Quantized careers : origins and consequences of the preponderance of temporary and junior jobs in academia

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CHAPTER 3

The coming of age of the academic career: Differentiation and professionalization of German academic positions from the 19th century to the present

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Abstract

In modern academic career systems there are a large number of entry positions, much smaller numbers of intermediate positions, and still fewer full professorships. We examine how this system has developed in Germany, the country where the modern academic system was introduced, tracing the historical development of academic positions since the early 19th century. We show both a differentiation and professionalization. At first, professorships and private lecturer positions were the only formal positions, but later, lower formal academic positions emerged. Over the whole period, the share of higher academic positions steadily decreased. This differentiation process was closely connected to professionalization: remuneration through salaries was extended from professors to almost everyone working in the German academic system. We propose that the process of differentiation and professionalization was induced by the expansion and democratization of higher education. Finally, our study shows that the opportunities for PhDs to obtain salaried (post-)doctoral positions have increased since the 1950s. On the other hand, opportunities for PhDs to become a professor or obtain another tenured job have decreased since the 1980s due to a slowdown of higher education expansion.

3.1. Introduction: many are called but few are chosen[1]

When university graduates seek to pursue a career in science[2], they are faced with the pyramidal structure of academic positions: a large number of PhD candidates at the base and only a few professorates at the top. In most countries, graduates start their careers in "apprenticeships", first as PhD candidates and later as postdoctoral researchers, during which they are more or less considered to be "qualifying" as scientists (and in many systems seen as students during the PhD period; Singer, 2000; Taylor, 2011). During this period they are typically on scholarships or temporary employment contracts. However, even when considered as students, they do account for a large share of scientific output (Larivière, 2012; Whitley, 1984). After this probationary period, postdoctoral researchers may obtain a permanent position if successful and if a post is available (Dooris & Guidos, 2006). This means university graduates aspiring to an academic career can be employed on temporary contracts for more than ten years: first, two to five or more years as a PhD candidate, and then for up to five years or more as a postdoctoral researcher (Nerad & Cerny, 1999).

Researchers and policymakers identify problems regarding current academic careers with a high level of consensus, notably the small number of PhD candidates eventually becoming tenured staff at academic institutions and the long probationary periods (Konsortium Bundesbericht Wissenschaftlicher Nachwuchs, 2013; Waaijer, 2013). To put it another way: "many are called but few are chosen".[2] A commonly stated sentiment is that it has become more difficult to obtain professorships because their number has decreased compared to the number of PhD positions, i.e., the academic career pyramid has become narrower at the top and broader at the base.

However, these statements refer to recent decades. To fully understand why the academic career system is as it is, we need to look back further and trace how academic careers have changed with regard to numbers of different positions and their characteristics, e.g., their associated employment conditions. This enables us to determine whether the pyramidal structure has indeed become flatter, making it more difficult to obtain a professorate.

First, we consider what an academic career is, looking at the literature on jobs, occupations, professions and careers, and introduce a stylized scheme of the academic career. Second, we provide more background information regarding Germany, the country we investigate in this paper, and describe its current academic career system. Third, we describe the differentiation of

[1] Matthew 22:14 (King James Bible).

[2] In an Anglo-Saxon context, the word "science" does not refer to disciplines such as mathematics, engineering and the humanities. Following the German tradition, we will use "science" like the more general *Wissenschaft*, which does include these fields.

academic positions in Germany from the beginning of the 19th century and the developments that led to this differentiation. Fourth, we describe the professionalization of the academic career in Germany from just before the 19th century and specifically focus on the recent increase in temporary positions. We show that the differentiation and professionalization are likely due to expansion (and more specifically democratization) of higher education. Finally, we investigate the academic career opportunities for PhD graduates by looking at the number of academic positions available to them at German universities and show that the opportunities to become a professor increased from 1953 until 1965, but have decreased ever since. We show that opportunities to obtain higher, permanent, academic positions are correlated with higher education expansion: they increase when growth of higher education is large, but decrease when growth slows down.

3.2. Concepts: what is an academic career?

3.2.1. Literature: jobs, occupation, professions, and careers

In the International Standard Classification of Occupations (ISCO-88) a job is defined as "a set of tasks and duties performed, or meant to be performed, by one person, including for an employer or in self employment", and an occupation as "a set of jobs whose main tasks and duties are characterized by a high degree of similarity" (International Labour Organization, 2012). ISCO-88 classifies occupations according to skill level and specialization, but not according to job titles. For example, because the skill specialization (e.g., the field of knowledge required) of a full professor in chemistry is different from the skill specialization of a full professor in anthropology, the two are assigned to different occupational groups. This means we cannot describe the development of an academic position as the development of an *occupation* (as defined by ISCO-88), because even when academic positions carry the same job title, they may belong to different occupations.

Another classification method is the grouping of jobs into *professions*. Defining professions may be done according to various approaches (Schmeiser, 2006): a trait catalogue approach (e.g., Barber, 1963; Goode, 1961), a functionalist approach (e.g., Parsons, 1959), a power approach (e.g., Abbott, 1988; Johnson, 1972; Larson, 1977), an interactionist approach (e.g., Hughes, 1963), or a systems theory approach (e.g., Stichweh, 1987). However, no consensus in the professions literature exists as to the method of delineating the academic profession, and even as to whether academic work actually constitutes a profession (Gläser, 2012; Stichweh, 1987). Therefore, in this study we will not examine the development of academic jobs as the development of a *profession* (or multiple professions), but instead we will treat academic jobs as formal or informal *positions* and will classify them according to their job titles.

Job titles send a signal about the career stage an individual is in. A career may be defined as "a process of development of the employee along a path of experience and jobs in one or more organizations" (Baruch & Rosenstein, 1992, p. 478). The traditional view of careers is that of vertical movement through a rigid, well-defined system within one organization, but over the past decades, as careers have become more fluid, career models that are more dynamic and multidirectional have been proposed, both with regard to the position on the career ladder and between different organizations (Baruch, 2004; Peiperl & Baruch, 1997). In contrast to careers in many sectors, careers in academia are usually still quite linear with regard to positions – one typically enters at a young age, works as an "apprentice" and tries to move up the career ladder, i.e., obtain a position considered to be higher. Most researchers who do not succeed in moving up leave academia to work in another sector. Horizontal, inter-organizational mobility is quite high; especially when transitioning from the PhD to the postdoctoral phase, researchers are expected to change institutions and preferably even work abroad (Ackers, 2008; Enders & Kaulisch, 2006).

3.2.2. Structure of academic careers

In this paper we consider the structure of careers in academic research, that is, research in public institutes. Most academic research takes place in (research) universities, but it may also occur in institutes of scientific societies, e.g., the German *Max-Planck-Gesellschaft* and *Fraunhofer-Gesellschaft* (Kreckel, Burkhardt, Lenhardt, Pasternack, & Stock, 2008, pp. 65-72). However, since most career systems within such institutes are based on those of universities, we will focus here on university career systems. As a point of departure, the archetype of the modern academic career, particularly in the U.S., is shown in Figure 1. It is an hierarchical picture of five university positions with associated characteristics. This scheme is not a realistic depiction of the actual occurrence of academic positions, but is the stereotypical image of academic careers that many, even experts on academic careers, have in mind (Academic Careers Observatory, 2010). As such, it does not model positions of all leading scientific countries or periods, omits some very important characteristics, such as when tenure is granted, when one is allowed to supervise students, when one is allowed to pursue one's own research line, etcetera. The complicating aspects of the archetypical scheme are dealt with in the scheme in Figure 2. The latter makes explicit four important aspects of the academic career: how scientists perform research, the extent to which they have to attract funding, the control they have over their scientific activities and over resources (similar to Whitley's notion of control, cf. Whitley, 1984, pp. 227-234, and his notion of "protected space", cf. Whitley, 2012), and their terms of employment. These are all broken down into multiple characteristics. In addition, we sketch how we expect these characteristics to progress during a typical academic career. Progression in these dimensions is not necessarily uniform but can differ between career systems.

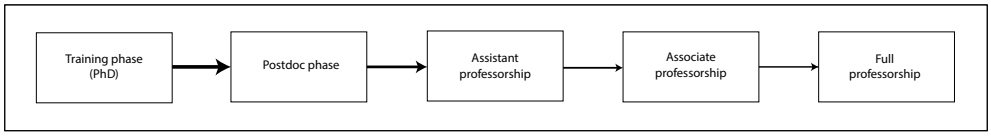

Figure 1. Archetypical academic career in the United States. The thickness of the arrows stands for the percentage of researchers moving from one position to another

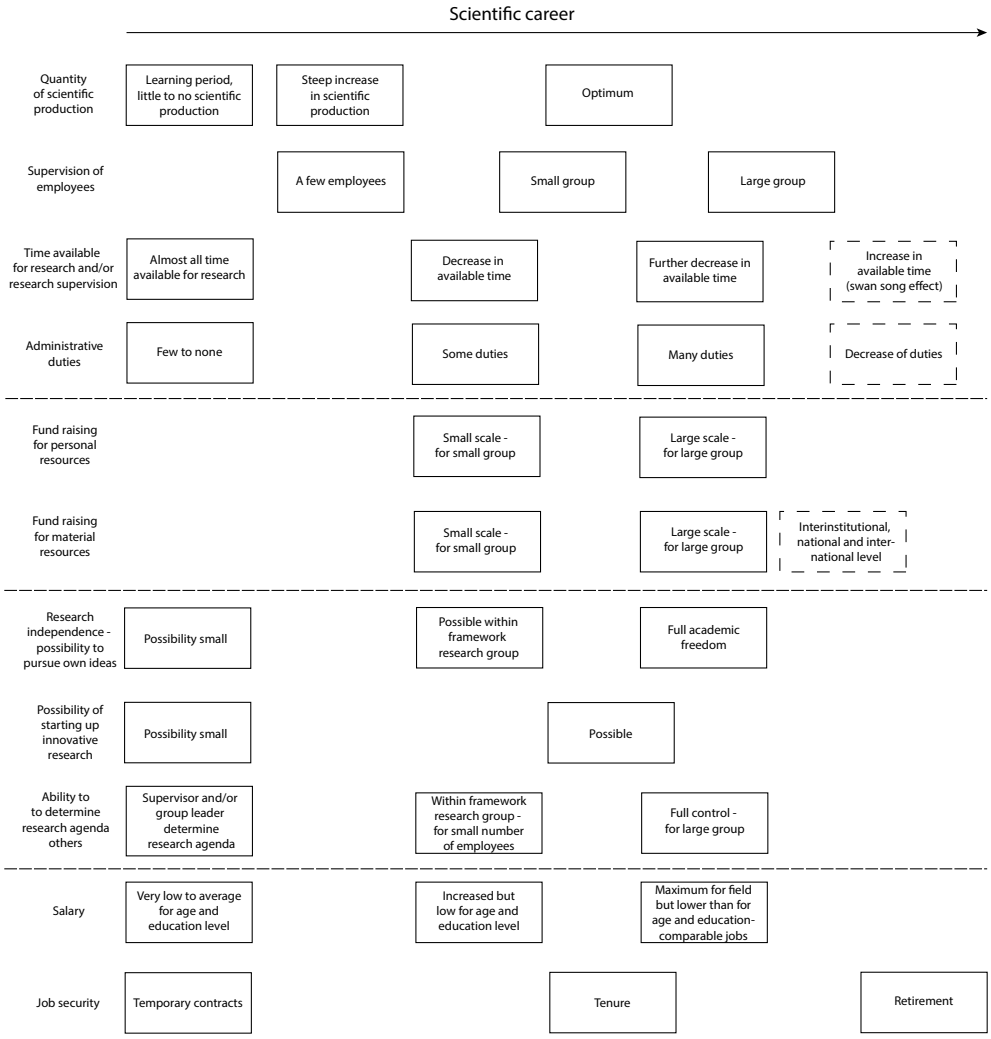

Figure 2. Structure of the academic career with its various characteristics. Horizontally the progress in the academic career is depicted; the further to the right, the higher the status of the researcher. Dashed boxes are developments that occur in some researchers' careers, but not in others'

In principle, each of the characteristics is needed to classify an academic position: salary, tenure, degree of independence, degree of supervision received or given, etcetera. Therefore, academic career systems of different countries, institutes, or scientific fields can only be compared using a multidimensional approach. In practice, however, it is impossible to collect quantitative information for long periods on each of the characteristics concerned. Instead, the scheme must be borne in mind when collecting and analyzing the data that are actually available. These data, supplemented where necessary by qualitative historical information, then serve as proxies for the characteristics underlying academic careers in Figure 2. With this approach, it turns out that a fairly good picture emerges of the German career structure from the 19th century until the present.

3.3. The German career system

3.3.1. Why Germany?

Germany is one of the leading countries in science and technology (S&T), spending 2.82% of its gross domestic product on research and development (R&D) in 2009 (OECD, 2009), having the fourth largest number of scientific publications based on the total number of citable publications in the Web of Science database in 2011 (own calculations), and having 39 universities in the top 500 research universities as measured by the Leiden 2011/2012 ranking (Centre for Science and Technology Studies, 2012). The German career system is even more interesting to study because of its historical development and the influence it has had on academic career systems across the globe. The concept of the research university originates in Prussia, from linguist, philosopher and government official Wilhelm von Humboldt. Before the 19th century, teaching students was the primary focus of universities. Humboldt introduced a model of higher education with unity of research and teaching at its core. Humboldt's idea was that students should not merely study existing knowledge, but should perform scientific work themselves, under the supervision of academic staff. Whereas the universities' focus had been to disseminate existing scientific knowledge, their focus was now on staff and students working to increase scientific knowledge (Gellert, 1993, pp. 7-9). The Humboldtian university model would be adopted by many countries and is the model on which current research universities are based.

The focus on science at German universities has likely contributed to Germany becoming the leading country in chemistry, physics and medicine from the 19th century until the end of the Weimar Republic in 1933. An example of the German dominance in science is that between 1901 and 1932 Germany was leading in the number of Nobel prizes for the sciences – a total of 32. Like the United States from the mid-20th century, Germany was the country to move to

in order to work at the most prestigious institutes (Taylor, Hoyler, & Evans, 2008). It seems likely that its proven success and influence on foreign scientists made the German academic career system a standard for other countries.

3.3.2. The present system

A minor difficulty in studying the German system in an international context is terminological, as no standard translations of German job titles into English exist. In Table 1 we give an overview of the English terms we use for German positions as well as descriptions of them. Roughly four different types can be distinguished in the German academic career system: professors, lecturers, university teachers, and research affiliates and assistants. Professorships (including ordinary, extraordinary, and junior professorships) are characterized by their independent research and teaching. Lecturers (positions just below the professorship) in practice also fulfil their research and teaching tasks independently, but do not hold the professorial title.[3] University teachers have a focus on teaching and are often employed part-time. Finally, research affiliates and assistants are researchers who do not set their own research agendas, but rather assist "their" professors in the realization of the professors' research lines (Kreckel et al., 2008, p. 51).

Professorships are the highest academic positions; within this group full professorships are considered to be highest, followed by extraordinary professorships and junior professorships. Professors have much influence over the research agenda of their groups, implying that the current German system can be qualified as being fairly hierarchical. The largest group of academics is lowest in rank: research affiliates and assistants. The difference between the two positions is that affiliates are employed full-time, whereas assistants are typically employed part-time and expected to work on their PhDs for the remainder of the time. Together, the affiliates and assistants make up the early-career scientists, who are considered to be training to obtain professorships themselves (Kreckel, 2012). Academic careers typically start with a period as a PhD candidate (*Doktorand*)[4], for whom a variety of positions and remunerations exist. In the natural sciences, PhD candidates usually have a position as a research or teaching assistant, or research affiliate. In the humanities and social sciences on the other hand, the percentage of PhD candidates on a scholarship or even without any financial allowance is much higher (Fräßdorf, Kaulisch, & Hornbostel, 2012).

[3] However, strictly speaking, only researchers in the professors group perform research and teaching independently according to German higher education law (*Hochschulrahmengesetz* §43).
[4] The German translation for a female PhD candidate is *Doktorandin*. For the sake of brevity, we will use masculine forms of German terms throughout the text.

Table 1 Main current academic positions in Germany

Position	German term	Description
Professors		
Full professors	*W3 Professoren*; until 2005 *C4 professoren*	Academic staff occupying a professorial chair; responsible for research and teaching of a full scientific field.
Extraordinary professors	*W2 Professoren*; until 2005 *C3 professoren*	Academic staff independently performing research and teaching in (parts of) a scientific field.
Junior professors	*Juniorprofessoren* (W1)	Starting group leaders setting up independent lines of research.
Lecturers		
University lecturers	*Hochschuldozenten*	Academic staff, non-professorial.
University teachers		
Adjunct professors	*Lehrbeauftragte*	Freelance teacher of specific subjects.
Private lecturers and senior private lecturers	*Privatdozenten und außerplanmäßige Professoren*	Private lecturer: independent *Habilitation*-holding teacher; senior private lecturer title is given to private lecturers who have been private lecturer for 2-6 years (depending on state). Used to be the main position below professorships, but has been replaced by junior and extraordinary professorships.
Research assistants and affiliates		
Research affiliates	*Wissenschaftliche Mitarbeiter*	Junior researchers (postdocs and PhD candidates) performing research and teaching under the supervision of a professor.
Research assistants	*Wissenschaftliche Hilfskräfte*	Students assisting in research projects, often to fund own PhD research. Note: bachelor and master students providing research assistance are grouped into this category as well.

Sources: Busch, 1963; Bock, 1972; Enders, 1996; Kreckel et al., 2008; Statistisches Bundesamt, 2011.

After the PhD, researchers can obtain positions as (postdoctoral) research affiliates (the designation for doctoral and postdoctoral research affiliates is the same: *wissenschaftliche Mitarbeiter*).[5] Postdoctoral research affiliate positions are often used to work on a *Habilitation*, a "second dissertation". Researchers who have obtained this are referred to as private lecturers (*Privatdozenten*). Historically, the *Habilitation* was required to obtain the *venia legendi*, the formal right to teach at universities, which was needed until the end of the 20th century to become a full professor. In the present century an attempt has been made to reduce the role of the *Habilitation* (bringing the system in line with other countries) by introducing junior professorships (Böhmer & von Ins, 2009). With a junior professorship, scientists with a PhD can set up their own research group and research line without having obtained the *Habilitation*. In addition to professorships, so-called "habilitated scientists" may be employed as lecturers or university teachers.The employment conditions of the different positions vary; professors are typically employed on permanent contracts (with the exception of junior professors), whereas almost all research assistants and affiliates are employed on temporary contracts (Kreckel et al., 2008, pp. 45, 51). Lecturers and university teachers may be employed on either type of contract.

3.4. Differentiation of academic positions

From the mid-19th century quantitative data on academic positions are available for Germany. However, the quantitative studies employ different methodologies, especially in how they define groups of scientists. Various reasons for these differences exist: the focus of the study (e.g., focus on professors or a broader scope including other positions), the existence of positions (thus, junior professorships are a recent phenomenon), and methodological choices (e.g., are ordinary and extraordinary professors lumped together or broken down into two separate groups?). We focus on "the big picture" and sketch developments in academic career systems with such data as are available. We combine quantitative data on academic positions from various sources with qualitative scientific literature on the history of academic careers.

3.4.1. Differentiation before WWII

At the top of the 19th-century hierarchy of official academic positions were the professors: the ordinary professor (*ordentlicher öffentlicher Professor* or *Ordinarius*) and extraordinary professor (*außerordentlicher Professor* or *Extraordinarius*). The difference between the two is that the ordinary professor held a professorial chair in a broad subject, whereas an

[5] According to the German law on academic employment (*Wissenschaftszeitvertragsgesetz,* 2007), a researcher can be employed on a temporary contract (as research affiliate or assistant) for up to six years before and also up to six years after the PhD (nine for medicine). However, positions paid by third-party funding are exempt from these regulations.

extraordinary professor did not hold a chair and typically worked on a narrower subject (Eulenburg, 1908, pp. 55-60).

A third academic position in 19th-century universities was that of private lecturer (*Privatdozent*). Private lecturers were non-professorial academics giving lectures and performing research independently (Busch, 1963). A private lecturer could be promoted to extraordinary professor or directly to ordinary professor. An extraordinary professor could fill that position for his entire career, but could also later be promoted to ordinary professor. As these customs show, ordinary professorships were considered to be higher positions than extraordinary professorships (Eulenburg, 1908, p. 51; von Ferber, 1956,pp. 102-111). Some extraordinary professors received remuneration from the university, whereas others only received a professorial title by appointment as extraordinary professor (Eulenburg, 1908, pp. 3-4; von Ferber, 1956, p. 46). From the 1920s, an explicit distinction was made between paid (*planmäßige*) and non-paid, "honorary" (*außerplanmäßige*) extraordinary professorships (von Ferber, 1956, pp. 22, 82), which is reflected in university employee statistics.

Another category of employees was research assistants (*wissenschaftliche Assistenten*). We now associate these assistantships with "apprenticeship" positions for scientists at the beginning of their careers. However, originally research assistants were literally employed as assistants to professors. As described above, in the Humboldtian model, education by experimental work was considered vital for students. An assistant's job consisted of aiding experimental demonstrations by professors during lectures and of facilitating and performing experimental work for their professors. In addition, supporting personnel such as librarians and museum curators were given assistant positions. Over time, a so-called "assistant career" developed. This tiered career ladder consisted of three positions called 1st, 2nd and 3rd research assistant, which could be obtained based on age, years of service, and merit (Bock, 1972, pp. 120-121). Assistantships could become holding posts ("*Bewährungsaufstiege*") for researchers who had not been able to obtain a higher position despite excellent work, and even sometimes unofficially functioned as department heads (Bock, 1972, p. 127). This shows that the academic career structure at that time did not necessarily reflect the seniority and responsibilities of German academics. Immediately after WWI, a discussion regarding the role of the assistant position arose. Following this discussion, a differentiation was made between more permanent positions for scientifically established specialists and positions for those still qualifying as a scientist (Bock, 1972, pp. 187, 221-223). This meant the formal introduction of positions for scientific "apprentices" and a more formalized career system, with the positions assistant – private lecturer – professor comprising its stages (Busch, 1963).

To the best of our knowledge, the first study on numbers of different academic positions was performed by Christian von Ferber, who investigated the German academic career system as it developed from 1864 until 1953 (von Ferber, 1956). He counted the numbers of different types of professors, (private) lecturers, and university teachers at eleven time-points. Unfortunately, his data do not include numbers of persons working to obtain a PhD or a *Habilitation*, probably because such individuals would still be considered to be "qualifying" to become a scientist, i.e., obtain the *venia legendi*, for a major part of this period. Nevertheless, his study reveals some very interesting developments in the shares of academic positions.

Most notably he shows that the proportion of ordinary professors had steadily decreased from half of all academic employees in 1864 to approximately 25% by 1953 (Fig. 3). From 1864 until 1910 there was an increase in the share of private lecturers, but after this period it decreased again, falling below the 1864 proportion. The line showing the share of extraordinary professors is uneven as well; it suggests the share of extraordinary professors remained stable until 1920, but had increased dramatically by 1931. A possible explanation could be that honorary, non-paid extraordinary professorships, which used to be grouped with paid extraordinary professorships, were explicitly measured for the first time around 1930; after World War II the proportion had decreased again. In the whole period of von Ferber's study, the position with the largest increase in share was that of university teachers. This group, however, is a fairly heterogeneous group consisting of university teachers paid on a contractual basis, part-time professors and research candidates[6], so it is difficult to say definitively which subgroup or subgroups contributed to the increase.

The main trend in these figures (already noted by Ben-David and Zloczower [1961]) is that the share of ordinary professorships declined, whereas other positions below the professorship (private lecturers, extraordinary professors and a heterogeneous group of [part-time] university teachers and scientists) grew. Our analysis shows that different positions took turns "filling the gap" left by the relative decrease in ordinary professorships.

The conclusion that positions below the professorship became more prevalent is further supported by von Ferber's analysis of the relative numbers of private lecturer positions and non-paid extraordinary professorships in comparison to the numbers of the ordinary and paid extraordinary professorships. The analysis shows that the relative number of private lecturers and non-paid extraordinary professors increased dramatically over time, especially in medicine and the natural sciences (Fig. 4).

[6] Von Ferber referred to them as "*Kandidaten der wissenschaftlichen Forschung*", which most likely indicates researchers working on a *Habilitation*.

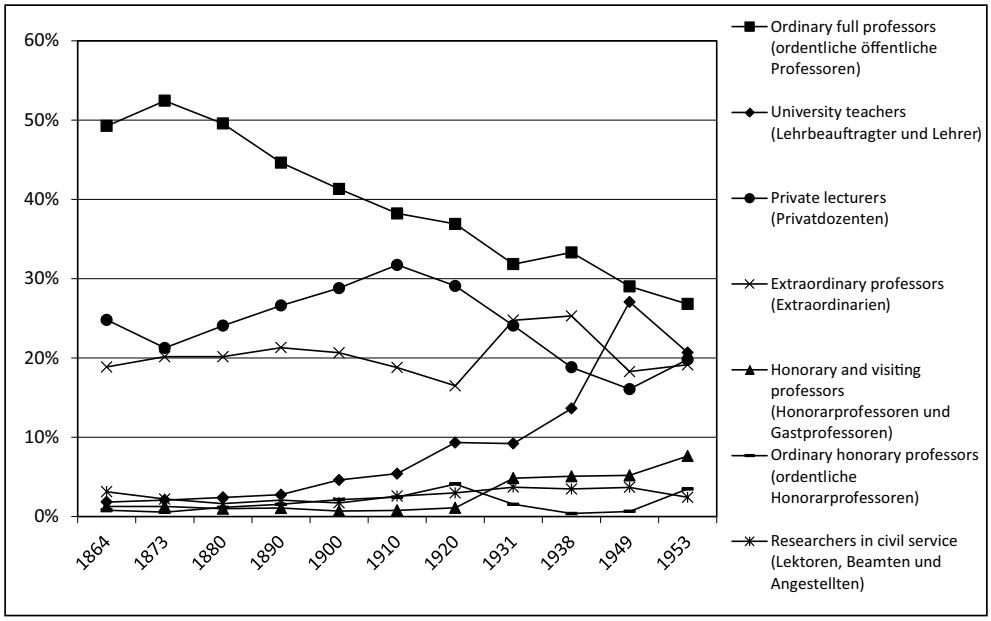

Figure 3. Distribution of academic positions at German universities by academic rank, 1864-1953. For 1953 West Germany only. Source: von Ferber, 1956, pp. 195, 210

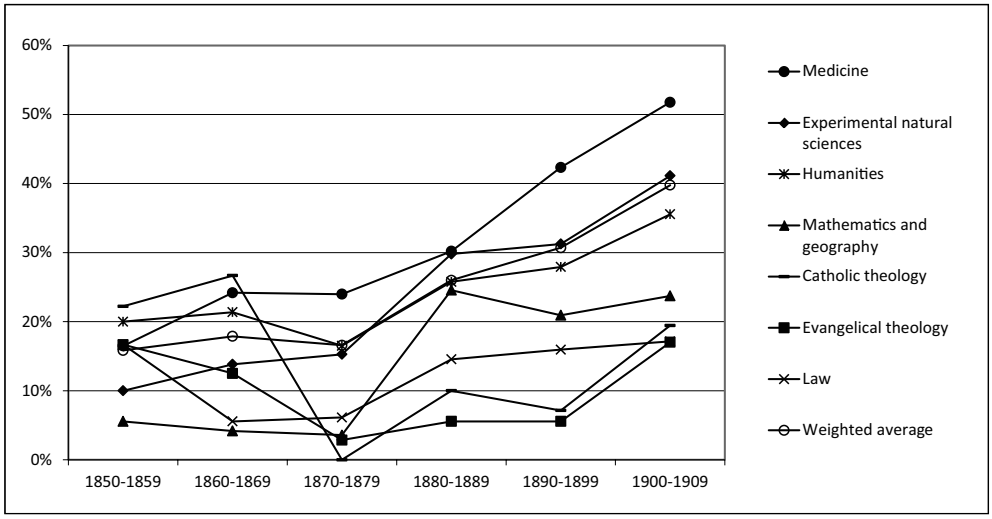

Figure 4. Private lecturers plus non-permanent extraordinary professors as a percentage of all higher academic positions per subject area. Source: von Ferber, 1956, p. 81

3.4.2. Differentiation after WWII

To investigate the distribution of academic positions from around 1950 until now, we turn to publications on this subject by the German Federal Statistical Office (*Statistisches Bundesamt*) published from 1952 (Statistisches Bundesamt, 1953; 1966; 1969; 1976; 1982; 1992b; 2001;

2004b; 2011). They not only contain the numbers of professors, lecturers, and university teachers, but also of other university employees. This means that data on research affiliates and assistants can now be incorporated into our analysis. A limitation of these publications is that their classification of academics has changed over the years due to the fact that designations and job descriptions have changed; this makes it difficult to track the development of specific positions. Therefore, we show differences in the academic career system by showing the development of the four groups of positions we discussed above: professorships (ordinary, extraordinary, and junior professorships), lecturer positions, university teacher positions, and research affiliate and assistant positions. An overview of all current academic positions as distinguished by the German Federal Statistical Office and a description of these positions is given in Table S1 in appendix 2).

These data show that the relative number of professorships (ordinary, extraordinary, and junior) declined even further from close to 30% in 1953 to approximately 10% in 2010. This decline is due to the appointment of a large number of research affiliates and assistants; their percentage rose from about 40% to almost 70% (Fig. 5). In addition, the share of lecturers declined. The share of university teachers remained stable over this period (except for a dip in the 1960s). In conclusion, the current German academic career system of research positions is characterized by a small top of professorships, few intermediate positions, and a broad base of junior research positions.

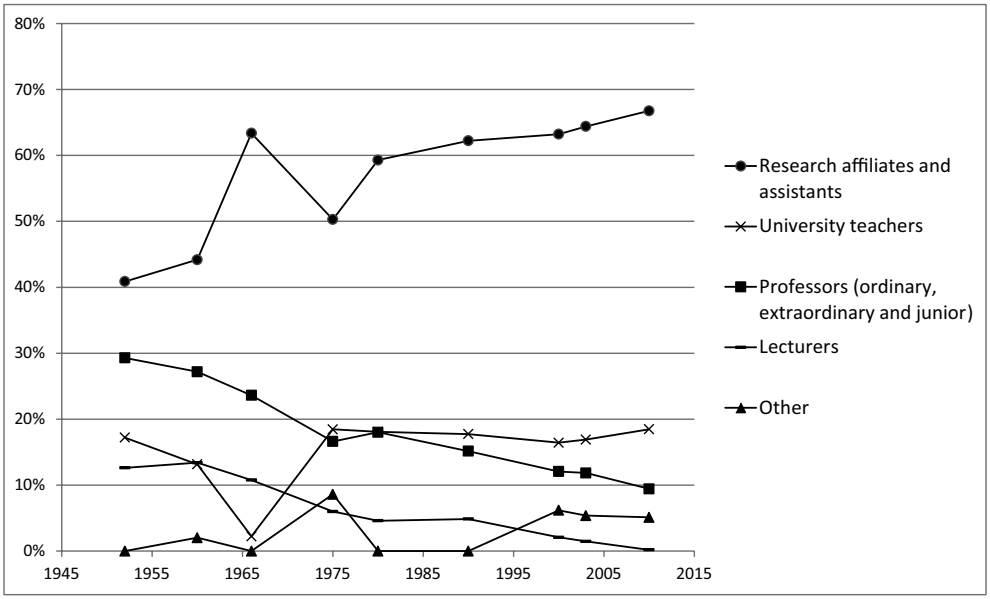

Figure 5. Distribution of academic positions at German universities by academic rank, 1952-2010. For 1953-1990 West Germany only. Source: Statistisches Bundesamt (Personal an Hochschulen, 1953-2011)

3.4.3. Conclusions and possible causes

It is quite clear from the above description that the stereotypical academic career of Figure 1 cannot be used to describe the development of the German career system. Instead, the more elaborate concepts of Figure 2 are needed to understand the available data. These data show that from the early 19th century on, a differentiation of formal academic positions took place. Whereas at the beginning of the 19th century the only official positions had been professorships and private lecturer positions, later new positions such as research affiliate arose. Furthermore, there were changes in the relative numbers of positions – the proportion of lower academic positions grew, whereas that of the highest academic positions (professorships) steadily declined. This does not necessarily mean that the ratio of "trainee" scientists to professorships increased, however. Before the full formalization of PhD and *Habilitation* work in research affiliate/assistant positions, scientists pursuing their PhD and *Habilitation* were already working in the science system, only they were not included in university employee statistics.

The main question arising from the continued differentiation towards (formal) academic positions for academics working on a *Habilitation* and PhD is what could have caused this development? The differentiation of academic positions was part of the exponential growth since the 16th or 17th century in the number of people we would now call scientists. This growth led to large absolute increases in the number of scientists in the 19th century, which were especially apparent in Germany (Gascoigne, 1992, pp. 556-557).[7] Later, further expansion, and importantly, democratization of higher education occurred: the access to higher education expanded to students from all social backgrounds.[8] Even before the beginning of the 20th century, children from middle-class families were increasingly enrolling at universities (Windolf, 1997, pp. 55-56). However, it was not until after WWII, when the number of students at universities grew rapidly, that more children from lower-class families started going to university (Enders, 1996, p. 64; Windolf, 1997, p. 57). In the 1950s, the educational burden on assistants due to the expansion of higher education had become so great that they did not have enough research time to pursue a *Habilitation*. As the growing numbers of students also meant an increase in universities' resources, more assistants could be hired. Whereas it had been common for professors to have one assistant at their disposal, in the 1960s they were able to hire two or even three (Bock, 1972, pp. 194-195). Thus, the expansion of higher education had led to an increased demand for academics.

Literature on organizational structure shows a larger size of organizations may be correlated with an increased vertical span of control (Pugh, Hickson, Hinings, & Turner, 1968; Hinings

[7] An exponential growth has also been observed in the number of scientific papers (De Solla Price, 1963; van Raan, 2000).

[8] Defined as "external democratization", in contrast to "internal democratization", which is employees' and students' involvement in university governance (Hermans, 2002).

& Lee, 1971). Our data suggest a similar mechanism was at play at German universities. An important difference, however, is that there was no increase in the vertical span of control *per se* (no additional types of positions between professorships and affiliate positions were introduced in the 1960s and 1970s). Instead, the number of people in the pre-existing types of lower positions was increased relative to the number of professorial positions (also noted by Enders [1996, pp. 59-79]). This increase in the number of researchers in pre-existing types of lower positions rather than an increase in the vertical span of control might be due to the traditional master-apprentice relationship in science (Huisman, de Weert, & Bartelse, 2002).

3.5. Professionalization of academic positions

In addition to the differentiation of academic positions, a professionalization of science took place, as research became a fully paid job over the course of the 19th and 20th century. Furthermore, the ways in which scientists were remunerated have varied throughout this period. In this section we show developments in the professionalization of academic positions using various qualitative and quantitative sources.

3.5.1. Remuneration before the 19th century

Before the 19th century, across the world scientific research was not ordinarily remunerated through paid research jobs, but mostly performed by amateurs who were paid through other occupations (Ben-David, 1972; Crosland, 1975; Hahn, 1975). This is not to say these amateurs provided sub-standard work; like Crosland in his paper on the professionalization of academic careers in France, we use the terms "professional" and "amateurish" not as an indicator of the quality of the work but in a strictly occupational sense, i.e., being paid for scientific work or not (cf. Crosland, 1975). Furthermore, before the French Revolution, science and literature were not clearly demarcated (Crosland, 1975). The first steps towards the professionalization of science were taken with the foundation of Academies of Science, which gave out allowances to their members. However, these allowances were hardly sufficient to support a family (Hahn, 1975). During the French Revolution and the subsequent Napoleonic wars, scientific knowledge was increasingly valued for practical (war-time) use, and consequently, scientific work became a fully paid job. This led to a differentiation between science on the one hand and literature on the other. But whereas scientific research in France was now more fully recognized through paid employment, it took place at other locations than the university alone (Ben-David, 1972). This was different in the German states, where, due to the introduction of the research university, research and teaching were practised jointly within the universities.

3.5.2. Professionalization from the early 19th into the 21th century

Even though all formal academic positions existing at the beginning of the 19th century constituted "paid employment" as we define it now (International Labour Organization, 1993), the mode of remuneration and security of positions varied. Of the three official academic positions, only ordinary professors were paid salaries from the universities. As mentioned above, this was not always the case for extraordinary professors: some received salaries, whereas for others the professorial title was only honorary. The third position, private lecturer, was not remunerated by the universities (Ben-David & Zloczower, 1961; Weber, 1918). Instead, private lecturers were paid on a "freelance" basis through lecture fees they had to collect directly from their students (Weber, 1918). All types of academics received lecture fees (Eulenburg, 1908), but ordinary and paid extraordinary professors were less dependent on them. Thus the private lecturer's income was variable and uncertain. The uncertain nature of the private lecturer position has even been described by Busch (1963) as "they [the private lecturers] were more or less without rights, but they were under great pressure to do good work as scientists and as teachers. The *Privatdozenten* were, in a sense, the 'proletarian reserve army' serving the 'ruling class' of full professors." (Busch, 1963). By 1875, however, industrialization had led to a greater demand for highly educated individuals in other professions and the pool from which to draw professors had shrunk. Therefore, the Prussian Minister of Education established a fund to give stipends to private lecturers (Busch, 1963). Still, according to Busch, private lecturers remained underpaid as these funds were "chronically exhausted" (Busch, 1963, p. 331).

The government fund was an important yet not the only possible source of income for private lecturers. The position of assistant, which was first used for employees who literally assisted professors, later became a salaried position for scientists striving for a professorship (Bock, 1972). As such, it was used to appoint both those pursuing a *Habilitation* and those who had already obtained it, i.e., private lecturers (Eulenburg, 1908). Thus, a scientist could be both private lecturer and assistant: the private lecturer title gave the academic right of *venia legendi* and the position of assistant provided remuneration (Busch, 1963).

As described above, the position of assistant became more formalized after WWI. In addition, assistants' salaries were set out precisely (Busch, 1963). In contrast, the legal position of private lecturers did not change and they did not have formal financial security. However, in practice, by this time they were assured of a steady income through various forms of remuneration (Busch, 1963).

Table 2 Research affiliates at German universities on permanent contracts, 1980 and 1990

	All fields	Humanities (excluding art)	Sports science	Social sciences	Mathematics and natural sciences	Medicine	Veterinary medicine	Agricultural, forestry and nutritional sciences	Engineering	Art and art history	Central office and not specified
1980											
Total number of research affiliates	36914	4515	379	3393	8655	9548	434	1136	5858	363	2633
Of which on a permanent contract (%)	47.9	64.2	86.8	36.0	46.1	43.8	31.1	55.6	39.8	81.0	64.1
1990											
Total number of research affiliates	66409	6428	395	5408	17900	18864	564	1746	9775	608	4721
Of which on a permanent contract (%)	26.5	37.0	50.1	21.5	21.6	26.3	21.5	17.4	25.6	52.6	38.0

Sources: Statistisches Bundesamt, 1982, p. 22; 1992, p. 20. Research affiliates on permanent contracts: *akademische/wissenschaftliche Oberräte auf Dauer, akad./wiss. Räte auf Dauer*, and *wissenschaftliche und künstlerische Mitarbeiter auf Dauer*. Research affiliates on temporary contracts: same job titles, but *auf Zeit* instead of *auf Dauer*.

In the 1960s, research affiliate positions were not only used to employ private lecturers or scientists working on a *Habilitation*, like before WWI (von Ferber, 1956), but also to employ scientists working on a PhD (Bock, 1972). Thus, virtually all academic positions became formal, salaried positions. The fact that academic degrees are conferred for work performed in these paid jobs shows the dual role of the research affiliate or assistant (cf. Enders, 1996): on the one hand, "qualifying" to become a scientist, while on the other hand being paid as an actual scientist, and accounting for a large share of scientific output (Larivière, 2012; Whitley, 1984).

3.5.3. Temporary contracts

As described above, the first 70 years of the 20th century saw PhD candidates and postdoctoral researchers increasingly becoming paid employees. At the end of that period, many of them had an employment contract. The share of permanent contracts for research affiliates differed per scientific discipline, but in 1980 on average almost one-half had a permanent contract (Table 2). After 1980, there was a change in the other direction as the share of permanent contracts declined. Differences in the share of permanent contracts persisted across disciplines, but this share did decrease among all. By 1990, on average three-quarters of the contracts were temporary. The halving of the share of permanent contracts during the 1980s was only the beginning. This trend has continued and these days, permanent contracts for research affiliates are a rarity (Kreckel et al., 2008).

3.5.4. Conclusions and possible causes

The main trend in the remuneration of German academics is a sustained professionalization: whereas at the beginning of the 19th century professorships were the only salaried positions at universities, later on positions below the professoriate became paid, down to the position of PhD candidate. Employment security varied as well, as private lecturers were first remunerated on a "freelance" basis, and later through stipends, or, alternatively, through employment as research assistants. On the other hand, whereas in the years following WWII more research affiliates were getting permanent contracts, this trend has been reversed and affiliates are increasingly employed through temporary contracts. This reverse trend took place against a background of liberalization of the entire public sector, of which the main proponents were the Reagan and Thatcher administrations in the United States and the United Kingdom, but which was also followed to some extent in Germany by the Kohl administration (Engartner, 2007). This liberalization led to an increase in temporary contracts in the whole public sector (Hassel, 2011). Furthermore, there has been an increase in the importance of third-party funding (*Drittmittel*) in German science. For example, the percentage of research affiliates paid from third-party funding increased from 16 per cent in 1975 to 21 in 1980 and 32 in 1990 (Table S2 in appendix 2). By 2011, one-third of the total university budget came from third-

party funding (Statistisches Bundesamt, 2014). It is likely that the increase in importance of third-party funding has contributed to the increase in temporary contracts. On the other hand, of all *wissenschaftliche Mitarbeiter* with a permanent contract in 1980, one-third was paid from third-party funding, so at least during this period third-party funding and permanent job contracts were not mutually exclusive (Statistisches Bundesamt, 1982).

The democratization of higher education not only led to changes on the *demand* side of the academic labour market, but also to changes on the *supply* side, as more children from middle- and lower-class families were going to university (Windolf, 1997). Following the democratization of undergraduate education, an increase in the share of PhD candidates from the middle and lower classes was to be expected. These individuals could not easily afford to work on their doctoral and *Habilitation* dissertations unpaid, so a need developed to compensate the lower academic ranks financially (see for example Bock, 1972, pp. 188-89 for an example of this reasoning). The early 20th century saw an increase in the share of habilitated academics whose fathers had not obtained a university diploma – from 9 per cent in the 1890-1919 period to 26 after 1945 (von Ferber, 1956). This process of PhD democratization continued and by 1955 already 39 per cent of all PhD graduates were from lower- and lower middle-class families (Hartmann, 2002). This share further increased to 46 in 1985. Conversely, the share of PhD graduates from the absolute upper classes (*Großbürgertum*, making up only one-half of a per cent of the general population [Hartmann, 2002]) had decreased from 15 in 1955 to 8 per cent by 1985. These data show that the democratization of higher education has contributed to both the differentiation and professionalization of academic positions.

3.6. Being called and being chosen: academic career opportunities for PhD graduates

A focal issue in academic career policy is the imbalance between the number of people entering the scientific workforce (i.e., PhD candidates) and the number of available faculty positions (Waaijer, 2013). A common sentiment is that it is more difficult for today's new PhD candidates to obtain a permanent faculty position than it was a few decades ago, but hard facts on this issue are lacking. To determine whether it has actually become more difficult, one has to look at the supply (academic jobs) and the potential demand (PhD graduates) in the academic job market. We have calculated the ratio of the numbers of different academic positions and the number of successful PhD defences (with interpolated data for years with missing figures).[9]

[9] For the missing years, we have estimated the number of positions and successful PhD defences by interpolation. I.e., $x_t = x_l \cdot (1 + g_{s-l})^{t-l}$, where x_t is the number of positions at time t, x_l is the number of positions at the last available time-point, g_{s-l} is the average annual growth rate in the number of positions between time s (subsequent available time-point) and time l (last available time-point), and $t - l$ is the number of years between time t and time l.

We have only included positions that imply (full-time) university employment. For example, honorary and visiting professors, freelance teachers (*Lehrbeauftragte*) and research assistants (*wissenschaftliche Hilfskräfte*) were excluded as these are not typically positions upon which an academic career is built. The ratio between positions and finished PhDs provides an estimate of the career opportunities available to PhD graduates: an "opportunity ratio". In this analysis one must take into account that it takes time to obtain some of the positions. Therefore, we have compared the number of successful PhD defences from one year with the number of positions a certain number of years later. First, we will show the results of this analysis for (ordinary, extraordinary and junior) professorships. Within the investigated period, the average age at PhD graduation ranged from 31.0 to 33.0 (Table S3 in appendix 2). Meanwhile, the average age of those obtaining a professorship ranged from 38.1 to 44.3 (Table S4 in appendix 2). The difference between the two is seven to eleven years. Germany, however, has a relatively large number of external PhD candidates who work on a dissertation in addition to their non-research jobs. This causes a relatively high average age at PhD graduation (Kehm, 2009). In most cases, external PhD candidates do not aspire to an academic career. PhD candidates who do have these ambitions and later become professors, start *and* finish their PhD at an earlier age on average than the total group of PhD candidates. Therefore, a period of 15 years between PhD and professorship seems reasonable. Consequently, in the calculation of the "professorship opportunity ratio" for 1953 PhD graduates, we divided the number of professorships in 1968 by the successful PhD defences in 1953. For persons who obtained their PhDs between 1953 and 1965, the opportunities for professorships had improved (Fig. 6a). However, from then on, opportunities have steadily declined, and are now almost back at the immediate post-WWII level.

For the position of lecturer the situation is quite similar. We took 10 years between PhD graduation and becoming a lecturer. It became relatively easier to obtain a lecturer position for PhD graduation from 1953 until 1965 (Fig. 6b). From then on, opportunities decreased again. This can be explained by the fact that hardly any researchers are being appointed as lecturers anymore; the position of lecturer is becoming extinct in Germany (cf. Fig. 5).

For university teacher positions, we also assumed a period of 10 years between PhD graduation and obtaining a position. Before 1975, statistics on academic employees did not distinguish between full-time and freelance university teachers (among which the largest group are the *Lehrbeauftragte*). Therefore, we chose to analyze the data for university teachers from 1975 (PhD in 1965). Their opportunity ratio has fluctuated to a small extent, but has remained relatively stable compared to that for the other types of positions (Fig. 6c).

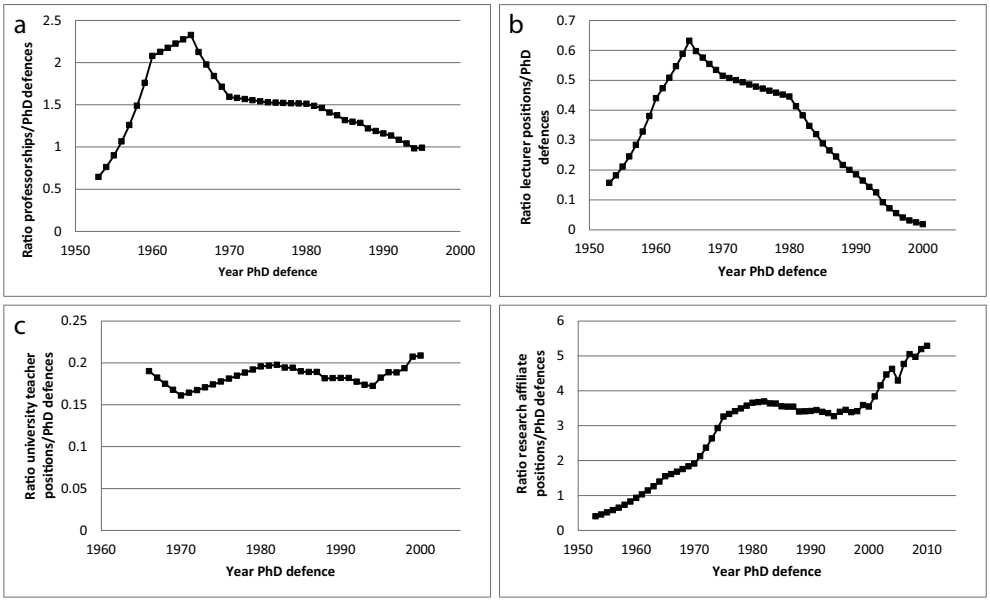

Figure 6. Opportunities per year. The ratio between the number of academic positions and number of successful PhD defences is depicted assuming a fixed period between PhD defence and eligibility for the position (data for missing years interpolated). For 1953-1992 West Germany only.
(a) Professorships (ordinary, extraordinary, and junior): 15 years between PhD and eligibility for position. (b) Lecturer positions: 10 years. (c) University teacher positions: 10 years. (d) Research affiliate positions: none.
Sources: Statistisches Bundesamt, 1953-2012

Finally, we look at the opportunities for becoming a research affiliate. Our analysis shows that the opportunity ratio for affiliates has greatly increased over the investigated period (Fig. 6d). Unfortunately, German federal statistics do not distinguish between doctoral and postdoctoral research affiliates. This makes it impossible to conclude whether the increase is due to relatively more PhD candidates obtaining positions as an affiliate, more postdoctoral researchers obtaining such positions, or a combination of both.

A cautionary note in interpreting these results which bears repeating is that in Germany a PhD not only serve as a gateway to an academic career, but also as a degree that increases a person's standing in the non-university sector (Konsortium Bundesbericht Wissenschaftlicher Nachwuchs, 2013). An increase in the share of PhD graduates who do not aspire to a further academic career effectively increases the career opportunities for those who do. Thus, the *demand* for professorships does not have to be proportional to the number of PhDs. Still, the opportunity ratio serves as an indicator of the *supply* of career opportunities relative to all of those who have become qualified, i.e., PhD graduates.

These significant changes in the opportunities for progressing from PhD to higher academic positions are highly correlated with the large university expansion and subsequent slowdown of this expansion. Figure 7 shows the growth rate of all academic positions per year plotted against the opportunity ratios of the different positions.[11] For all positions, an increase in the ratios can be observed for the 1953-1975 period, when there was a large increase in the total number of positions. However, when growth slowed down, opportunities to obtain a professorship or lecturer position decreased (Fig. 7a-b). Conversely, opportunities for university teacher positions remained quite stable, and opportunities for research affiliate positions mainly increased (Fig. 7c-d). This suggests that when universities undergo massive expansion, like they did between 1961 and 1975, the opportunity to be appointed to an academic position increases for PhD graduates. But when this expansion slows down again, opportunities for the higher academic positions decrease.

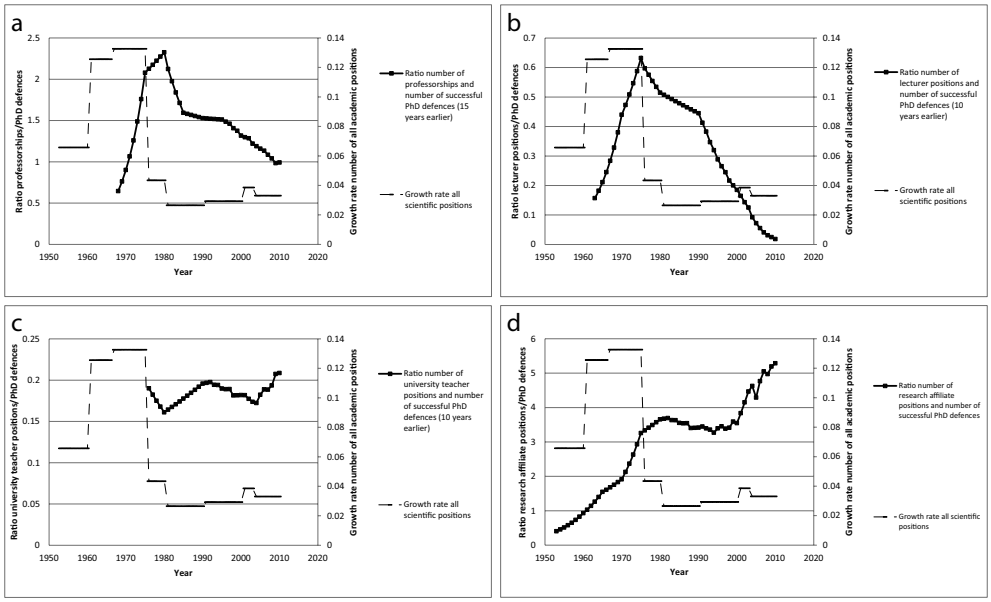

Figure 7. Relationship between career opportunities and growth of the university system. The growth rate of all scientific positions is plotted, as are the opportunity ratios (defined as in Fig. 6) for the year in which a position is obtained.[10] Periods between PhD and eligibility for a position as in Figure 6. For 1953-1992 West Germany only.
(a) Professorships (ordinary, extraordinary, and junior). (b) Lecturer positions. (c) University teacher positions. (d) Research affiliate positions.
Sources: Statistisches Bundesamt, 1953-2012

[10] In this figure, the ratios are plotted for the years of obtaining the positions, instead of the year PhD was obtained (as in Fig. 6).

Ben-David and Zlowzower (1961) already described for Germany from the 19th century until the end of WWII that in times of large expansion, many researchers are appointed on permanent contracts, but when the expansion slows down, there is almost no room for new hires. Here we show that the same holds true after WWII. Opportunities to obtain positions that usually entail a permanent contract (i.e., professorships) decrease. Conversely, opportunities to obtain positions that typically entail a temporary contract (i.e., a research affiliate position) increase, despite the slowdown of university expansion. This suggests that universities use temporary contracts as a "coping mechanism" when their growth slows down.

3.7. Discussion and conclusions

With respect to academic careers as conceptualized in Figure 2, we can conclude that in the 19th century, official academic positions in Germany were only found in what we would now call the higher echelons of the academic career ladder and that over time, through a process of differentiation, positions below the professorate became formal academic positions of their own. The primary official academic positions used to consist only of the professorate and the position of private lecturer. Within this group, the share of ordinary professorships already declined in the 19th century. During this period, aspiring scientists working towards a *Habilitation* did not occupy official positions. This began to change in the second half of the 19th century with the emergence of larger laboratories, where research assistants contributed to experimental science. By the mid-20th century, PhD candidates also often held formal positions as research affiliates. The 1960s saw a disproportionate growth in the share of these lowest positions, so many more researchers could be employed as a doctoral or postdoctoral researcher.

Terms of employment such as salary and tenure have changed in step with differentiation in a professionalization process. At first, only professors were paid; later, researchers in lower positions were remunerated as well. In the 19th century, this only applied to *Habilitation*-holding academics, but later also to those working on a PhD or *Habilitation*, by employment as a research affiliate or assistant. Our data show that the current era of "probationary periods" as a research assistant or research affiliate on temporary contracts have replaced an era ending in the 1980s when trainee scientists were quite often employed on permanent contracts. However, in an even earlier era, trainees were still considered as students when working towards a PhD or *Habilitation*. Arguably, the current situation constitutes an improvement in employment conditions for PhD candidates and postdocs *vis à vis* the 19th century, but a disimprovement *vis à vis* 1960-1980.

In this paper, we have treated the characteristics of the academic career scheme in Figure 2 independently of each other, and focused mainly on terms of employment, level of control over scientific activities and resources, and level of supervision to characterize positions. However, the different characteristics may well influence one another. Interesting questions to be addressed in future research are whether terms of employment influence the level of control over scientific activities (i.e., does an increase in temporary contracts lead to less innovative research?) (cf. Whitley, 2012), and whether the source from which funds are obtained in turn influences terms of employment (i.e., does an increase in third-party funding lead to an increase in temporary contracts?).

Our research shows that developments underlying the differentiation and professionalization of the academic career are the expansion of the university system and the democratization of higher education. The massive expansion during the 1960s and 1970s and its subsequent slowdown have influenced career opportunities in academic research. PhD graduates' opportunities to become a professor or lecturer first increased from 1953 until 1965, but have since decreased. Opportunities to become a university teacher have remained stable. On the other hand, opportunities to obtain a (temporary) position as a research affiliate have increased substantially despite the slowdown of higher education expansion.

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