Empirical Essays on the Labor Market Outcomes of PhD Graduates

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PhD Dissertation

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Politica

ISBN: 978-87-7335-196-3

Cover: Svend Siune
Print: Fællestrykkeriet, Aarhus Universitet
Layout: Annette B. Andersen

Submitted February 27, 2015
The public defense takes place August 3, 2015
Published August 2015

Forlaget Politica
c/o Department of Political Science and Government
Aarhus University
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Denmark

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Preface

The PhD dissertation is written in the period from March 2012 to March 2015 at the Danish Center of Research and Research Policy, School of Business and Social Sciences, Aarhus University. The center has provided an excellent environment for carrying out the research, which I am grateful for.

The content of this dissertation is a product of my ideas and decisions since I started developing the concept for the project. However, it would have been impossible for me to gain all this knowledge on my own. I am extremely appreciative of the help a wide range of people, both inside and outside the Center, has contributed with since I started developing the idea for the project more than three years ago. First of all, I would like to thank my advisor, Associate Professor Carter Bloch, Aarhus University for good advice, inspiration and support along the way. I would also like to thank my second advisor, Professor Michael Rosholm, Aarhus University who has had a significant impact on the content of my scientific contributions in the dissertation. I would also like to thank Professor Barry Bozeman, Arizona State University for hosting me during my research in the beginning of 2014 at ASU. Bozeman and Associate Professor Monica Gaughan, Arizona State University were both great mentors for my third empirical contribution for which I am very grateful.

Furthermore, I am also thankful to all my colleagues at the center for their great ideas and making me feel at home. A special thanks to Head of Research Ebbe Krogh Graversen, for always taking the time to discuss whatever challenges I have faced and giving good advice. I would also like to thank Senior Researcher Jesper Wiborg Schneider's for always having an open door whenever I needed to discuss anything. I also want to thank Niels Mejlgaard for giving me the opportunity to work on the dissertation at the center, Postdoc Kaare Aagaard for his great ability to give advice and Mads P. Sørensen for his valuable comments and observations.

A special thanks to the PhD group, which have been a vital part of me getting through the obstacles along the way. Sanne Hasse and Lise Degn have with their seniority in the PhD group provided great assistance on a practical level and they have always been open to discussion about the project. Furthermore, I would like to thank Tine Ravn for always having a positive perspective and Mathias for support throughout the process of writing the dissertation. You have all had a tremendous impact on the outcome of the project but certainly also on my well-being during the process, for which I am very grateful.

Last, but certainly not least, I want to thank Jane Frølund Irming for being the heart and spirit of the center. She has always brightened my day with our conservations and eagerness to help in every way she found possible.

On a personal level, I am thankful for all the support my family have always given me. I owe a great deal to my parents for imprinting the importance of having my own opinion (though you sometimes may have wished for a little less stubbornness) and my big sis for always supporting me in my choices. A special thanks goes out to my friends who have always been there for me. Finally, I want to thank Brian for always being my most enthusiastic supporter and having tolerated my neurotic outbursts especially during the final phase of completing the dissertation. You mean the world to me.

Chapter 1: Introduction

Understanding the motivations for the career decisions made by researchers constitutes a core puzzle in the economics of science. The link between research and growth is obvious, but the classical economic theories may provide limited insight into complex career decisions (Stephan, 1996). According to neoclassical theory of labor supply, for example, the supply of individual labor is positive if the current wage exceeds the reservation wage; but the choice possibly also depends on preferences and non-wage income. The classical economic models may be too simplistic to capture the important dimensions of the incentive structure in research, as individual career decision are not limited to being dependent on wage. Nonetheless, other economic theories prove relevant when examining the research incentive structure. This dissertation adds to the existing literature by exploring the career decisions of the increasing numbers of PhD graduates. The need for the improved competitiveness of developed economies may have resulted in an increasing demand for high-skilled workers with research competencies. However, the effects of nearly doubling the number of PhD graduates in the past 10 years remain largely un-examined (Auriol, 2007). The substantial increases in the number of researchers may have made PhDs available across sectors and potentially aligned supply and demand; however, the increasing supply of PhDs may have influenced the career options available to the recent cohorts, where increasing numbers must find employment outside the traditional research sector. Whether this also has resulted in an alignment of preferences for employment *across* sectors and demand *within* sectors is unclear. The motivation of the present dissertation is to increase the understandings of which factors determine the career choices made by PhDs after the supply of researchers has increased substantially. It seeks to elaborate on which factors that determine initial sector choices as well as how employment choices evolve in the early career. It aims to increase our understanding of what shapes the careers and mobility choices made by researchers and yield novel and important insights that are critical to the improvement of the incentive structure in research careers by evaluating how new PhD graduates in Denmark form their career decisions.

The dissertation addresses elements on how incentives across sectors affect PhDs' career choices. Using economic frameworks, classical economic measures, such as wages and education, as well as factors such as personal

preferences and supply and demand are included in the analysis. The analysis primarily focuses on differences in a range of determinants among PhDs that choose different sectors of employment. This dissertation thus provides new insight into how PhDs make job choices and how this influences their subsequent career choices. The dissertation considers career decisions as dynamic choices; that is, that the initial employment choice may influence later career opportunities. The motivation of this focus has been to assess how a range of determinants all contribute to form employment choices and job mobility as well as whether PhDs are finding employment in the sectors where stakeholders have expected them to find employment. I have narrowed the focus down to three empirical aspects of how career decisions are formed. The first empirical contribution addresses the incentives to choose a career in the private sector when holding a PhD degree by evaluating the monetary premium of holding a PhD compared to a master's degree. The second empirical contribution investigates the motivations behind sector mobility to the private sector. Here, indicators on individual characteristics and preferences, job content and more aggregated measures of supply and demand are used. The third empirical contribution investigates how social capital in the form of scientific, human and political capital affect career decisions among PhDs who initially opt for employment in the academic sector. It provides insight into the motivations and characteristics of PhDs that continue the search for academic employment and those that, at some point in their career, de-select the academic career path. The empirical contributions address issues that are complementary in assessing what determines career choices of recent cohorts of PhDs in both the private and academic sector. They do not cover all the potential factors that determine career decisions; rather, they represent an initial attempt at addressing some of the questions that have emerged alongside the increasing PhD graduation rates. The empirical contributions address some of the main concerns expressed by stakeholders, including policy makers, employers and PhDs; thus, the analysis covers a range of perspectives on careers in both the traditional academic sector, the private sector – where increasing shares are expected to find employment – and the government sector, as well as mobility patterns across sectors.

The remaining part of the introductory chapter is outlined as follows: subsection 1 defines the PhD as to the purpose of training researchers, how the education has transformed over time and it describes the new requirements stakeholders set out for the new cohorts of PhDs. In subsection 2, the theoretical framework is introduced by describing how the economics of science is a relevant frame for investigating career choices in terms of a discussion of

the market for PhDs, therein both demand and supply considerations. In subsection 3, the Danish case is presented and the main challenges surrounding the increasing numbers of PhDs for employment opportunities are discussed. Subsection 4 describes the data foundation of the dissertation, drawing parallels to the data sources previously used to evaluate career trajectories, while subsection 5 links the previous subsections together by presenting the research objective of the dissertation.

1.1 Doctoral degrees: definition, transformation of education and skills

Doctoral degrees are the highest academic degree that universities can award to students who have successfully completed a defined program of work in a particular field of study (Park, 2007). One of the most widely used doctorates is the PhD degree (Doctor of Philosophy) (Park, 2005; Taylor, 2012). "doctorate" and "PhD" are used interchangeably throughout this dissertation. The origins of doctoral degrees can be traced back to mediaeval universities and the accreditation of teachers, but they were transformed to the Humboldtian doctorate in the early nineteenth century to provide for the development of future researchers (Taylor, 2012). The doctoral education became a socialization process whereby students dedicated themselves to the research tradition by demonstrating their ability to carry out academic research and advance knowledge. Doctoral training has since undergone change, from a master–apprenticeship model to a formal education based on improving standardized skills (Park, 2005; Schneider & Sadowski, 2010). The past ways, where senior faculty introduced students to the academic tradition, where they had reason to expect lifelong employment serving academia, are outmoded (Blaxter, Hughes, & Tight, 1998). The focus of the doctoral education has shifted from the PhD degree being a product, that is, the contribution to the advancement of knowledge through an original item of research, to being a process whereby the training provides the necessary competencies to become knowledge workers fitting the needs of the global market in the knowledge economy (Park, 2005). The transformation of the PhD education has been based on the changing dynamics of world markets; to overcome challenges resulting from globalization, countries have focused on making high-skilled workers available across sectors to support the knowledge economy. When the doctoral education originally was introduced, it was primarily seen as a process of preparation for a career in the university system (Blume, 1986). Today, however, the doctoral education has

become a labor market qualification (Park, 2007). Increasing numbers are working outside of the academic sector (Austin, 2002), which has raised new issues with respect to what PhD programs must encompass. Even today, it is difficult to identify the specific competencies that a doctoral education should provide to students for them to become effective early-career researchers (Matas, 2012). The skill push articulates the normative expectations of PhD graduates through lists of skills, attributes, competencies and dispositions, including: disciplinary knowledge, research and technical skills, project management and leadership skills; teaching competence; the capacity to communicate verbally and in writing; effectiveness as a team player and as autonomous self-manager; administrative competence; and the capacity to be an ethnical, adventurous, innovative, motivated, creative and flexible individual (Mowbray & Halse, 2010).

Over the past two decades, the changes in doctoral education programs include perspectives on commercialization, massification, internationalization and diversification (Matas, 2012; Taylor, 2012). First, the knowledge society, where the limitations of distance have been reduced due to new technologies, has also resulted in greater expectations to the effectiveness of universities; they are expected to run effectively, as public-subsidized but self-financed businesses (Walker, 2008). In return for the public funding, stakeholders expect universities to contribute to the training of future professionals and the advancement of knowledge (Matas, 2012). The increased focus on attracting scarce funding has resulted in universities becoming knowledge factories, where a main competitive advantage is being able to commercialize research results. Doctoral students are speeding up the knowledge productivity and thus perceived to increase knowledge productivity in the international innovation race (Matas, 2012). The ambitions to commercialize knowledge have essentially transformed how systems use doctorate holders to advance knowledge.

Second, in the past, it was only the most skilled and motivated individuals, who undertook research educations. In the past two decades, however, the number of students enrolled in doctoral programs has grown rapidly (Cyranoski, Gilbert, Ledford, Nayar, & Yahia, 2011; Powell & Green, 2007). This development may have been influenced by at least three factors: first, the shift observed in many countries from an elite to a mass system of higher education institutions at both the undergraduate and postgraduate levels, which has enhanced the eligible population but also the attractiveness of holding a research degree; second, increasing demand for researchers in the knowledge economies; and third, the financial incentives for recruiting students (McCulloch & Thomas, 2013). The massification of undergraduate

and graduate education has resulted in a greater need for teachers to train the new cohorts. The main implication may be, however, that systems are organized in ways that require the need of undergraduate and graduate students to conduct the increasing amount of research in, for example, the laboratories and fieldwork to be able to meet the new productivity standards.

Third, international competition and the global financial crisis have resulted in some universities around the world having repositioned themselves as globally competitive higher education institutions (Brooks & Heiland, 2007). The developed systems now recruit internationally for doctoral students to overcome undergraduate shortages (Powell & Green, 2007). In an international perspective, the training of non-native students both generates growth within the country but potentially also outside the country; there is a potential brain-gain for countries with a net export of PhDs (Stark, Helmenstein, & Prskawetz, 1997). Nonetheless, the increasing use of foreign students may have severe consequences for the economies if the majority of the graduates decide to return to their native countries after graduation and the national demand cannot be satisfied.

Finally, the increase in the number of graduates has been associated with increases in the diversity of the domestic population of early career researchers (Taylor, 2012). The traditional perception of a traditional doctoral student was typically white, male, young and middle class (Petersen, 2012). The increasing numbers of doctoral students have challenged this perception, however, and the diversity among graduate students is increasing (Taylor, 2012). This implies that universities must re-think how they recruit new PhDs, as the traditional model for employing PhDs, which imitates the previous generation, may no longer be a proper strategy if admission to faculty positions needs to reflect the diversity of the doctoral students.

The presented dimensions have contributed to the modification of doctoral education due to research system externalities. To meet the increasing expectations regarding the purposes played by PhDs in society, there has been an increasing focus on improving the elements in doctoral education programs to ensure that new doctorate holders are equipped with the competencies that enable them to meet the increasing requirements to their skill set. The purpose of training is to enable doctoral students to conduct independent research that significantly contributes to frontier knowledge as well as professionals equipped with the advanced skills necessary to cope with the increasingly complex working situations stemming from the transition to becoming systems that are increasingly dependent on knowledge (Durette, Fournier, & Lafon, 2014). Despite countries having similar ambitions for what

doctorate holders must be able to do after obtaining the degree, doctoral education assumes various forms. Diversification in the education itself is also observed; both in terms of length, delivery and the assessment process. In some countries, it consists of pre-defined tasks, such as taking advanced coursework and conducting academic research with access to academic advisors along the way. Elsewhere, the education is exclusively based on research, the student effectively serving an apprenticeship under the guidance of a principal supervisor (Park, 2007). The different views on how to construct PhD programs has meant a differentiated set of skills among new PhDs, which may affect how well different sectors can exploit their competencies in the both production and R&Dprocess. Evidently, systems that equip PhDs with generic skills through PhD programs may be better equipped to meet the challenges of the knowledge economies. The list of expectations to a PhD's skill set is nonetheless daunting, and it is rather questionable whether they all can be met within the parameters of the formalized PhD program (Craswell, 2007). This then poses the question of whether systems can expect PhDs to contribute to the development of the knowledge society to the extent that policy makers have expected.

1.2 Economics of science & PhDs

The relevance of economics of science and the market for scientists are thoroughly discussed in Stephan's (1996) essay, 'Economics of Science'. The present section is largely based on this essay and draws on the arguments and conclusions presented therein, but with a primary focus on the market for PhDs. Stephan (1996) states that science needs the attention of economists for at least three reasons: first, and foremost because science is a source of growth; second, scientific labor markets and the human capital embodied in PhDs offer fertile ground for study; third, a reward structure has evolved in science that aims at solving the appropriability problems associated with the production of a public good. Economics is the study of incentives and costs and how scarce resources are allocated across competing wants and needs (Stephan, 2012). In this manner, it provides an extensive theoretical framework for evaluating the contribution of PhDs' work efforts as well as why they consider pursuing a PhD and their subsequent labor supply choices.

Further, Stephan (1996) notes that science is a public good; it is not depleted when shared, and once it is made public others cannot easily be excluded from its use. In addition, the incremental cost of an additional user is virtually zero. Unlike the case with other public goods, however, not only is

the stock of knowledge not diminished by extensive use, it is often enlarged. Part of the foundation of economic theory is that competitive markets provide poor incentives for the production of a public good because providers cannot exploit the benefits derived from its use; this. relates to the market-based benefits of science. Sociologists such as Merton (1957) and Reskin (1977) have elaborated on the non-market reward structure of science, which provides incentives for researchers to behave socially responsibly. The organization of science and the reward structure embedded therein allows for the investigation of the system itself together with the behavior it encourages.

The Mertonian perspective on the priority in scientific discovery is the foundation of the reward system in science. Merton (1957) argues that the goal of researchers is to establish priority of discovery, thus being the first to communicate advances in knowledge, and the reward is in the form of recognition from peers for being "the first." One form of recognition is publication, which contributes to establishing the priority of discovery (Stephan, 1996). However, there are also other rewards than recognition for being first; financial remuneration is another element. Researchers are paid according to their new discoveries (often in the form of the number of publications) (Diamond, 1984) but are also financially rewarded regardless of their success in advancing knowledge. Another reward is the satisfaction derived from the puzzle-solving nature of science (Hagstrom, 1965): researchers are argued to be intrinsically motivated by solving complex issues. Stephan (1996) argues that economists can contribute with better understandings of how the reward structure of science leads some agents to behave in socially irresponsible ways while others act responsibly.

1.2.1 The PhD market

Increasing graduation rates have resulted in more PhDs than the academic sector can absorb, which in turn changed the dynamics of the labor market for researchers. However, this development has been one of the main intentions of increasing the stock of PhDs: Policy makers around the world have accentuated the need to make researchers available across sectors and industries to support R&D across sectors. For example, OCED (2002; 2010b) encouraged systems to increase the stock of researchers due to expected increases in the demand and even current shortages in some industries. It was underpinned that to obtain a competitive advantage (, the developed countries needed to expand their knowledge-intensive industries.

Policy makers have tried to promote job mobility to the private sector by ensuring a surplus of PhDs in higher education institutions. These transitions are expected to be important as PhDs transfer state-of-the-art knowledge to the industries that are able to make downstream innovations to research activities, thereby monetizing knowledge (OECD, 2010a). In this way, the increasing graduation rates have been a policy tool for re-directing PhDs towards the sectors where policy makers expected the greatest potential growth to lie. However, the issue of directing new graduates to specific sectors may not be as straightforward as expected: the market for PhDs involves both demand and supply considerations. Demand is necessary to make use of PhDs, but they need to willingly supply their labor to the employers who are interested in their labor; demand and supply must be aligned to create a match between the employer and the PhD to meet the expectations of both parties.

1.2.1.1 Demand

Traditionally, the majority of the demand for PhDs has been from the higher education sector, which has educated and subsequently employed PhDs. In recent years, however, national and supra-national organizations have predicted that the demand for PhDs in the private sector would increase as the knowledge society developed; the thinking here being that firms will require increasing numbers of high-skilled workers to conduct an increasing amount of R&D as industries become more specialized (OECD, 2010b). The understanding of issues related to the demand for such high-skilled workers across sectors and disciplines is necessary for governments worldwide to ensure the availability of researchers to generate growth.

The shifting demand patterns for PhDs have impacted several modifications in what societies expect of the skills that PhDs possess. It is commonly acknowledged that the demand for skills differs across sectors: research in non-academic sectors often has a downstream focus, whereas it often has an upstream focus in the academic sector due to the applied versus basic research focus (Agarwal & Ohyama, 2013). However, labor market statistics for doctoral graduates also show that substantial numbers also engage in non-research related activities outside the academic sector (Auriol, 2007, 2010). There has even been evidence suggesting that PhDs are over-educated in the positions they hold (Auriol, 2010; Schwabe, 2011), meaning that lower-degree graduates are able to maintain the responsibilities that PhDs are in charge of. However, it is also expected that other PhDs holds positions where the job content may match the skill set of a lower-degree

graduate—but the PhD may be superior in performance or may contribute to developing the work. Moreover, employers possibly also become more aware of how to exploit the skills that PhDs bring to the workplace as non-traditional sectors of employment increasingly hire PhDs. Nyquist (2002) argues that the goal of producing PhDs is not a goal in itself and that that new graduates must perceive themselves as scholar-citizens that are able to connect their knowledge to the needs of society. He notes further that new PhDs in academic, corporate, non-profit or government jobs must "move from a research and writing focus into a multidimensional range of activities and time commitments, including committee work, team meetings, reports, teaching, worker training, planning and budgeting, recruitment, and managerial oversight." The demand patterns have thus evolved from having primarily focused on advancing knowledge within research institutions to now also focusing on the generic skills that enable PhDs to encompass a large range of competencies that can improve activities across sectors, and PhDs are intended to outperform lower educational groups—also for work that is not research-related.

In the past decades, demand in the university sector has changed; universities have undergone organizational reform resulting in downsizing, outsourcing and the adoption of flatter structures, becoming more dependent of external funding and using flexible workers to survive in the increasingly competitive and global market (Blaxter, Hughes, & Tight, 1998). The organizational imperatives have mainly changed the career paths of recent cohorts of researchers by increasing the competition for research positions in the traditional sectors *and* the increased use of researchers on time-limited contracts (Cabral-Cardoso, 2001; Stephan & Ma, 2005). Stephan (2012) suggests that the current organization of the academic system needs the (cheaper) labor that graduate students and postdocs provide, the catch being that the academic system is not able to absorb the independent researchers due to, among other factors, economic constraints. Demand patterns in the academic sectors have therefore shifted towards increasing demand for young researchers who can boost productivity, the problem being that they often become redundant once they have acquired the skills to become independent researchers with their own research agenda.

The demand patterns in non-academic sectors, including business, industry and government, have been investigated less often; today, we know little about what determines the demand in these industries. Nonetheless, a study by Garcia-Quevedo, Mas-Verdú, and Polo-Otero (2012) has shown that cooperation between universities and businesses increases demand of PhDs, while Herrera and Nieto (2013) found evidence that the provision of

technical knowledge, finding innovation partners, and previous failed attempts at innovation are contributing factors to employing PhDs. Furthermore, Herrera and Nieto (2014) found that PhDs both take part in the traditional upstream R&D activities as well as in downstream tasks undertaking knowledge-exploitation activities. Nonetheless, these studies are based on firms that are already focused on innovation; we know little about the demand for PhDs in government and non-innovative firms.

An important factor shaping the demand for PhDs is the country-specific demand patterns; demand within the private sector relates to the composition of industries, while demand in the academic sector relates to the composition of current faculty and traditions for educating and employing academics. Some countries have longer traditions for using doctorate holders in industry. Stephan (2012) describes how 25 years ago, one-in-four PhDs in the sciences and engineering were directed to industry, a figure which is 40 percent today. The use of researchers in industry and government has been more uncommon in Europe, where the graduation rates have generally merely replenished university faculty (OECD, 2010b). Moreover, the demand in the academic sector may be stable in some systems while increasing in less developed systems with fewer traditions for producing and employing PhDs both inside and outside of the academic sector. Worldwide, however, the flows to other sectors are increasing and increasing numbers of PhDs will work outside the academic sector instead of becoming professors (Austin, 2002; Fox & Stephan, 2001). Demand patterns are thus system-dependent and may increase substantially in countries that have not historically been used to employing PhDs outside the academic sector while demand may have already reached a steady-state in countries with large stocks of PhDs and traditions for using PhDs across sectors.

1.2.1.2 Supply

Supply-side considerations are another parameter that influence the match between PhDs and the employer, and therein also sector choice. Shifting demand patterns have meant that new PhD graduates must respond to the new demand patterns when they supply their labor. The increasing PhD graduation rates have meant that not everyone can expect to find employment in the academic sector, as they exceed the number of academic positions (Recotillet, 2007). It is commonly acknowledged that these increasing graduation rates affect the market for PhDs and thereby the supply decisions of new PhD graduates, but they potentially also affect the career decisions of the existing stock of PhDs as well. Sauermann and Cohen (2010) suggest

that the choice of sector relates to contingent benefits as well as individual preferences for such incentives; implying that the attractiveness of employment sector depends on how the individual PhD values each of the job attributes—and selects the sector where the sum of benefits is highest. This means that the supply decisions depend on how the individual PhD valuess job offers across sectors and subsequently decides where to supply their labor.

The sector choice may not be a purely black-and-white choice that is determined by preferences; it potentially also depends on a number of demand-related external factors: career prospects in sectors, the valuation of contingent benefits and specific job attributes. First, the career prospects in sectors are one element that may affect where PhDs choose to supply their labor; workers generally value job certainty, and uncertainty therefore reduces the value an agent associates with a job. In the developed countries, a similar trend of using temporary contracts at the entry level to academia has been observed. The increasing use of temporary positions with decreasing prospects for obtaining a tenured position may influence the supply decision: PhDs that either do not wish to be employed on a temporary basis or cannot get their contract in academia renewed may have to search for employment in other sectors. Second, the individual's perception of the attractiveness of a job relates to how the individual values each job attribute. For example, PhDs who require a high degree of job certainty might disregard their preference for academic science, instead choosing a private sector job (due to the uncertainty created by the frequent use of temporary positions). Others might still associate high value to doing academic science, however, and this may be more important than all other job considerations; thus, they will maximize utility by supplying their labor in the academic sector. The supply decision thus depends on a range of parameters, and the specific sector and job choice depends on how each PhD values each parameter relative to other. It is important to note that the supply decision is not made in a vacuum, as it depends on personal preferences as well as the organization of work in the sectors and demand across sectors: when demand increases in some sectors (while remaining stable in others), PhDs will flow to the sectors experiencing growth.

Despite career decisions being a product of several dimensions relating to preferences and demand, a mismatch between the preferences for job content and demand for skills may have negative implications for the satisfaction and productivity of PhDs. For example, the increased frequency of temporary positions may push some PhDs into other sectors while others are pulled into the non-academic sectors due to the attractiveness of the job

and employment attributes in these sectors. PhDs who are attracted to academic science may be pushed into other sectors, possibly reducing motivation and subsequently also efficiency. PhDs who find other jobs more appealing than the one they occupy may only do the job that is expected of them, whereas highly motivated individuals may seek to improve the effectiveness of the job and potentially also extend the job description to include other elements. The motivation related to do a job may be one of the most important factors when it comes to exploiting the knowledge possessed by PhDs; if they are unmotivated, employers cannot expect the PhDs to improve the business whether it being doing frontier research, improving production processes or management.

The reflections concerning the market for PhDs show that it has changed in recent decades, as multiple sectors now offer employment opportunities to PhDs. The academic career prospects have changed due to increasing competition but still attract substantial numbers of PhDs to the academic profession. Businesses, industry and government institutions increasingly demand doctorate holders, however, thereby providing employment alternatives to the academic sector. However, we know little about the demand for PhDs in these sectors and whether the work attributes in these new sectors are sufficiently attractive for the new cohorts of PhDs who are trained in the academic tradition.

1.3 The Danish case

In 2000, The Lisbon Agenda formulated the ambitious goal for Europe to become "the most competitive and dynamic knowledge-based economy in the world" (European Parliament, 2000). To fulfill this ambition, the so-called Barcelona Target was set in 2002, which aimed at increasing R&D investments to 3 percent of GDP by 2010 (European Parliament, 2002). In Denmark, the Barcelona Target is perceived as the main motivation for the intensified focus to provide high-skilled labor to economies in order to conduct the increasing amount of research. Hence, there has been an intensified focus in the past decade on increasing the number of PhDs across Europe to ensure a flow of researchers, especially to the private sector, to accommodate expected increases in demand alongside the transformation of industries to become more dependent on knowledge-intensive workers. To meet the standards set forward by the European Parliament, Denmark increased funding to doctoral education programs; the most notable initiative to increase the PhD labor force has been the *Finance Act* of 2005, where the government allocated the necessary funding to increase the number of PhD

students by 33 percent by 2008. Furthermore, the *Globalization Agreement* in 2006 meant that the number of PhDs was to be increased to 190 percent of the 2004 level by 2010. The full effect of the intensification of the intake at PhD programs was reached by 2010, with an annual admission of 2,600 students to PhD programs (Statsrevisionen, 2010).

In Denmark, policy makers could easily influence PhD admissions, as the universities and PhD students are public financed. The initiatives that were implemented to increase the stock of PhDs was based on the commonly acknowledged assumption that researchers generate growth and prosperity. In line with the expectations concerning industrial developments outlined in the European Union and the OECD, Denmark decided to provide the private sector with more knowledge-intensive labor in order to support the innovation capacity of private sector industries. Further, the supra-national organizations outlined a specific need for PhDs within science and engineering; and Denmark also emphasized this need in both the Finance Act of 2005 and the Globalization Agreement in 2006: 90 percent of the new PhD students should be working within the natural, health and technical sciences, while the remaining 10 percent should be working with the social sciences and humanities. The main argument behind the emphasis on these scholarly fields was that they possessed the competencies to meet the increasing demands in industry and traditionally had a closer relationship to the industry and would therefore easily be absorbed into the private sector industries.

1.3.1 More Doctorate holders: the right approach?

The Danish State Auditors concluded that there were several assumptions regarding the PhD venture worth questioning—and raised concerns regarding the societal benefits of educating more PhDs. First and foremost, the state auditors emphasized how the Ministry of Science had not assessed supply of PhDs adequately; the main argument for increasing the number of PhDs in 2005 was based on a prediction made in 2004, which analyzed the consequences of an increased intake of 500 PhD students for the recruitment process. Here, it was concluded that there were sufficient numbers of qualified applicants to increase the PhD intake with 500 students annually. Furthermore, they predicted that the demand for PhDs would increase in both the academic and especially the private sector; but that there would also be a generational change in the universities, which would require more PhDs. The state auditors concluded that predictions concerning demand may be difficult to assess but that the analysis conducted by the Ministry of Science was inadequate; it only provided inconclusive answers as to whether demand in

fact could be expected to increase and in which industries demand would lay. The assumption of increasing demand was based on observations of increasing demand in the late 1990s, that the demand would thus continue to increase in the future, and that the demand for PhDs could be evaluated using PhD employment rates. The State Auditors concluded that demand could not be based alone on assumptions of continued increases in demand based on the previous increases and that employment rates may not reflect demand, as the employed PhDs are possibly overeducated for the positions they hold. Furthermore, ahead of the *Globalization Agreement* in 2006, there had been no analyses or predictions of the effects with respect to whether there were sufficient numbers of graduate students to increase the number of PhD students further, nor whether the demand was increasing to the same extent as the supply of PhDs. The auditors also underlined that the increasing uptake of PhD studies would increase the need for foreign PhD students as the graduation rates at master's graduate level would be unable meet the increasing number of PhDs to be recruited; and that this may have an important impact on the capacity for innovation if the foreign PhDs decide to leave Denmark after graduation.

The initiatives implemented will result in three times as many PhDs graduating in 2015 as in 2004, amounting to 1,500 new PhD graduates per year. The State Auditors emphasized that it is unclear how the increasing numbers of PhDs are to be absorbed into the labor market and whether the private sector is sufficiently specialized to exploit PhDs' skills in the development of their products and processes. If there is a surplus of PhDs, they may be forced to find employment outside their preferred sector or end up unemployed. If industries are not specialized enough to exploit the PhDs' skills sets they might well end up in positions that are not exploiting their skills, possibly resulting in unsatisfied employees who are not challenged by their work. Our current understanding of what PhDs contribute to Danish society is limited, for not to mention how the increasing numbers of PhDs will impact the labor market and growth prospects in industries. More evidence will thus be beneficial to evaluate how the increasing numbers of PhDs affect the labor market choices of the existing PhDs, how demand and supply of PhDs harmonize, and what the long-term effects on growth.

1.4 Data Sources

For decades, researchers have been focusing on examining the organization of science and the career trajectories of PhDs. Most of these studies are based on surveys, either online or e-mail questionnaires that typically cover

either a group of PhD students or graduated PhDs (who mainly work in the academic sector). In the surveys using students as respondents, they are typically asked about their preferences for employment sector and how they perceive the attractiveness of working in the respective sectors. In the second type of survey, using PhD graduates as respondents, they are asked about their career decisions, the factors contributing to their choices and sometimes also about their publication records or collaborations with other academics. Both types of surveys include information on demographics, education and other relevant background information.

However, representative data sources on the career trajectories of PhDs are not easy to come by. Many of the existing studies are based on smaller samples that focus on the career development of PhDs from a single or few universities together with a limited number of observations in which the representativeness of the population cannot easily be identified (due to some of the characteristics of the population being unknown). The small – and potentially non-random – samples may result in either biased estimates or they may only be representative for a part of the population; but the results may not be extended to the population. For example, a sample drawn from one university may reflect the career developments of researchers within that university and may be extended to similar universities in the region; but the results may be very different if the sample was drawn from another university in another region. The implications of this extensive use of small samples drawn without knowledge of the population may reflect some of the inconsistencies in the results provided in the existing studies. Other data sources are collected when, for example, new initiatives are implemented and are intended as follow-up material. This often provides extensive information on the specific initiative; but the implemented initiatives often only cover a non-representative sample of the population, thus hindering the generalization of the results. Finally, CV data has become an important data source when analyzing academic career trajectories. In the academic world, it is easy to find researchers' CVs as it is more or less required that stakeholders can gather information on the research interests of PhDs; thus, the openness is quite large and enables trajectory analyses. Nonetheless, PhDs outside the academic sector appear to govern their privacy by not making their work activities public and are thereby less easy to track using CV data.

Nonetheless, data sources based on surveys and CVs can have numerous limitations. First, data based on surveys possibly omits important information if the respondent does not regard it as relevant or have forgotten it; second, in both surveys and CV data, the employment sectors are often grouped into highly aggregated sectors and possibly exclude important in-

formation about the employers that is important for the sector choice; third, it is often difficult to track PhDs over longer periods with surveys and the timing perspective may be vague, since respondents may have difficulties remembering far back (on employers, position or wages). Fourth, data collection using CV data only offers limited insight into careers outside the academic sector. Finally, the lack of knowledge regarding the representativeness of the sample relative to the population involves several drawbacks with respect to being able to generalize the results obtained in the studies.

However, there have been several attempts at constructing representative samples of the population of PhDs. To the author's knowledge, the most voluminous data collection is the *Survey of Earned Doctorates*, collected by the National Science Foundation (NSF) in the US. The census has been collected annually since 1957 and includes data on demographics, previous education and post-graduation plans (National Science Foundation, 2013b). The NSF also has a biannual panel on *Survey on Doctorate Recipients* within the scholarly fields of science, engineering and health that covers demographics and career history information (National Science Foundation, 2013a). Both surveys allow for the identification of several aspects that are important and relevant for increasing knowledge about PhDs' careers and the expectations regarding their career opportunities.

In the European context, the Careers of Doctorate Holders (CDH) has developed the most extensive data collection, collected in 2006 and 2009. Funded by the European Commission but collected by OECD and EUROSTAT, this data was aimed at increasing knowledge of career and mobility patterns by collecting internationally comparable indicators. The data is weighted according to populations of doctorate holders, which are in this manner representative of the European PhD workforce. The data includes demographics, education information, career choices, job descriptions and the motivations for choosing their current jobs (OECD/EUROSTAT, 2013). The CDH data allows for the identification of employment sectors and determinants of employment choices across a large population of PhDs in the EU.

The present dissertation makes use of registry data that covers a similar range of variables covering employment choices, demographics and educational attainment as that used in previous studies. These characteristics of the data allow for similar analyses as previous studies have investigated. However, the registry data includes data on objective variables that are directly observable and therefore cannot provide direct information on determinants such as preferences and motivations. This implies that the data source is not directly able to establish relationships between subjective factors and career decisions directly; instead, indicators are needed to establish

these types of relationships. However, the registry allows for the tracking of career choices after PhD completion due to the panel feature of the data, which is a somewhat rare opportunity with respect to PhD career trajectories. Another benefit of the registry data is that it overcomes some of the challenges observed by the existing data collection methods (i.e. small and non-random samples). The data foundation of the dissertation thus allows for new analyses based on the determinants found to have an impact on PhDs' career decisions in previous studies but add a new dimension to career development analyses and by tracking individuals over time and across sectors. The registry data is not superior to survey data, as there are relationships that cannot be investigated (mainly subjective determinants), as the registry data provide objective measured variables; this does not infer that it is inferior, however, as it includes a range of variables that are often not available in the existing surveys, and the measures are often more precise and also measured in the same way (i.e., not subject to misunderstood survey questions). The registry data is thus complementary to survey data and allows for the investigation of new aspects of the career decisions made by PhDs that increase our understanding of how career choices are determined.

In this sense, the registry data has limitations resulting in the analyses in this dissertation explicitly focusing on job decisions based on objective measures, including financial considerations and generally observable characteristics, such as educational attainment and previous labor market statistics. The limitations of the registry data present several challenges when examining career choices; hence, it might be necessary to construct indicators of these non-observable factors that, theoretically and empirically, have been proven important for career decisions when analyzing the career decisions made by PhDs. The specific focus in each empirical contribution in the dissertation is thus formed by the limitations and opportunities provided by the registry data, where the main ambition is on providing evidence that can enhance our understanding of the career choices made by PhDs in the new research landscape.

1.4.1 Danish registry data

Statistics Denmark administers the Danish registry data, which includes the PhD registry covering the entire population of individuals who have been awarded a PhD degree. In Denmark, all individuals can be tracked using their social security number, and the authorities automatically provide Statistics Denmark with the relevant registry information. The PhD registry is combined with other registries that include information regarding demographics,

education attainment and matched employer–employee data. The panel includes PhDs graduating from 1996–2010 and contains information on each individual over the course of the entire observation period if they lived in Denmark during the year of observation. Only data up until 2010 is available, which means that the evidence is not capturing the effects that the newest cohorts of PhDs have on labor market choices, as the largest cohorts have graduated since 2010. However, it still provides insight into some of the challenges facing the new cohorts of PhDs; and potentially provide indications of the types of challenges we can expect as a society. The data is an unbalanced panel due to the individuals who have been abroad or are non-native, as they are only observed while residing in Denmark. Nevertheless, it is an extensive data source that provides opportunity to investigate labor market decisions for a population of PhDs combined with their personal characteristics.

The registry provides objective measures for a range of observable variables, which is highly comparable as the collection approach is identical across the population. The data is a panel, where the information on gender, age, marital status, and the number and age of children is observed annually. The demographical data ensures that the analyses can include considerations on personal characteristics that may have a fundamental impact on career decisions.

The registry also includes variables on educational attainment, which are recorded upon the completion of a given education program. These variables include high school GPA, year of completion for master's degree and PhD degree, academic field of master's degree and PhD degree, and enrollment and graduation dates for PhD program; there is also data about which institution the individuals were enrolled at when completing their master's and PhD degrees. The variables on educational attainment allow the tracking of PhDs' educational records; for example, the time between completing one's master's degree and starting a PhD, identification of whether the master's degree-awarding institution also was the PhD degree-awarding institution, and finally the high school GPA provides a rare measure of ability.

The matched employer–employee data includes information on where the PhD is employed, characteristics of the firm (including information on employment sector—according to the NACE/ISIC classification), information on primary and secondary sources of income, and precise information on when the employment starts and ends; it thus provides the foundation of examining each of the labor market decisions that individuals make. The data on labor market statistics provide extensive data for evaluating all of the employment decisions made by PhDs, both before they begin their PhD pro-

gram as well as after. Furthermore, the data also provides characteristics on the employer, including sector classification, number of employees and average wages in the firm. Overall, it allows for the tracking of every labor market choice made by the PhDs over the course of their career.

The analyses performed on this type of data can only include general, observable characteristics and not elaborate on personal preferences. This implies that analyses of personal motivations cannot directly be estimated; but enables analyses focusing on financial and economic perspectives can be elaborated on. Similarly, it is not possible to include data on publications or citations, which are important factors when evaluating career the decisions made by PhDs.

1.5 Research idea, questions and operationalization

The background for educating PhDs and the description of the current labor market for new cohorts of PhDs posit several issues for achieving the outset goals of education more PhDs. First, is there an increasing demand for PhDs? The existing evidence of how PhDs are exploited, how academia, business, industry and government make use of their skills, and how PhDs generate growth must be further investigated in order to allow for an evaluation of whether the increasing investments in the education of PhDs meets expectations. Second, are the current labor markets able to profit from PhDs' skills? The degree of specialization of sectors is a key driver of which skills are in demand; if the degree of specialization is low, however, PhDs might not be able to advance knowledge, as firms are not yet ready to exploit their skills. Further along these lines is the matter of whether or not PhDs possess the skills to hold the wide range of positions that stakeholders expect them to take care of. Third, are the right PhDs being trained? The intensified focus on PhDs within the health, natural and technical sciences may be the right approach for industries that are specialized to exploit such competencies; however, it may not be the optimal approach for all countries; thus, more knowledge about how PhDs within each scholarly field contribute to the advancement of knowledge and patterns of how they are absorbed into the market are needed to align supply and demand. Fourth, is it realistic to assume that PhDs flow between sectors and transfer knowledge? The existing evidence suggests that PhDs prefer work in a single sector; thus, job mobility may often take place within a sector—not across sectors; this can possibly have a substantial impact on the potential for the exchange of knowledge.

Finally, is the increasing number of PhDs socio-economically efficient in terms of the return on investment? The overall ambition for educating PhDs has been to generate growth; but have more PhDs accelerated societal productivity? A general evaluation is needed to assess the cost-effectiveness of the PhD venture.

In the Danish context, there is very limited evidence for what forms career choices despite the availability of registry data to illuminate the career trajectories of the PhD population. The Auditor General's Office has pointed out several concerns after having evaluated the PhD venture, concerns which may be extended to a range of other countries that have increased the stock of PhDs; major points in their evaluation include the effects on the quality of the intake to PhD education and how the increasing number of PhD graduates affect the career prospects of the new graduates. The formulation of the general research questions in this dissertation is based on these concerns and conclusions. The motivation for the present dissertation is to elaborate on the career paths of the increasing shares of PhDs, in an economic framework using registry data. More specifically, I aim to investigate the incentives to pursue a PhD and the determinants of specific sector choices and mobility during the early career of the new cohorts of PhDs. The dissertation also aims to contribute to the (emerging in some way) literature on the career choices of recent cohorts of PhDs after the graduation rates have increased substantially. The overall research question to be answered in the dissertation is:

> How are the career choices of recent cohorts of Danish PhDs determined, and what are the implications of the current organization of the labor market for their career trajectories?

The research question sets the framework for the purpose of the dissertation, but the operationalization is divided into chapters in the remainder of this dissertation. Each of the empirical contributions provides knowledge concerning the challenges surrounding the PhD labor market and provides insight supporting the assessment of the main research question. Each of the following sub-research questions will be explored by one scientific article:

- Are there monetary incentives to pursue a PhD education and subsequently choosing a career in the private sector? What is the premium for holding a PhD degree compared to a master's degree in the Danish private sector?
- Which factors determine job mobility to the private sector—both initially after PhD completion and subsequently after having held a position in

another sector? Do the determinants affect job mobility differently depending on the initial sector choice?

- How do measures of social capital, therein technical and scientific human capital *and* political capital, advance and hinder a career in the academic sector?

The three sub-research questions cover some important aspects of how career choices are constructed. The first paper solely focuses on the incentive structure in the private sector, whereas the two remaining articles present a more dynamic view of careers, as they also include past career choices. In combination, the three articles intend to enlighten the understanding of the main research questions by investigating the dynamics of the career decisions made by recent cohorts.

1.5.2 Dissertation outline

Chapter 1 outlines the main areas of research in the dissertation and the frame in which they are to be analyzed by presenting the placement of my work in the policy and scholarly debate. Chapter 2 elaborates on the econometric methods used in the empirical chapters. The remaining chapters present the specific research questions used to investigate different aspects of the career choices made by PhDs. The dissertation consists of four contributions, which are partial studies of the labor market structure facing new PhD graduates; and they are presented in Chapters 3 through 6. Chapter 3 is intended as an introduction to the dissertation by presenting how the increasing stock of PhDs affects labor markets and identifies differences and similarities across countries. The scientific article provides insight into the policy motivations of countries to increase the number of PhDs and discuss the current labor market choices of PhDs on an aggregated level and provides guidelines for where research efforts will enhance the understanding of the complex effects that the increasing stocks of PhDs have on labor markets and what the effects are for the individual. Chapter 4 investigates the monetary incentive structure of completing a PhD program and provides estimates of the rate of return on a PhD degree. The motivation of this chapter is to elaborate on the incentive structure for finding employment in the private sector when holding a research degree. Policy makers have expected PhDs to easily find employment in the private sector; but we know little about the attractors that dominate job mobility to the private sector. The chapter thus investigates whether PhDs in the private sector are financially compensated for their PhD degree compared to master's graduates, thereby assessing how the market remunerates PhDs outside the academic sector and indirectly re-

flecting how the private sector values the worth of PhDs in their business. Chapter 5 investigates job mobility to the private sector among PhDs in their early career. The chapter also focuses on what later attracts the PhDs who initially choose employment in other sectors to the private sector. The paper is intended to investigate the features of the private sector and specific job attributes that attract PhDs to the sector while also investigating which characteristics possibly reduce mobility to the private sector. Chapter 6 investigates the career choices made by PhDs who are initially employed in temporary positions in an academic institution. The chapter is intended to investigate social capital factors that either encourage or terminate a career in the academic sector for the PhDs who initially preferred the academic career path. Chapter 7 presents the findings from each of the empirical contributions, discusses the implications of the findings, and attempts to identify how the conclusions address the overall research question. Finally, the concluding chapter points to where future research may be appropriate to further address the socio-economic effects of the increasing number of PhDs.

Chapter 2: Methods

The registry data has several advantages when it comes to using econometric models, among them the fact that it provides objective measures across large samples, which ensures consistency in terms of how variables are constructed. In this dissertation, I employ several econometric approaches to shed light on the incentives to pursue a PhD degree together with the career choices that follow. An OLS regression on a matched sample and duration models are employed. Due to the limited space in the articles presented here, the approaches and assumptions of the methods are described and discussed below instead.

2.1 Matching and OLS

One of the methods applied in this dissertation is matching; I construct a sample counterpart to imitate the outcome of PhDs had they not completed a PhD by using a sample counterpart of lower-degree graduates. Based on this framework, the comparison group must be highly comparable to the group of PhDs to justify measuring the difference-in-means of income between these two groups. In this manner, I seek to ensure high comparability between PhDs and their sample counterpart, to estimate unbiased wage premiums, by matching on parameters that affect the decision to pursue a PhD degree. The validity of the measured wage differential thereby relies on the quality of the match, as wage differentials measured at a later point in time are attributed to the PhD degree.

The registry data allows for matching the sample of PhDs with lower-degree graduates, and thereby evaluate differences in career choices among different educational groups—but who are otherwise similar on observable measures. The registry offers information about the population of lower-degree graduates and allows for identification on parameters that are important for ensuring the comparability of the PhDs and their counterfactuals.

The main identification issue of the approaches in the quasi-experimental evaluation literature relates to not observing the outcome in the absence of treatment; that is, not observing wages if PhDs had not obtained the degree. Counterfactuals are employed to imitate the outcome of not holding a PhD degree. The parameter of interest in the analyses is the

average treatment effect on the treated (henceforth, ATT). Several methods based on counterfactual outcomes to retrieve treatment effects are suggested in the literature. The most common methods include simple regression, instrument variable regression, regression discontinuity design, control function, propensity score matching and exact matching (see e.g. Imbens & Wooldridge (2009) for a survey of methods and limitations).

Ensuring the consistency of estimates is important; however, regression estimators may be biased when covariate averages are very different across the two groups. The regression model is then used to predict outcomes far away from where the parameters are estimated. This implies that the results can be sensitive even to minor changes in the specifications unless the linear approximation to the regression function is globally accurate. Similarly, the biasness of matching estimators is shown to increase with the dimension of (continuous) covariates. Even when bias is fairly limited, matching estimators are generally not efficient (Abadie & Imbens, 2006).

Currently, the best practice is to combine linear regression with either propensity score or matching methods (Imbens & Wooldridge, 2009). Abadie and Imbens (2011) show that bias-adjusted matching estimators have the advantage of an additional layer of robustness, because matching ensures consistency. The bias-adjusted matching approach combines some of the advantages of both regression and matching estimators, which include the advantage of asymptotic consistency and asymptotic normality, irrespective of the number of covariates.

Identification of the ATT relies on a bias-adjusted matching approach. By employing an exact matching approach, I seek to construct a valid sample counterpart for the missing information on the treated outcomes had they not been treated by matching each participant with one member of the non-treated group of master's graduates. Abadie and Imbens (2011) find that the match quality deteriorates when the number of matches increases. However, restricting the sample to those with exact matches on selected parameters ensures valid match pairs. The pool of lower-degree graduates is significantly larger than the sample of PhDs, thus allowing for a relatively high match rate despite the requirements of exact matches on the selected covariates. The matching approach is a data-hungry method. For this specific use it is feasible, however, as the pool of lower-degree graduates is significantly greater than the PhD-graduate pool. After matching individuals, wage premiums are assessed by using a bias-adjusted regression to control for potential heterogeneity between the matched individuals related to dynamic choices.

Most of the regression methods relying on counterfactual outcomes to evaluate ATT are based on the key assumption of unconfoundedness, which requires that, conditional on observed covariates, there are no unobserved factors affecting the assignment to treatment or potential outcomes.

Assumption I. Unconfoundedness

$$T_i \perp Y_i(0) - Y_i(1) \mid X_i$$

where T is a treatment indicator, Y is income and X is a vector of covariates.

The second assumption needed to identify the treatment effects is common support, which requires that each treated observation can be reproduced among the non-treated. This is only possible when observables do not predict participation exactly and when leaving some room for unobserved factors to influence the treatment status. The second assumption, however, ensures that the region of observables represented among participants is also represented by non-participants.

Assumption II. Common support

$$0 < P(T_i = 1 | X_i = x) < 1, for\ all\ x$$

where T is a treatment indicator and X is a vector of covariates.

Assumptions for matching are weaker than those for the assessment of ATT and can thus be considered as fulfilled if unconfoundedness and common support are satisfied.

Theoretically, ATT is identified under these two identifying assumptions. In practice, however, especially the assumption of confoundedness is controversial. It is debatable whether all of the factors influencing the choice to pursue a PhD degree are controlled for; especially as we may suspect that unobservable factors, such as preferences for intellectual (academic) challenges, are influencing the choice of a research career. If individuals self-select into treatment, the estimator becomes biased and the validity of estimations may be questioned.

2.2 Duration models

Two of the articles in the present dissertation use duration models that capture the timing perspective in job mobility patterns and evaluate how determinants influence the transition rates from one job to another. Regular regression methods do not account for the timing of transitions; thus, these methods potentially eliminate important information from the analyses. Du-

ration models capture the timing of events and are therefore feasible methods to correctly estimate the effects of indicators on job and sector transitions. The relationship between covariates and the propensity to transition (i.e. the hazard rate) need to be specified either by a proportional hazard (PH) or accelerated failure time (AFT) model. I employ PH models in the current dissertation, as this type of model appears most realistic; the effects of covariates on the hazard rate at each point in time are proportional.[1] This assumption is, however, not directly testable.

There is a variety of models to choose between, including parametric, semi-parametric and non-parametric models. The main difference between these types of models is the assumptions put on the hazard rate; that is, the propensity to transition. The strongest assumptions are placed on the parametric models, but they are also the most efficient under the regularity conditions (Wooldridge, 2002).

The analyses in the dissertation are performed using either semi-parametric PH models or Cox's PH model. The models do not require *a priori* specification of the hazard rate. The first type of model employed is the piecewise-constant duration model, which allows for different hazard rate slopes within pre-specified time intervals. The second model is a Cox's PH model, which does not impose any distributional restrictions on the baseline hazard (and is thus more general than the piecewise constant duration model).

Job-to-job transitions are dynamic choices; thus, a realistic model must account for the timing of events. The suggested models allow for a dynamic approach, but they differ in the underlying assumptions. First, the piecewise constant model assumes that the hazard is constant within each of the pre-specified time intervals, but the hazards are allowed to vary across intervals. In addition, the model is assumed to follow an exponential distribution within each time interval.

In the piecewise constant model, the hazard is defined as:

$$\theta(t, X_t) = \begin{cases} \bar{\theta}_1 \cdot \exp(\beta' X_1) & t \in (0, \tau_1] \\ \bar{\theta}_2 \cdot \exp(\beta' X_2) & t \in (\tau_1, \tau_2] \\ \vdots & \\ \bar{\theta}_K \cdot \exp(\beta' X_K) & t \in (\tau_{K-1}, \tau_K] \end{cases}$$

1 Theoretically, I can reject the AFT model as it does not fit the data well, as search theory and labor market statistics show that individuals with higher tenure are less likely to transition into a new term of employment.

Where $(\bar{\theta})$ is the baseline hazard and is constant within each of the K intervals but is allowed to differ across intervals. The vector of explanatory variables, X, is assumed constant. The piecewise constant PH model is thus equivalent to having interval-specific intercept terms in the overall hazard (Jenkins, 2005). This implies that there is an observation for each time interval.

Cox's PH model is specified as:

$$\theta(t, X_t) = \theta_0(t) \cdot exp(\beta' X_t)$$

The baseline hazard, $\theta_0(t)$, is left unparameterized. Hence, the model does not require us to specify any functional form for the baseline hazard function. The model is estimated by partial likelihood (and not maximum likelihood as ordinary duration models). For more information, see Cox (1972).

Chapter 3: New Doctoral Graduates in the Knowledge Economy: Trends and Key Issues at Stake

Published in *Higher Education Policy and Management*.
http://dx.doi.org/10.1080/1360080X.2014.957891

Chapter 4:
Are PhDs winners or losers?
Wage Premiums for Doctoral Degrees in Private Sector Employment

Article is currently re-submitted to *Higher Education*

Not available in online version.

Chapter 5: When Do New PhDs Opt for Private Sector Employment? Evidence on Determinants of Mobility Choices in a Changed Research Landscape

Not available in online version.

Chapter 6: Temporary positions, network, and non-academic partnerships: Mobility choices in a centralized academic system

Article is currently under review in *Research Policy*

Not available in online version.

Chapter 7: Perspectives on the Empirical Contributions

The present chapter connects the preceding chapters and discusses how the main findings from each of the three empirical research articles address the main research question as outlined in chapter 1: "*How are career choices of recent cohorts of Danish PhDs determined, and which implications does the current organization of the labor market have for the career trajectories?*" The overall research question has set the frame for the empirical articles and the sub-research questions that were also outlined in the introductory chapter. The purpose of the present chapter is also to outline future research areas of interest in order to increase understandings of the mechanisms at play when PhDs make their career decisions and discuss policy implications of the findings in the dissertation.

7.1 Empirical Findings and Conclusions

The increased PhD program admissions have facilitated a changed labor market for recent cohorts of PhDs. Today PhDs have multiple career paths to choose among; but simultaneously they also face limitations of where they are able to find employment as demand may have remained stable in some sectors while increasing in others. The recent cohorts of PhDs are thus not only directed towards an academic career but increasingly towards careers outside the 'Ivory tower'. Recent cohorts are expected to bring their knowledge towards all sectors that can benefit from having PhDs involved in both up and down stream tasks in the value chain; in this way, policy makers have expected that PhDs are able to utilize their competencies even though the jobs are not only research related. A deeper understanding of how PhDs form their career choices in the changed labor market they operate in, by accounting for both supply and demand considerations, brings forward knowledge that can increase the societal benefits of increasing the stock of PhDs. The present dissertation has a main focus on how initial career choices are made. Given that the largest increases in the numbers of PhDs did not take place until the late 2000s, the data cannot measure longer term career effects.

The studies conducted in the dissertation have shown that career choices are complex; the incentive system for choosing jobs consists of considera-

tions on several dimensions. It is important to recognize that job decisions are not made in a vacuum and that, for example, personal preferences influence the employment choice; but that it also may include considerations of demand and other PhDs' supply decision. Economic theory refers to this valuation process as utility maximization where the individual seeks to satisfy as many of the requirements they have to a job under the constraints that are present. By the use of econometric models these individual and aggregated effects have been included in the analysis as an attempt to capture the *ceteri paribus* effect of factors on career choices.

The empirical studies indicate that PhDs and master's graduates have similar incomes, three and five years after PhD completion; and the same goes for differences on the wage premiums to income increases three and five year after PhD completion. This may be an indication of 1) PhDs not being superior to add value for employers, by improving or inventing new products and processes, may not be fulfilled since industry do not wage compensate PhDs. 2) that employers do not know how to utilize the skills that PhDs bring to the work place. 3) master's graduates accumulate human capital when the PhDs are completing their research degree, which firms value equally important for their business. 4) that PhDs not are highly concerned with wage but rather other job attributes or 5) There may be an oversupply to the private sector which drive down the premium to PhD degrees. Despite the reasons for awarding PhDs similar wages as master's graduates, the results suggests that the incentives for PhDs to find employment in the Danish private sector may be limited when it comes to wage. However, the results also indicate that PhDs are employed in different jobs than master's graduates, thus the reason for the similar wage level among the two groups may also be related to the job choices which influence the wage and other job attributes.

The studies in the dissertation have investigated a range of job attributes that may be of importance when it comes to employment decisions after PhD completion. Personal characteristics, such as age, gender, having children and scholarly field, are important for employment decisions. Mobility both across and within sectors are shown to be decreasing with age. The results suggest that older PhDs are more aware of their preference and choose the sector that suits them best in the first round *or* settle with jobs within their initial sector of employment. The findings in the dissertation indicate that females have similar propensities to continue in the academic sector after PhD completion; however, males are more likely to get tenured in the early career. There is, hence, evidence of a penalty of being female on advancement in the academic career system. Interestingly, females are not more

likely to de-select academia despite they have lower chances for obtaining tenure. Furthermore, differences in employment sector is observed for PhDs that initially de-selects the academic sector; males are more prone to find employment in the private sector while females are more often employed in the public sector. The findings suggest that gender is an important parameter for the employment decision even when holding factors such as preferences and ability constant. The studies also show that having small children limits job mobility; 1) from public or academic sectors to the private sector, 2) from the academic sector to the public or private sectors and, 3) from temporary positions to tenure in the academic sector. The findings suggest that PhDs with small children are immobile both within and across sectors. Finally, the scholarly fields also have an effect of both the initial sector choice and subsequently job mobility. This most likely reflect the differences in stocks of PhDs within scholarly fields but also the tradition for employing PhDs in non-academic sectors. For example, Social sciences and Humanities train less PhDs and PhDs from these scholarly fields are not as often employed outside the academic sector.

The study in chapter 5 has investigated what factors attract PhDs to the private sector. The determinants that have an effect on the employment decision is characteristics of jobs available in the sectors and personal preferences for the job types. The studies have found that the attractiveness of employment in the private sector increase with the availability of research positions. The results imply that PhDs who are able to find positions that have a research focus are more prone to choose private sector employment. However, the evidence suggests a negative relationship between choosing private sector employment and both the preference *and* aptitude for doing academic science. PhDs with a string preference for the academic sector, thus, have less incentive for choosing employment in other sectors. The finding also suggests that low attachment to the initial sector, measured by previous job mobility in non-private sectors, positively influence mobility rates to the private sector later in their career. The level attachment to the initial employer appears to have a great effect on the subsequently career opportunities. Low attachment may infer that PhDs are necessitated to shift sector during their career. Furthermore, the study shows that more PhDs who initially start in the academic sector shifts to the private sector later in their career. This may be a result of the increasing competition for positions in the academic sector or reflect a potentially high job security in the public sector. The inclusion of aggregated supply and demand proxies in the analyses, indicate that employment choices are only to a lesser extent dictated by these factors. For example, the chapter shows that the change in number of PhD

degrees awarded only have a limited impact on employment decisions. The findings indicate that PhDs choose job according to what they find appealing and their skills; nonetheless, there are PhDs who following either change their perception of attractors to sectors of employment or unwillingly leave their initial sector of employment.

Chapter 6 analyses how elements of social capital influences career choices among PhDs that initially are employed in temporary positions in the academic sector. The aptitude for doing academic science is not having an impact on whether PhDs exit from the academic sector or get tenure later in their career, which contradicts the general perception that the more able PhDs advances faster than others. Interestingly, the study reflect that as time since PhD completion increases more PhDs leave the academic sector but the opposite is true for getting tenure; thus, PhDs who get tenure within the first 5 years from PhD completion get it rather fast while the remaining part continue in temporary positions. However, a large share of PhDs remain in the academic sector despite the difficulties in getting tenure. These PhDs are supposedly driven by their preference for working in the academic sector and value it more highly than having more job security in other sectors. The analyses also shows that network pre-graduate level and returning to the PhD awarding institution (after having held a position at another academic institution) promote tenure. Opposite, collaborations with non-academic partners have a negative effect on advancement in the academic system. Moreover, PhDs who collaborate with non-academic partners are much more likely to leave the academic sector during their early career; however, whether there is a correlation between collaborating with non-academic partners and later career choices cannot be established. Nonetheless, advancement of triple-helix concept does not appear to be supported by the organization of the academic career system.

In the present dissertation, the personal supply perspectives have proven less difficult to estimate than aggregated supply and demand. The effect of demand on career choices may be a difficult dimension to capture as PhDs often find employment in only the high-skill segment of sectors but nonetheless they are employed in a wide number of sectors, which makes it difficult to capture only demand for PhDs and not for the entire sector. Similarly, the use of aggregated supply, which measures of stock of PhDs, has been problematic. Again, the measure appears to be too aggregated to capture the dimensions that affect employment decisions. The limited use of the demand and supply issues have implicated that PhDs 1) are not taking demand or supply into account when making career decisions *or* 2) they are only taking career decisions for a small group of PhDs (potentially PhDs with

similar characteristics as themselves) into account, which cannot be measured in the aggregated measures. Both theoretically and intuitively, career decisions are dependent on demand and supply considerations, thus the main reason for the limited effect estimated in the empirical papers are most likely due to indicators not being efficient in measuring the effects.

The findings presented in this dissertation reflect that personal characteristics but also job attributes are important determinants of employment decisions. The studies infer that attractiveness of employment in the private sector hinges on the availability of doing research related work, thus PhDs appear to be motivated by using their research competencies. The studies also suggest that elements of social capital are important parameters for advancement in the academic sector, thus questioning whether quality is the main parameter for career progression in academia. Surprisingly, the analyses presented evidence of limited collaboration between the sectors, which may limit mobility between sectors as skills may not be transferrable or employers may be reluctant to hire PhDs that have been working in other sectors for several years. Moreover, the results obtained in the empirical studies showed that the initial sector choice is a valid indicator of where PhDs end up in the following jobs; the sector mobility is thus limited during the career. The limited career mobility may be a result of the limited collaboration between sectors, which may have severe implications for the knowledge sharing between sectors, and fundamentally alter the effects of providing sectors with increased access to PhD labor.

7.2 Theoretical Contribution and Data Challenges

Since economics is the study of incentives and costs, of how scarce resources are allocated across competing wants and needs, it provides an extensive theoretical framework for evaluating career choices and mobility. The framework intends to examine the incentive structure of science on both aggregated and individual level. Economic theory provides a valid framework as science is an important source of growth. Moreover, economic theory are relevant to study both scientific labor markets (and the human capital embodied in PhDs) and the reward structure that has evolved in science, which aims at solving appropriability problems associated with the production of a public good. With the outset in economic theory, the concept *economics of science* provide a theoretical framework to investigate the impact of science on growth.

The main theories used are human capital theory, utility maximization under constraints and social capital theory. Each of the theories that frames

the empirical contributions has both been rewarding and challenging. The main contribution from the economic theory has been the new insights to how career decisions are formed by investigating the incentive structures across sectors. For example, the *economics of science* approach have allowed for quantification of the rate of return to holding a PhD degree in the private sector, evaluation of the incentive structure for employment across sectors, and assessment of how elements of social capital form career decisions.

However, during the writing of the dissertation it became apparent that investigation of career choices in an economic framework is not without challenges. A main obstacle has been that data foundation that despite having several advantages also have limitations; especially the lack of data on individual-level characteristics have implicated limitations in the findings. For example, I have been able to quantify some preferences among PhDs but there are still others that cannot easily be quantified and are therefore missing in the analyses. This includes qualitative factors that are not directly observable or were it is not possible to construct proxies of these parameters such as valuation and comparison of different job alternatives and intra-family considerations.

Despite the limitations on data, the economic frame has been beneficial when it comes to evaluating some of the easier quantifiable determinants in the incentive structure. The dissertation have elaborated on how incentives across sectors define employment decisions, and have provided new evidence on what affect mobility choices during the early career. The conclusion based on the challenges that I've met by using an economic framework implies that it is continuously important that 'economics of science' is investigated as these studies provide relevant perspectives on how science is organized within and across sectors and how this relates to factors that determine job choices and provides insightful information on how both PhDs perceive attractiveness of employment across sectors as it is also an indicator of whether societies are able to keep attracting individuals to undertake PhD education. Identification of the benefits with holding a PhD degree is a main motivator to undertake PhD education. Economic frameworks are essential in the process of making the benefits but also challenges apparent for potential PhD students – but data foundations for conducting the analyses needs to improve to provide stakeholders with the information they need.

7.3 Future Research Areas of Interest

The dissertation has been an initial attempt to establish evidence on how PhDs determine their career choices in a Danish context; but with potential extensions to international decisions processes and labor markets. However, alongside the writing of the dissertation it became apparent how many difficulties and constraints both the theoretical framework and the data foundation has put on the analyses. This implies that there are extensive areas which are important to shed light on to understand the process of making a job choice but that have been out of the scope for the present dissertation. The first chapters of the dissertation have already outlined several research areas that are not covered in this dissertation but deserve attention; and moreover, the scientific articles have also highlighted limitations within the analyses and guided further research on the subjects. To broaden our knowledge of the universe in which PhDs make their career decisions it is important to include more specific information on preferences; preferably more in-depth than clustering preferences in boxes such as 'preference for science' and 'preference for commerce'; I acknowledge that these terms have been very useful to get an initial understanding of the mechanism regarding employment choices but the research has now reached a stage where more narrow concepts are needed to extent on our definitions to make valid predictions. Another area where better indicators are need is on aggregated supply and demand; as mention above the highly aggregated measures were not able to establish relationships of how supply and demand affect career decisions. However, both theoretically and initiatively there is a relationship between these factors; but estimation-wise we need more valid indicators of demand and supply of PhDs that more directly measure these perspectives. Finally, the registry data have provided more general insight to career decisions of PhDs than most previous studies. The extensive data foundation is excellent to evaluate job mobility patterns across entire cohorts; and this type of overarching data should be used more often to evaluate career trajectories of PhDs as it brings more solid evidence that is not easily affected by scholarly field, regional legislation and culture, and focus on sectors separately. However, when that is said I strongly encourage further investigations, in a Danish context, to be conducted on a combination of registry data and survey data which allows for tracking of a population but adding perspectives on individual preferences and motivations of job and mobility choices.

7.4 Policy Implications

A main motivation of the current dissertation has been to provide stakeholders with evidence on how the increasing investments in educating more PhDs have affected the labor market conditions for PhDs. Chapter 3 describes the motivations for increasing the stock of PhDs and outlines that the expectations of the increasing numbers of PhDs are mainly to increase knowledge sharing between sectors, and therein bring their skills to sectors that only to a limited extent use PhDs in their business. The main expectation has been that increasing shares find employment in the private sector where only a limited share has been employed in the past. The findings in the empirical articles have shown that only a similar share have in their first job found employment in the private sector the past 10 years, thus the increasing numbers of PhDs do not appear to increasingly find employment in industry or in the business sector. Furthermore, the analyses have shown that in the first five years from PhD completion only few shift to another sector than the one they initially started in. This development is worrisome as the expected mobility between sectors throughout the PhDs' careers is most likely not taking place to the extent that policy makers have predicted. A main reason for the limited attractiveness of private sector employment among the majority of PhDs may be caused by the organization of the PhD education where academic values and norms are instilled into the students; and with only limited input from outside stakeholders. However, the studies suggest that almost the same number of PhDs find employment in the government sector as in the academic sector and increasing shares of the new PhDs find employment in these two sectors. However, what makes the government increasingly attractive has not been investigated in the dissertation. Nonetheless, the development suggests that there is a mismatch between the expectations and the actual development; thus there needs to be an alignment of the incentives for choosing to work in the private sector before the new PhDs will choose this career path. One barrier may be that there are switching costs of choosing to work in another sector; this may be caused by very different work tasks; but as argued in the dissertation, there are alike job descriptions across all sectors, thus switching costs most likely arise because employers do not know how to utilize the skills of PhDs. The expectation of directing more PhDs towards the private sector may thereby also require 'training' of the mindset of employers in the private sector; when employers recognize what PhDs are capable of they may be more willing to employ them. The expected outcome is therefore that PhDs may be valued more highly by the private sector when they start to see the contributions that PhDs provide to

the firms' development – but this may require policy makers to make active interventions to further this process.

Summary

Policy makers worldwide have accentuated the increasing need to educate more PhDs in order to overcome the prevailing challenges of globalization. PhDs are argued to be among the main drivers of growth and prosperity and are therefore effective in terms of increasing the capacity for innovation in economies. Both national and supra-national organizations have emphasized that the demand for PhDs is increasing due to industries becoming more specialized. This has resulted in graduation rates nearly doubling in the past decade in developed countries (Auriol 2009). However, the evidence on how the increasing stock of PhDs mobilize in the new work environment remains limited. Traditionally, PhDs received their education and found employment in the academic sector. Today, this career path is no longer the only available option, as both government institutions and the private sector increasingly employ PhDs. Nonetheless, the employment decision-making process and incentives for choosing careers in both the traditional academic sector and the less traditional sectors, such as government, industry or business, are important to study in order to allow for the evaluation of how the new research landscape—with an increasing stock of PhDs and multiple career paths—affects employment trends.

The focus of this dissertation is to investigate how the career choices of recent cohorts are determined and assess the implications that the current organization of the labor market has for the employment patterns among the recent PhD cohorts. The dissertation analyzes how personal preferences, individual characteristics and job attributes affect employment decisions, both immediately after PhD completion as well as in the years to follow. The motivation of the dissertation is also to contribute to the literature on the career choices of recent PhD cohorts since graduation rates have increased substantially. The analyses are performed using Danish registry data that covers a population of PhDs graduating from 1996–2010. This data is combined with other registries that include information concerning demographics, educational attainment and matched employer–employee data. The registry data thus allows for the tracking of post-PhD job mobility and investigation across scholarly fields and institutions, providing a rare opportunity to track employment decisions following PhD graduation. By using economic frameworks, incentives for choosing employment across sectors are analyzed using econometric models, including OLS regression and duration models. More specifically, the dissertation investigates the incentive structure for pursuing a PhD and subsequently choosing a career in the private sector,

where increasing numbers are expected to find employment; but the project also examines which factors are the most important for both the initial employment decisions and job mobility later in their career.

Other studies have previously investigated the career trajectories of PhDs, but most analyses are based on US data and to a much lesser extent European cases. Few attempts have been made to examine the career paths of PhDs in the Scandinavian context. The structure of the Scandinavian labor markets differ both in terms of the level of flexibility of hiring and firing employers as well as the welfare system. Further, there have been fewer traditions in Europe for employing PhDs outside the academic sector than in the US. The structuring of the labor market and sectors may have implications for how PhDs mobilize but, expectantly, trends observed in other Western economies may have a similar impact on career decisions, as PhDs are generally highly mobile and the labor market is international.

The dissertation builds upon existing evidence focusing on the determinants of career mobility. However, the majority of studies have focused on single-sector career development, mainly in the academic or industrial sector. To incorporate a more dynamic approach to investigate career paths, the present dissertation focuses on both intra and inter-sector job mobility, as these forms of mobility mirror the career options available to the recent cohorts.

The project demonstrates how personal characteristics, such as gender, age and family situation, are important parameters for employment decisions. Moreover, the studies have also found support for preference parameters also being decisive for where PhDs are employed; for example, both the aptitude and preference for doing academic science is important for the employment decision and following job mobility.

The empirical studies in the dissertation have reflected how PhDs are not wage-compensated for their research degree when compared to master's graduates in the private sector. This may indicate that 1) PhDs are not better at adding value for their employer's business compared to master's graduates, 2) employers do not know how to utilize the skill set that PhDs bring to the workplace, and/or 3) PhDs not are overly concerned with wages, focusing instead on other job attributes. The studies produce mixed results as to whether PhDs are taking remuneration into account when choosing employment in the private sector; it is thus possible that PhDs are not really motived by wage and the limited wage premium to PhD degrees may not necessarily influence whether they search for employment in the private sector.

The main predictive job attributes include personal preferences, including preferences for doing academic research and being part of the aca-

demic community *or* being motivated by creating new products or processes in industry and the business sector. The empirical studies have also found that demographic characteristics are the main determinants of employment choices and mobility. The findings indicate that PhDs choose jobs according to what they find appealing as well as according to their family situation; however, their choices are dictated to a lesser extent by aggregated supply and demand factors. For example, many PhDs are found to remain in the academic sector despite the struggle to obtain tenure. These PhDs are supposedly driven by their preference to work in the academic sector, which they value more highly than the superior job security in other sectors.

The dissertation reveals the limited mobility between sectors after the initial sector choice is made. Furthermore, in the past decade, a constant share has been employed in the private sector, while increasing shares are employed in the academic and government sectors. These results are surprising, as policy makers had otherwise expected the PhDs to be mobile throughout their careers in order to increase the exchange of knowledge between sectors. The limited job and sector mobility may have severe consequences for the socio-economic consequences of educating more PhDs, as the expected outcomes are not taking place as often as predicted.

Resumé

På verdensplan har beslutningstagere påpeget det stigende behov for at uddanne flere antal ph.d.er, for at imødegå nogle af de udfordringer, som globaliseringen har medført. Ph.d.er er antageligt essentielle for at skabe vækst og velstand og de er dermed med til at øge økonomiers innovationskapacitet. Såvel nationale som supranationale organisationer har understreget nødvendigheden af at imødekomme den stigende efterspørgsel fra specialiserede industrier, hvilket har resulteret i, at ph.d.-dimission raterne næsten er fordoblet i det forgangne årti (Auriol 2009). Der er dog kun begrænset evidens hvad angår den stigende population af ph.d.ers mobiliseringsmønstre på arbejdsmarkedet, som har ændret sig i takt med et større udbud af forskere. Den traditionelle karrierevej for en ph.d. bestod i uddannelse på en akademisk institution hvilken også senere hen blev ansættelsesstedet. I dag er der dog flere forskellige karriereveje, som omfatter ansættelse i både offentlige regi og på det private arbejdsmarked grundet den stigende efterspørgsel efter ph.d.er i disse sektorer. Beslutningsprocessen vedrørende valg af ansættelsessted samt incitament strukturen for at vælge ansættelse(s) i både den traditionelle akademiske sektor og de mindre traditionelle sektorer såsom offentlige institutioner, industrien eller forretningsområdet, er vigtige at belyse for netop at evaluere, hvordan det ændrede forskningslandskab med en stigende population af ph.d.er samt de nye ansættelsesmuligheder påvirker ansættelsesmønstre.

Det overordnede fokus i den nærværende afhandling er, at undersøge hvorledes karrierevalg formes blandt de nye årgange af ph.d.er, og evaluere hvordan den nuværende organisering af arbejdsmarkedet påvirker ph.d.ernes karrieremønstre. Afhandlingen analyserer således hvordan personlige præferencer, individuelle job karakteristika og job attributter påvirker ansættelsesvalget. Motivationen med denne afhandling er også at bidrage til litteraturen om ph.d.ers karriereveje blandt de nyere årgange, som kommer ud på et forandret arbejdsmarked. Analyserne er baseret på dansk registerdata, som omfatter populationen af ph.d.er som blev uddannet i perioden 1996-2010. Ph.d.-registret er kombineret med andre registre som omfatter informationer om demografi, uddannelse og data der knytter ansættelsesstedet og medarbejderen sammen. Data giver mulighed for at følge ph.d.erne over tid efter erhvervelsen af ph.d.-graden. Ydermere, er der mulighed for at analysere effekter på tværs af fagområder samt institutioner og giver derved en sjælden mulighed for at følge beslutningsprocesser over tid.

Økonomisk teori danner rammen for projektet, der undersøger incitamentsstrukturen på tværs af sektorer ved brug af økonometriske modeller, som omfatter OLS regression og varighedsmodeller. Afhandlingen søger at afdække incitamentsstrukturen for at tage en ph.d.-uddannelse og efterfølgende vælge en karriere i den private sektor, hvor et stigende antal forventes at finde ansættelse. Projektet søger ydermere, at identificere hvilket faktorer der er relevante for det initiale ansættelsesvalg samt job mobilitet i den tidlige karriere.

Tidligere studier har undersøgt karriereveje blandt ph.d.er, men størstedelen af analyserne er baseret på data fra USA og i mindre grad på europæiske data og kun få analyser er lavet i en skandinavisk kontekst. De skandinaviske arbejdsmarkeder differentierer sig fra andre grundet det høje fleksibilitetsniveau angående ansættelser og fyringer men også det udbyggede velfærdssystem. Ydermere, i Europa har ph.d.er i mindre grad været ansat i den private sektor end i USA. Organiseringen af arbejdsmarkedet og sektorer kan have betydning for måden hvorpå ph.d.er mobiliserer sig. Dog betragtes arbejdsmarkedet for ph.d.er som værende internationalt, da de er meget mobile hvilket kan betyde at mønstre observeret i andre lande kan overføres til den skandinaviske kontekst.

Nærværende afhandling bygger oven på den eksisterende evidens vedrørende karrieremønstre. Men de fleste studier har kun fokus på en enkelt sektor, hovedsagelig enten den akademiske sektor eller industrien, hvorfor projektet søger at inddrage et mere dynamisk perspektiv på karrierevalg ved at fokusere på såvel intra- som inter-sektor mobilitet, da denne tilgang illustrerer de karrieremuligheder ph.d.erne har til rådighed.

De empiriske analyser har vist, at ph.d.er ikke er kompenseret økonomisk for deres ph.d.-grad når de sammenlignes med personer med kandidatgrader i den private sektor. Dette kan være en indikation af, at ph.d.er ikke genererer mere værdi for arbejdsgiverne, at arbejdsgiverne ikke formår at udnyttet ph.d.ernes egenskaber eller at ph.d.er værdsætter andre job attributter (end løn) mere.

Analyseresultaterne viser at personlige karakteristika såsom køn, alder og familie-relaterede faktorer er vigtige parameter i ansættelsesbeslutninger. De vigtigste parametre for ansættelsesbeslutningerne omfatter personlige præferencer, såsom at udføre akademisk forskning og værende aktiv i det akademiske samfund eller at deltage i udviklingen af nye produkter og processer i den private sektor. Studierne indikerer, at ph.d.erne træffer deres karrierevalg baseret på deres præference men inddrager også deres familierelaterede behov. Beslutningsprocessen er dog kun i lille grad baseret på aggregerede efterspørgsels- og udbuds parametre. Et eksempel herpå er at

en stor andel af ph.d.erne finder arbejde i den akademiske sektor på trods af den store konkurrence om at få fastansættelse. De ph.d.er er antageligt drevet af deres præference for at arbejde i den akademiske sektor og værdsætter arbejdet i akademia højere end jobsikkerheden, som andre sektorer i højere grad kan tilbyde.

Resultaterne viser at der er begrænset jobmobilitet mellem sektorerne efter at det initiale sektor valg er truffet. Ydermere, i det forgange årti har kun en konstant andel af de nyuddannede ph.d.er fundet ansættelse i det private arbejdsmarked, mens stigende andele har fundet ansættelse i både offentlige institutioner samt den akademiske sektor. Disse resultater står i kontrast til de opstillede forventninger, som beslutningstagerne i Danmark har fremsat om at et øget antal (svarende til halvdelen af de nyuddannede) finder arbejde i netop de private sektor. Den begrænsede job og sektormobilitet der er observeret kan have negative konsekvenser eftersom de socioøkonomiske gevinster ved at uddanne ph.d.er og ansætte dem i den private sektor ikke finder sted i det forudsete omfang.

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