authors identified a number of structural, institutional and individual transformations in doctoral education in and across different national contexts. Assuming a dialectical perspective, one could argue that these transformations are both the result and drivers of change in doctoral education. In fact, the identified transformations can be seen simultaneously as the effect of changes and the promoters of other changes, which may or not be convergent. The transformations are related to the form and content of doctoral education, its locus of delivery and its recipients.

Transformations in the Form and Content of Doctoral Education

For centuries, doctoral education has been in constant flux; one of the paradigmatic outcomes of this being, with the rise of the modern university, the institutionalisation of the 'traditional doctoral degree'. This has unquestionably pervaded for decades, based on the development of research work supported by the supervisor-apprenticeship relationship (Amaral & Carvalho's chapter).

There is a consensus in all chapters that the form and content of doctoral education have been changing, with standardisation being one of the crucial dimensions of this change, highly promoted by public policies. However, this standardisation has been accompanied by a higher diversification of doctoral education.

Public policies in the field of higher education seem to lead to the standardisation of doctoral education in two distinct ways. First, as Nerad and Balaban mention in their chapters, public policies try to directly influence doctoral education funding by giving monetary incentives to those universities, and/or programmes, which meet the desired outcomes. Second, there is also the indirect influence of quality assurance, which is used as a political instrument for the regulation of doctoral education (Cardoso and colleagues' chapter).

The emergence of the flagship doctoral programmes, under the influence of innovation policies defined by governments, is a good example of the way funding might contribute to an ideal-model of doctoral education. Examples of these programmes can be found all over the world, as is the case of those referred to by Nerad and Balaban's chapters. Based on features such as a multi-disciplinary and a problem-solving focus, skill building, international collaboration, mobility and employability outside academia, flagship programmes are, as argued by Balaban (see Balaban's chapter, pp. xx), '(…) meant to "lead the way" in doctoral education and show what "future-oriented" programmes ought to be like'. As stressed by Nerad in her chapter, besides inducing changes at the level of doctoral programmes, grant funding schemes for flagship programmes have also contributed to the stratification of doctoral education in a two-tier system. The first tier is constituted by a small number of well-funded, well-designed and well-recognised doctoral flagship programmes, which seem to converge in terms of characteristics. The second tier includes a higher number of 'ordinary' programmes, less funded, but providing the bulk of doctoral education.

The rapid expansion and change of doctoral education raises questions about several of its dimensions (e.g., funding, access, completion, supervision, graduates' employability) and makes it the target of growing public concern about its effectiveness, efficiency and quality. As a result, and following a global trend, doctoral education is put under the scrutiny of quality assurance, induced both internally—under the remit of universities—and externally—under the remit of external quality assurance systems and agencies (Bao et al., 2016; Bartelse & Huisman, 2008; Byrne, Jørgensen, & Loukkola, 2013; Fortes et al., 2014; Nerad, 2014).

Both internal and external quality assurance seem to be converging towards a more standardised doctoral education (Bernstein et al., 2014; Byrne et al., 2013; Clarke & Lunt, 2014; Fortes et al., 2014; Kehm, 2006; Kivistö, Pekkola, & Siekkinen, 2017). As suggested by Nerad, Cardoso and colleagues and, to some extent, Neumann, in this book, internal quality assurance is being directed to different dimensions of doctoral programmes (e.g., admission, supervision, competences, completion and graduates' employability) inducing them to comply with similar norms regarding these dimensions. The same is valid for external quality assurance, as it leads to the harmonisation of practices and criteria serving as benchmark for the quality of doctoral education; and this despite the specific national configurations assumed by the external quality assurance systems, as evidenced by Cardoso and colleagues.

A good example of the standardisation tendencies is the emergence of structured doctoral programmes, integrated by both a curricular and a research component (Bitusikova et al., 2010; Byrne et al., 2013; Fortes et al., 2014). Under concerns about the degree duration and completion, a general tendency is also noted towards the shortening of its length. As acknowledged by Nerad's chapter, the trend is for this length to be three years, not only in Europe (due to the influence of the Bologna Process) but also in other parts of the world.

Along with the trend towards standardisation, another dimension of the changes identified along the chapters is, in an opposite direction, the diversification of doctoral education materialised in the emergence of new and different types of programmes. Multiple doctoral programmes are offered, with different goals and purposes, in a vast range of knowledge fields, trying to meet increasingly diversified profiles and interests not only of doctoral candidates but other stakeholders as well (e.g., from other sectors of society and economy).

As acknowledge by Kehm in this book, the most traditional form of doctorate (i.e., the research doctorate) currently coexists with other forms such as the professional doctorate, the taught doctorate, the PhD by published work, the practice-based doctorate, the integrated doctorate, the joint doctorate, the cooperative doctorate and the industrial doctorate. This last type, which emerges as the result of university/industry collaboration, can be explored in more detail in the chapter by Tavares and colleagues. Revealing a functional differentiation in doctoral education, the proliferation of new types of programmes has not come about without criticism, with opponents and supporters arguing its pros and cons (see Kehm's chapter).

Overall, it can be argued that the transformations in the form and content of doctoral education assume, simultaneously, tendencies for standardisation and differentiation. The standardisation tendencies are related to the duration and the organisation of the programmes (three-year duration, teaching component, multi-disciplinary, problem-solving focus, collaboration-based, mobility and employability orientation). Nevertheless, the pressures towards standardisation seem to result in a higher differentiation of doctoral programmes' offerings, leading to their potential hierarchy. Other than transformations in the form and content of doctoral education, relevant changes can also be identified in its locus of delivery.

Transformations in the Locus of Delivery of Doctoral Education

The same global factors that have contributed to transforming doctoral education are the same that have roughly contributed to transforming universities as loci of its delivery. As stressed by Deem's chapter, these transformations are especially evident at the level of the university purposes, which are increasingly geared towards generating profit, reputation and prestige, as well as towards responding to the needs of the external environment. Aligned with this, academic cultures and academic work itself are also rapidly changing, becoming increasingly more demanding, scrutinised, casualised and speeded-up. This influences doctoral education delivery, namely with regard to the supervision activity (on the part of academics) and relationship (between the supervisor and the student), due to a decrease in the availability and motivation of supervisors. Specifically regarding supervision, Nerad argues in her chapter about a paradigm shift, based on the replacement of the apprenticeship model (supervisor/student) by another one, in which a team of supervisors or a committee share responsibility for supervision. The underlying purposes are to reduce the doctoral candidate's dependence on a single person, broaden input to multiple sources and potentiate students' acquisition of competencies required by an enlarged labour market outside of academia.

All these changes make up a context that can affect the mental health of doctoral students, as argued by Deem. Indeed, as evidenced by some studies which serve as basis for this author's argument (e.g., Flaherty, 2018; Levecquea, Anseela, De Beuckelaerd, Van der Heyden, & Gislef, 2017; Schmidt & Hansson, 2018), doctoral candidates seem to be particularly likely to develop some kind of mental illness, much conditioned by the current state of universities and academic work. Due to the important implications of doctoral candidates' mental health for their professional future or even for the production of knowledge, society in general, and universities in particular, should be more aware and proactive in promoting good mental health.

Notwithstanding the relevance of changes in supervision, one aspect that has significantly changed is the way universities are structuring and delivering doctoral education. Despite differences between countries or even within each country or institutional context, a tendency is noticed towards a more structured doctoral education, reflected in the establishment of new organisational structures aimed at its organisation and management (Bitusikova et al., 2010; Byrne et al., 2013; Clarke & Lunt, 2014; Kehm, 2006, 2007). That is the case, for example, of doctoral schools, which although common in countries such as the USA or other Anglo-Saxon countries (though under different denominations), have only more recently appeared in Europe (see chapter by Nerad).

In the European context, doctoral schools assume different typologies according to their institutional arrangements and practices (directed to different aspects of doctoral education), as shown by Amaral and Carvalho in their chapter. However, despite this diversity, an important aspect regarding doctoral schools is that they seem to be based on a new archetype of doctoral education. This archetype is framed by a new social, cultural and organisational dynamic, including both academic and business logics, and is thus aligned with market requirements and the entrepreneurial ideal. In addition to contributing to the previously mentioned trend towards standardisation, this new archetype can also be seen as a way to ensure, among other things, that doctoral students and graduates acquire the competences valued by the labour market, which is no longer confined to academia and increasingly includes the entrepreneurial or business sector. This new institutional and organisational order aims to transform not only the way knowledge is produced (via doctoral education) but also the identity of doctoral students, from researchers to entrepreneurs. The extent to which this transformation is effectively being achieved is however difficult to determine.

Also to be determined is whether doctoral schools (or similar organisational structures) are effective, despite the complexity of the effectiveness concept. As Baschung explains in his chapter, the meaning of effectiveness can change according to the context, as it has a normative nature. The analysis of the Swiss reality, as developed by the author, gives some clues on the issue, especially regarding doctoral schools' organisational structure. Besides being characterised by a heterogeneity of objectives, aims and operational purposes, doctoral schools are influenced in terms of their effectiveness both by endogenous (i.e., objectives and type of activities developed) and exogenous factors (i.e., forms of network collaboration, type of inception and developmental stage). Notwithstanding the complexity in terms of their organisation, aims and operational purposes, doctoral schools may indeed be, according to Baschung, effective structures to deal with the organisation and structuring of doctoral education.

Constrained to compete more and more for a relevant position in terms of doctoral education delivery, universities increasingly develop and foster management practices aiming not only to make delivery more efficient, but also more attractive to an increasingly larger and diversified audience. Senior leadership emerges as an essential element in promoting these changes, as revealed by Neumann's chapter, referring to an Australian case study. At a time when managerialism is increasingly pervasive in the practices of the university and challenge the power of the individual academic, university leadership can successfully contribute to making doctoral education competitive and attractive, while collegial and participatory processes, involving bottom-up decision-making, are preserved.

To sum up, the changes in the locus of delivery of doctoral education suggest that trends towards standardisation and structuring of this education are translated, at the institutional level, in a great diversity of responses. This is largely due to the agency capacity of key organisational actors.

Transformations in the Recipients of Doctoral Education

The political and social expectations regarding doctoral education, which induced the transformations mentioned earlier, are aligned with the knowledge society and economy, framed by neo-liberal and market ideologies. In this context, a new rhetoric on the relevance of doctoral education to the labour market and employability through the development of new skills emerged.

As stressed by Nerad, professional and cultural skills now add to the more traditional or academic ones. Working in multi-, trans- or interdisciplinary teams; applying knowledge in commercially viable and socially responsible ways; taking on leadership roles in complex organisations; effectively communicating research results inside and outside of the university are some of the new competences expected from doctoral graduates.

The emergence of the academic career as less attractive (due to job insecurity, excessive workload, orientation to metrics, etc.) while being increasingly difficult to access (see Deem's chapter), also persuades doctoral students to acquire skills eventually more aligned with the non-academic labour market. Moreover, as stressed by Horta in his chapter, in line with the political and institutional purpose of doctoral programmes to endow graduates with the skills deemed essential to the non-academic labour market, 'skill-push' policies are defined by governments and universities.

However, as Horta points out, acquiring broad skill sets does not necessarily ensure doctoral students' openness to broader employment choices, including outside of academia; nor does it ensure, as stressed by McAlpine in her chapter, that non-academic employers are more willing to hire doctoral graduates. Indeed, as suggested by some studies (Benito & Romera, 2013; de Grande, de Boyser, Vandevelde, & van Rossem, 2014; Teelken, 2018) on which McAlpine bases her argument, the willingness of the non-academic sector to hire doctoral graduates is low due to a still low value attributed to the doctoral degree by employers. Moreover, employers still tend to see doctoral graduates' work-related skills as not matching what they need, while not knowing what a doctoral graduate can actually offer (Teelken, 2018). Hiring doctoral graduates seems therefore to be determined by other factors such as the organisation's mission and characteristics, or financial costs (see chapter by McAlpine).

On the student side, the motivations and expectations regarding doctoral education seem to be more diverse. In her empirical study based on flagship doctoral programmes, Balaban concludes that these programmes, aiming to boost employability, are not always completely favoured by doctoral candidates. These programmes are seen as potentially conflicting with candidates' purposes, as they appear to be too ambitious and risk jeopardising training for a career both in and outside the academia.

Flagship programmes' focus on entrepreneurship and skills for the non-academic sector also seem to contribute to the 'alienation' of doctoral candidates seeking to pursue a career in academia. Indeed, as suggested by Horta's chapter, such skills are not so valued by students, as their initial motivations for embarking on doctoral education relate more to becoming an academic (despite the perceived difficulties finding a job in academia) as well as research and intellectual pursuits, rather than career prospects. This perspective is somewhat nuanced by the chapter by Tavares and colleagues whose empirical analysis suggests a more 'optimistic' view about students motivations and expectations. Enrolled in industrial doctorates (which, as flagship programmes, are designed to diversify career prospects and increase employability potential), students, besides being mainly extrinsically motivated, assume their doctoral research as a 'product' with potential to be commercialised. They also tend to perceive the contact with the dual culture of the industrial doctorates (i.e., an academic/entrepreneurial culture) as beneficial, as it potentially broadens career prospects. This suggests an instrumental view of the doctoral degree whose value is essentially linked to career opportunities, which are seen as more feasible in industry.

The apparent ambivalence demonstrated by the empirical results of the previous chapters may indicate that doctoral education is at a crossroads marked by the coexistence of two paradigms: one associated with a more traditional view of what doctoral education is or should be; the other associated with an instrumental view of the degree, based on aspirations of skills acquisition and employability. In this context, the political and social expectations leading to the transformations in doctoral education are not completely aligned with employers' and students' motivations and expectations. The expectations of both students and employers do not seem to be changing at the same pace, or at least as radically, as doctoral education.

Where Should Doctoral Education Go?

Change is not new to doctoral education (see chapter by Amaral and Carvalho). What is new and quite surprising is the pace and depth of change that characterised doctoral education, especially in the last two decades. Indeed, what constitutes doctoral education nowadays has become more complex and less transparent, namely due to the questioning of the traditional idea of the degree, thus challenging the distinctiveness of this level of education.

However, it is important not to take for granted the directions that transformations in doctoral education are taking. On the contrary, one must critically reflect on these transformations in order to avoid unexpected (or even unintended) results in the future of doctoral education. Drawing on the reflections allowed by the pertinent and striking discussions in the Douro Seminar in October 2018, and the insightful chapters of this book, the aim now is to present, in a reflexive way, some relevant considerations about the potential effects of the current transformations in doctoral education.

As previously evidenced in this concluding chapter, one of the main trends currently characterising doctoral education is its apparent standardisation and homogenisation in different geographical, social and cultural contexts. However, when one looks at the institutional level, what actually exists is an obvious diversity and heterogeneity with regard to the way universities are dealing with doctoral education. The unequal distribution of resources (e.g., financial) for different doctoral programmes along with the extraordinary differences in the symbolic value assigned to different types of programmes (such as professional or industrial doctoral programmes), draws attention to the fact that this might further increase the stratification and hierarchy of universities. This tendency, associated with other features such as the way science is funded and evaluated, may result in a stronger valorisation of some scientific fields over others, considered to be less relevant. In political contexts increasingly more 'adverse' to some particular scientific fields (such as humanities and social sciences), the tendency to associate the epithet of scientific to what is 'useful' for society may contribute not only to de-institutionalisation, but it can also lead to the potential abatement of long-established scientific fields.

Furthermore, the stratification and hierarchy of doctoral degrees and universities is geographically situated. Flagship doctoral programmes are located in the Global North, especially in the USA and EU, as refereed by Nerad and Balaban in this book. Whether this trend contributes to reinforce what Altbach (2007) named as neo-colonialism—that is, the domination of universities in smaller and developing countries by universities of developed countries, with the consequent loss of intellectual autonomy by the former, which emerged with the commercialisation of higher education—is still something to be verified.

Moreover, it is pertinent to reflect on the potential consequences of the transformations of doctoral education for the production of knowledge. Academic freedom has been considered as essential to the development of scientific knowledge. In a context where a few organisations (especially for-profit institutions mainly located in the Global North) have a stronger capacity to influence and dominate the research agenda, how can we assure that the knowledge that is being produced is relevant to all human and natural lives? Additionally, the increasing focus on employability and on 'useful skills' for the labour market also raises another important issue, concerning the feasibility of continuing to engage in science and produce knowledge without an ultimate purpose in mind.

While none of the chapters in this book focus specifically on knowledge production, reading this volume makes it inevitable to question the direction knowledge production is taking. It also leads to questioning the role of universities, as these institutions are being greatly altered in their purposes and missions. In assuming the knowledge society narratives and accepting the orientation of knowledge production for economic competitiveness, universities may be both accepting and incentivising the increasing privatisation of science. This privatisation is reflected not only in the definition of the issues assumed as being worth researching, but also in the dissemination of research results. These results are transformed into 'intellectual propriety' and, in this sense, end up inhibiting the free circulation and public use of knowledge. Furthermore, as Streckeisen (2009) emphasises, the pressure for universities to supply the economy with 'needed' skills, namely via shaping doctoral education according to the supposed interests and requirements of the labour market, can never be accomplished since skills requirements are always changing.

Furthermore, 'this permanent demand to match skills requirements serves as a mechanism to limit the relative autonomy of the education system vis-à-vis capitalist production' (Streckeisen, 2009, p. 195).

As previously discussed in this concluding chapter, the political and social expectations regarding doctoral education are to some extent misaligned with students' expectations. Although this can be seen as a result of the transition from a more traditional to a more entrepreneurial paradigm in doctoral education, it may also suggest that universities have not yet fully adhered to one of the paradigms. The role of institutional leaders and of collegiality seems to be fundamental at this level, as revealed by Neumann's chapter. This idea and the possibilities it envisages seem to allow ending this book with a note of hope. Actually, organisational actors still have the capacity, from an agency perspective, to reinterpret and transform changes imposed from earlier. Notwithstanding, it is important to keep in mind that these (re)adjustments to change are not made without personal costs. As Deem pertinently called attention to in her chapter, there is now considerable empirical evidence on the negative effects of these transformations for those directly involved in doctoral education. The proposal put forward for doctoral education 'as' public good as opposed to 'for' the public good seems not only appropriate but also fundamental if science and its production via doctoral education is to continue to contribute unselfishly to the development of societies.

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Index[1]

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