Jessica Ordemann* and Laura Naegele**

Forty and over the academic hill?

Biological and academic age and the race for tenure

Abstract: This paper investigates the relationship between age and attaining a tenured position in academia (postdoctoral researcher or professorship at a university of applied sciences or university). Following considerations about ageism towards doctoral graduates who were 40 years and older (40+) upon attaining a PhD and Robert K. Merton's idea of cumulative advantages in academic careers (*Matthew Effect*), we differentiate between *biological* and *academic age*. We test the relationships and the resources accumulated behind the latter using data from the DZHW PhD Panel 2014. Applying piecewise constant exponential estimations and an entropy balancing, we find that PhDs aged 40+ experience a significantly positive effect on attaining a professorship at a university of applied science or receiving tenure as a postdoctoral researcher. We interpret the finding as a positive effect of age discrimination.

Keywords: tenure in academia; biological age; academic age; Matthew Effect; ageism

Forty and over the academic hill?

Biologisches und akademisches Alter und die Entfristung im Wissenschaftssystem

Zusammenfassung: Der Beitrag untersucht, wie sich das Alter eines*r Wissenschaftler*in auf die Erreichung einer unbefristeten Stelle im deutschen Wissenschaftssystem (unbefristete Postdoktorand*innenstelle bzw. Professor*in an einer Fachhochschule oder Universität) auswirkt. Dabei unterscheiden wir basierend auf Überlegungen zu Altersdiskriminierung und zur von Merton geprägten Idee der kumulativen Vorteile (*Matthäus-Effekt*) zwischen dem *biologischen* und *akademischen Alter*. Wir testen unsere Überlegungen anhand der Daten des DZHW-Promotionspanels 2014. Unter Anwendung von Piecewise Constant Exponential-Schätzungen und von Entropy Balancing stellen wir fest, dass Wissenschaftler*innen, die bei ihrer Promotion 40 Jahre oder älter waren, einen signifikant positiven Effekt auf die Erlangung einer Professur an einer Fachhochschule und einer Anstellung als

* Jessica Ordemann, Deutsches Zentrum für Hochschul- und Wissenschaftsforschung GmbH (DZHW), Lange Laube 12, 30159 Hannover, E-Mail: ordemann@dzhw.eu.

** Laura Naegele, Bundesinstitut für Berufsbildung (BIBB), Friedrich-Ebert-Allee 114-116, 53113 Bonn, E-Mail: laura.naegele@bibb.de.

Soziale Welt, Sonderband 26 (2024), 457 – 489

entfristeter Postdoc hatten. Wir interpretieren den ersten Befund als ein Beispiel für positive Altersdiskriminierung.

Stichworte: Entfristung im Wissenschaftssystem; biologisches Alter; akademisches Alter; Matthäus-Effekt; Altersdiskriminierung

1. Introduction

As early as 1942, Robert K. Merton noted that pursuing research as a profession should be marked by *universalism* and not depend on a scholar's personal or social attributes, such as gender, nationality, religion, or class membership (Merton 1973). Despite this call for equal access, certain social groups appear to be less successful when trying to obtain tenured positions in German academia. In particular, women and scholars with a migration background often find it hard to succeed, making them an often underrepresented group among tenured faculty members (BuWiN 2021; Engel 2021; GWK 2020). Surprisingly, a *scholar's age* is a seldom-discussed topic when trying to explain why the talent or individual performance of a scholar is seemingly not enough in the so-called 'race for tenure' (Hüther et al. 2018).

Besides one's *biological age*, every PhD graduate that stays in academia following graduation has an *academic age*, the time that has passed since the attainment of the PhD. During this time, an academic career is shaped, and a scholar can accumulate the necessary scientific output to achieve the pinnacle of success: The attainment of a tenured professorship (Laudel/Gläser 2008; Auspurg et al. 2017). As professorships and other tenured positions in German academia are rare, and the law limits employment on fixed-term contracts, the competition amongst potential tenure candidates is great, and the window of opportunity is small: *"[…] This means every postdoc [that wants to remain in academia; note from the authors] either has to become a tenured full professor or has to drop out of the system eventually – usually around the age of 40"* (Lutter/Schröder 2014: 1000). To achieve the output needed to succeed in the academic labor market, scholars are urged to be highly productive right from the start of their academic careers. This is an expectation Merton (1968) discussed under the heading of cumulative advantages (CA), the consequences of which are known as the *Matthew Effect*. This discussion has shaped a culture that today is often termed 'publish or perish' (van Dalen 2021).

A scholar's academic age is not mandatorily linked to biological age, making it possible that two PhD graduates have the same academic age but were born years apart. When looking at biological age as a source of unequal treatment in labor markets ('ageism'), a rich body of research can be found (Bal et al. 2011; Ng/Feldman 2012; Naegele et al. 2018; Marques et al. 2020; Cebola et al. 2021). Discrimination based on age is often linked to chrononormative expectations of what career step is appropriate at what age and which competencies are assigned to a specific age group. Paradoxically, although a higher age is generally associated with a higher

level of competency, scholars who finish their PhDs in their 40s are often perceived as too old to start a research career afterwards ('being over the academic hill'). Behind this perception lies the stereotypical assumption that to gain experience and seniority and to be as productive as is needed for tenure (Evans 2014), one has to start out at a very early age. In fact, some studies indicate that a younger age at the time of achieving a 'Habilitation', that is, the formal teaching qualification in Germany, is beneficial for being appointed to a professorship (Jungbauer-Gans/Gross 2013).

At the moment, little is known about the relationship between biological age, academic age, and the achievement of a tenured position in German academia. In addition, most research concentrates on attaining professorships at university level, ignoring tenured positions in extra-university research institutions or universities of applied sciences. Therefore, this paper will focus on how both biological age and academic age affect academic success in regard to each of the three above-mentioned tracks. Hence, the definition of success will be expanded from the narrow specification of a tenured university professorship to the attainment of a professorship at universities of applied sciences and tenured postdoctoral positions in academia. We ask: *How do tenured positions in academia relate to the biological age and academic age of PhD graduates?*

To answer our research question, the paper is structured as follows: First, we provide an overview of the German academic labor market (Section 2) and the literature on the determinants of success in academia (Section 3). A special focus is placed on the literature and theoretical considerations behind biological and academic age as determinants of tenure in academia (Section 4). Using data from the DZHW PhD Panel 2014, we explore how biological age and academic age relate to attaining a tenured position in academia. The data, its operationalization, and the research design are described in Section 5. Section 6 presents the findings of our study. We find that a higher biological age reduces the probability of attaining a tenured post-doc position and increases the chance of attaining a professorship at universities (of applied sciences). However, once entropy balancing is applied to level differences in the performance of those younger than 40 years of age or older (40+), we find that only a positive age discrimination effect remains for a professorship at a university of applied science. Maturing academically only reduces the attainment of a postdoctoral position in academia. Section 7 concludes.

2. The German academic labor market

German academia can be considered a highly differentiated labor market that provides opportunities at different career stages and at varying institutions (for a description of its history, see Enders/Bommann 2001). However, German academia has a twofold reputation as a place for scholars to work. For one, universities and extra-university research institutes are known for their rich history and for being

adamant about their scholars' scientific freedom. In addition, academia attracts international students and produces excellent scholars and research output, which are globally recognized (Backes-Gallner/Schlinghoff 2010; Scott 2005; Gewinner 2020; Schneijderberg et al 2022). Nevertheless, contrary to this positive perspective on academia, the academic labor market in Germany is repeatedly criticized for its insecure working conditions and precarious career paths, which can especially, but not exclusively, negatively affect early careers (Bahr et al. 2022; Dirnagl 2022).

When looking at how the academic labor market is structured, it should be noted that higher education in Germany is organized at the state level and allows for a high degree of freedom at the organizational level. In practice, higher education institutions have, to a certain extent, liberties regarding employment and granting of tenure to scholars. Hence, the following paragraph refers to the general situation at universities (of applied science), but exceptions—especially at extra-university research institutes—are possible. Generally speaking, academic positions at German higher education institutions—be it at universities (of applied science) or extra-university research institutes—primarily fall into one of two categories: tenured positions such as professors, department heads, or senior researchers and fixed-term junior faculty ('Mittelbau'). The latter presents a particularity to the German system (Musselin 2005). Germany's academic employment law ('WissZeitVG') currently limits the employment of junior faculty to six years before and six years (nine for medicine) after the doctorate ('6+6 rule').[1] Although initially created to prevent German academia from being clogged at the postdoctoral level, and to incentivize German higher education institutions to create more positions that lead to tenured positions under specified criteria (tenure-track), the law failed to achieve the expected effect (Goldan et al. 2022).

Tenured positions in universities (of applied sciences) have decreased between 2000 and 2020 by 19.8 percent, a trend that especially affects fixed-term junior faculty (34.2 to 17.4 percent, Authoring Group Educational Reporting 2022 and the author's own calculations). As a result, most junior faculty move from one temporary job to the next and, if they are unable to secure one of the very few tenured postdoctoral positions[2] or are appointed as a professor, they are ultimately

1 The six years for the postdoc phase specified in the WissZeitVG can be extended under certain conditions, such as parental leave, care activities of dependents, scientific or artistic activities abroad, equal opportunity representations, basic military and civilian service or illness (WissZeitVG § 2). Furthermore, fixed-term contracts under third-party funding can extend the time beyond six years.

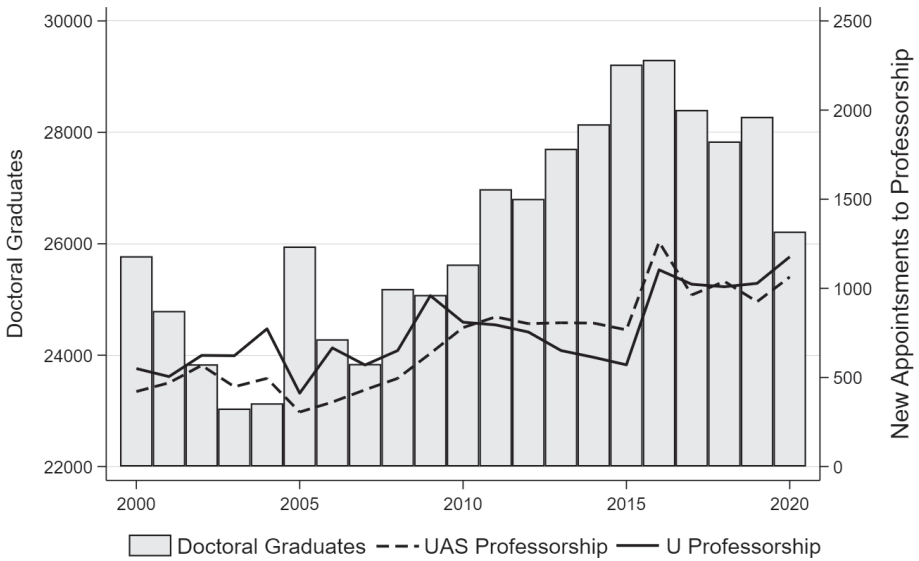
2 Albeit the cap that has been put upon untenured postdoctoral positions via the WissZeitVG, there still are some tenured positions available at postdoc level at universities (of applied sciences) such as e.g., 'Akademische Rät*in' or 'Lehrkraft für besondere Aufgaben (LfBA)'. It should be noted though, that these positions are more often the exception rather than the rule (less than five percent of all full-time personal, Authoring Group Educational Reporting 2022) and they have a strong teaching focus. Furthermore, tenured positions are more available in extra-university research institutions.

forced to leave academia for good, after 12 years (Dirnagl 2022; Schröder et al. 2021). If, during that time, they further qualify by submitting their 'Habilitation', and with it are accepted into professorial ranks, they must remain unpaid private lecturers ('Privatdozent*innen' (PD)) or otherwise lose this academic privilege. In 2002, an additional stepping stone toward becoming a professor was introduced, the 'Juniorprofessur' (W1). However, its nonobligatory tenure status, limited quota, and high workload contributed further to the often precarious career path in German academia rather than providing a remedy to it (Zimmer 2018; 2021). In June 2021, the already conflicted debate reached a new climax with the emergence of the hashtag #IchBinHanna on X (formerly Twitter). Since then, sensitivity to precarious working conditions in academia has increased. As at March 2022, according to the initiators of the hashtag, approximately 9,000 people had joined the discussion about #IchBinHanna in more than 134,000 tweets, criticizing employment conditions for junior faculty members in the German academic system (Bahr et al. 2022). This has been accompanied by a growing body of research that has sprung up, focusing on non-tenured scholars and the race for tenured professorships (e.g., Dirnagl 2022; Schröder et al. 2021).

Tenured professorships in Germany are anchored at universities (of applied sciences). There are no formal differences in academic rank between being appointed a professor at a university of applied science and being appointed at a university. However, neither institution has the same legal status and they also differ in teaching load and research mandate. Since introducing a new salary scheme in 2005, both institutions can appoint W2 and W3 professors. However, the position of a W3 professorship is a very rare occurrence at universities of applied science (Lutter/Schröder 2014; Backes-Gallner/Schlinghoff 2010). The formal entrance to a professorship appointment is, except in very few cases at universities of applied science, bound to a doctoral degree. When looking at the requirements for appointments at universities (of applied sciences), the main differences that can be found in regard to the 'practical work experience' of the candidates. Universities of applied science, with variations between the German states, usually require a mandatory three or more years of work experience outside of the university in a field relevant to the professorship that can only be exchanged for higher academic qualifications, the 'Habilitation', in some instances. As a consequence, the average age at appointment to a professorship at universities of applied sciences has gone up from an average of 41.5 years in 2000 to 43.0 years in 2020; at the same time the average age at appointment to a professorship at a university has gone down from 42.1 to 40.3 years (Statistisches Bundesamt 2022). It should be noted, however, that this sector is highly dynamic, and increasingly universities of applied science also emphasize the importance and relevance of research in their appointment decisions (Lackner 2020).

A professorship in Germany also means gaining privileges (e.g., appointment for life, generous salary, and social security entitlements) associated with the status

Figure 1: PhDs and newly-appointed professors, 2000 – 2020 (absolute)



Source: Special analysis by Statistisches Bundesamt (2022).

of a civil servant ('Beamte*r').[3] Therefore, the question of one's chances of appointment—or what might hinder them—is highly relevant. This is true not only for the individual but also from a societal point of view, e.g., if members of certain social groups—even though they are successful scholars—are being systematically excluded from the chance of attaining a professorship.

The selection process for a professorship is illustrated in Figure 1. It gives an overview of the numbers of PhDs (y-axis on the left) and newly-appointed professors (y-axis on the right) from 2000 to 2020. It is apparent at first glance that far more people receive doctoral degrees than appointments to professorships. Starting in 2010, increasing numbers of doctoral graduates have the formal entrance qualification to a professorship. However, we also find an expansion in newly appointed professors, albeit six years later. This dynamic is mainly driven by the expansion of new appointments at the universities of applied sciences. The ratio of junior faculty aiming for tenure to the total number of professorships available is very high, turning the time after receiving one's doctorate into a 'race for tenure' and scholars into competitors (Dirnagl 2022).

3 Influences of these privileges – albeit in a weakened form – also apply to tenured positions.

3. How to be successful? Determinants of research careers (in Germany)

How and whether a person can pursue a career in academia and what determines whether an academic career is successful enough to attain a professorship has been the subject of various studies (e.g., Auspurg et al. 2017; Jungbauer-Gans/Gross 2013; Lutter/Schröder 2014). While performance indicators such as a scholar's publication record (Schröder et al. 2021), relevant teaching experience (Heuchemer/Szczyrba 2016), access to research networks (Jaksztat et al. 2017), and the ability to acquire third-party funding (Jansen et al. 2007) are core indicators of professorship appointments, research has repeatedly pointed out that individual characteristics also play an important role in who can reach tenure. Contrary to this principle of selecting the best and most qualified candidate for the job, certain social groups seem to have unequal starting points in the 'race for tenure', which has led to an underrepresentation of these groups at the professor level (Schröder et al. 2021).

Reasons for this phenomenon are manifold, but in this paper, we want to explicitly address the effects of prejudices and related stereotypes regarding who is deemed suitable for a research career. Prejudice and stereotyping often lead to discrimination, which Aronson et al. (2021) define as *"[u]njustified negative or harmful action toward a member of a group solely because of his or her membership in that group"* (Aronson et al. 2021: 431). Discrimination may be obvious and direct, e.g., by choosing a candidate over another solely based on their gender, migration background, or age, a behavior that is in most cases illegal. However, in many cases, discrimination in the workplace or during the hiring process is internalized and/or institutionalized, making it more subtle and difficult to detect (Aronson et al. 2021). Older candidates might be viewed as less suitable for tenure due to an ageist perception of them being less productive or less innovative than their younger counterparts. In addition, they might be given less support or resources beforehand, making it difficult to even get to the position to compete on equal terms for tenure. Nevertheless, it should be noted that discrimination can go both ways, meaning in some cases a *preferential treatment of certain social groups* is observed ('positive discrimination'), for example, by assuming a person's age (and with that the stereotypical perception of the competences of members of this age group) is more fitting for a vacancy or a specific career step (Stypińska/Nikander 2018).

To demonstrate how discriminative behavior could hinder one's chances of tenure, this article first discusses two well-documented inequality categories in German academia: gender and migration background. Subsequently, the article will focus on ageism or ageist behavior in more detail to establish how a scholar's age could potentially become a source of unequal treatment on the pathway to tenure. It should be noted, however, that the categories described are by no means conclusive, and other inequality dimensions such as social status or social and family background (Keil 2018; Lörz/Schindler 2016; Möller 2016) have proven also to

(re)produce inequality in the race for tenure. Furthermore, these inequalities might not apply to all disciplines, are likely to be interconnected (intersectional), and might change over time.

When looking at who climbs the career ladder in academia successfully, the influence of a candidate's *gender*, especially regarding women in academia, is one of the most well-documented findings in the literature. As early as the 1980s, studies have described the phenomenon of women prematurely leaving higher education and academia under the umbrella term *leaky pipeline* (Berryman 1983; Gasser/Shaffer 2014). As a result, the share of women declines with each step of the academic ladder, counteracting the ongoing trend of rising numbers of female students and women starting a doctorate in Germany (Statistisches Bundesamt 2021a; Krais 2003). The reasons for the leaky pipeline are manifold. Whereas some studies point in the direction of individual career choices (Fassinger 1990; Fitzgerald et al. 1995; Berlingo et al. 2018; Astin 1984), other studies highlight the importance of unequal access for women to resources. This might be seen in relation to socio-economic status and class (Lapour/Heppner 2009; Leppel et al. 2001) or as a result of 'gendered life courses', which assign care responsibilities primarily to women. Hence, due to difficulties in reconciling care and family responsibilities with career, not only is the track to tenure less often successful for women (Gasser/Shaffer 2014; Lynch 2008; McDowell 1982; Springer et al. 2009), but substantial negative impacts on female scholars' (mental) health have been reported as a consequence. Furthermore, newer research points out that gender biases and gender discrimination in academia, especially in academic recruitment processes, play an important role in whether and how women are appointed to professorships. Interestingly, women are given preferential treatment when applying for positions at the lower end of the qualification scale, but this advantage diminishes with each step on the academic ladder (Solga et al. 2023).

A different factor that has also proven to be highly influential in achieving tenure is the *migration background and/or nationality* of a person (Gewinner 2020). Although research in this regard is both insufficient and methodologically challenging due to the often imprecise operationalization of the term 'migration background' (Will et al. 2019), statistically an underrepresentation of people with non-German nationality in tenured positions within German academia cannot be denied. Whereas approximately 45,300 of the 200,300 doctoral students enrolled in Germany in 2021 are of non-German nationality (Statistisches Bundesamt 2022), only around seven percent of the professors have a non-German nationality (Statistisches Bundesamt 2020; 2021b). In addition, studies carried out by Löther (2012) and Pichler/Prontera (2012) find that scholars with non-German nationalities are less likely to pursue a 'Habilitation', hold fewer tenured positions than their German colleagues, and are more often involved in areas of research where they can utilize specific competencies of their migration background (e.g., language or cultural knowledge). When looking at the source of these inequalities, scholars have pointed

toward the influence of *resource accessibility*, even though this factor could vary by country of origin. For example, it can be assumed that scholars from countries of the global South often have even fewer resources, such as funding opportunities, access to information or data, or not being granted a working visa for the host country (Arunachalam 2003; Bilecen 2012). Other studies suggest that *forms of (ethnic) discrimination* are the reasoning behind the stark underrepresentation of scholars with migration backgrounds. A study conducted amongst 406 professors in the German states of Berlin and Hessen finds that around one-third of the respondents reported having experienced negative impacts due to their migration background, with variations regarding gender, citizenship, and the specific migration background (Neusel et al. 2014). A qualitative study amongst scholars from the humanities summarizes the problem as follows: *"Scientists with a migration background seem to have a chance in the German university system mainly where 'German' scholars cannot be employed because they do not have the appropriate cultural, social and linguistic competences"* (Pichler/Prontera 2012: 100; translated).

4. Age-Stereotypes and age-based discrimination in academia

Until now, the influence of a *scholar's age* is a seldom-discussed source of unequal chances on the academic track. This underexposure is somewhat surprising since the educational trajectories and work courses of the younger cohorts are increasingly destandardized and consist of more detours, interruptions, equal allocations of care work and overall career changes than those of the older cohorts (Kohli 2003). Consequently, people not only enter academia right after obtaining their undergraduate degree but also after finishing vocational training or gaining work experience (Ordemann 2019; Ordemann et al. 2023) or after starting a family (Gasser/Shaffer 2014). In short, they come to academia from different life situations, at a later phase in life, and, on average, at an older age than ever before.

When talking about a *scholar's age* as a source of inequality, a distinction must be made between the *biological age* and the *academic age* of a scholar. Whereas the former is quite self-explanatory and starts with the birth of a person, *academic age* usually refers to the time that has passed since PhD attainment and the resources meanwhile accumulated (Auspurg et al. 2017; Reskin 1977).[4] Hence, it is possible that two scholars have the same *academic age*, even though they are born a decade

4 Some discussion deviates from how this article operationalizes the term 'academic age', mainly with regard to when to pinpoint the start of an academic career. In the international literature, academic age is often counted from the first publication (e.g., Primack et al. 2009, Milojević 2012). While we acknowledge this, our article bases its definition of academic age on two assumptions reflecting the German context: First, doctorate students are still somewhat bound to the leadership of a senior researcher (mainly professor) and only a completed dissertation will open the doors to a tenured professorship in academia. Secondly, many doctoral students opt to leave academia after receiving their degree; therefore, joining the race for tenure concerns only those who stay on to pursue an academic career.

or so apart (see also Milojević 2012) and that biological age can influence academic age (Cole 1979).

A broad body of research can be found regarding *biological age* as a determinant of inequalities in the labor market: *Ageism*, meaning discriminative behavior towards people of a specific age group due to stereotyping and misconceptions of their competencies and capabilities has proven to be prevalent in labor markets (Butler 1969; Iversen et al. 2012). Ageist behavior can be directed both towards younger as well as older age cohorts and can include both negative, e.g., older workers being less innovative, younger workers being too inexperienced, and positive stereotyping, e.g., older cohorts being more socially competent, younger cohorts being more digitally competent (Naegele et al. 2018; Marques et al. 2020; Marchiondo et al. 2016). These stereotypical perceptions of specific age groups are often based on chrononormative life-course expectations, which means the assumption of there being 'a right time' and 'a right age' for specific life phases or transitions. This links certain life phases (such as who should start a research career) to stereotypical perceptions of who should go through these phases and at what age, ultimately ignoring inter-personal differences (Freeman 2010; Wanka/Höppner 2020; Wanka 2020).

The academic labor market presents a fascinating case regarding age stereotypes and chrononormativity: Academia allows for a comparison of scholars with the same work experience, that is, academic age, but different biological ages (Allgood 2020). Although academic age is not necessarily related to a person's biological age, specific steps on the academic ladder are often attributed to certain age groups: for example, doctoral students in their 20s and people who reach a professorship in their early to mid-40s, depending on their discipline. Zuckerman and Merton (1972) already noted this age stratification regarding specific career steps in science and highlighted the importance of social definition and ascription: *"[I]n order for the given status to have social reality it must be validated by status judges, those institutions and agents charged with authenticating claims."* (Zuckerman/Merton 1972: 297). If these chrononormative expectations of said status judges are disrupted, e.g., by scholars being perceived as too old to start a scientific career or—on the contrary—appointment committees considering scholars to be too young, age stereotypes come into play. In addition, ageist perceptions with regard to older scholars being less productive and less innovative might play a role. Hence, one's (higher) *biological age* can become a source of unequal treatment when aiming for tenure.[5]

5 In this regard, it is important to address another particularity of the German academic labor market regarding the discussion of age and tenure in academia: The age barriers to becoming a civil servant. As mentioned before, with a professorship come certain benefits related to being a civil servant. However, in many states it is only possible to become a civil servant until the age of 50 or 52 years (see Appendix A1, also for the exceptions to this age barrier). Therefore, although an appointment as a regular employee without civil servanthood is still possible, the

Very few empirical studies explicitly address age other than it being a control variable, and even fewer studies look at age discrimination in the German academic labor market. Concerning *academic age,* Auspurg et al. (2017) find that in a study focused on 259 academic appointment procedures in one middle-sized university in Germany, the academic age has—depending on the statistical model used—either no or a negative effect on being appointed to a professorship. Schröder et al. (2021) find a positive effect for tenure if a scholar has completed prior steps on the academic ladder, e.g., completing a 'Habilitation' or 'Juniorprofessur'. The authors explain this in the form of a signaling effect that reduces the uncertainty for appointment committees as those candidates have undergone another form of external evaluation. These findings are not that surprising, as a long time spent in an academic career allows for more output (e.g., conference attendances, publications, third party funding raised), and gains in reputation, ultimately increasing a scholar's chances of an appointment. The latter ties into the idea of cumulated advantage (CA) over time, which Merton (1968; 1988) has applied to academic careers and dubbed the *Matthew Effect* or *Matthew Principle*. Here, the idea is that reputation and academic success are self-enforcing, in the sense that well-established scholars receive disproportionately more attention and recognition than relatively unknown scientists (Allison et al. 1982; Allison/Steward 1974; Feichtinger et al. 2021). Merton neglects to mention female scientists in his first paper and proceeds only to describe male academic career paths. However, later research has pointed out that this dynamic especially disadvantages women who often do not receive recognition for their scientific accomplishments, a phenomenon labeled the *Matilda Effect* (Rossiter 2003). Nevertheless, this does not mean that younger scholars or those with a lower academic age are less capable. Quite the opposite, as Zuckerman and Merton elaborate on in a later publication: *"Rather, it only announces a widespread belief that the best work in science is done at a comparatively early age. This posited linkage between age and significant productivity is still the focus of little research […]"* (Zuckerman/Merton 1972: 299). By linking scientific acknowledgment to productivity and age, scientists who start early and are highly productive are perceived to be more likely to succeed. At the same time, an academic culture is fostered that scholars have described as 'publish or perish' (Zuckerman 1977; Jungbauer-Gans/Gross 2013; van Dalen 2021).

This brings the effect of a scholar's *biological age* to the centre of interest. A study by Jungbauer-Gans/Gross (2013) shows that in line with Zuckerman's and Merton's age stratification argument, the median age varies at different stages of academic careers, across disciplines. Of the three disciplines investigated, sociologists have both the highest age and the widest age range when receiving a PhD or completing a 'Habilitation', followed by scholars of law and mathematics. Overall, the authors find that a relatively low biological age at the time of 'Habilitation' is

age barriers in place might divert scholars who have aged out of the opportunity to become a civil servant from academia.

beneficial for receiving a professorship. This effect remains stable for all examined disciplines. Other scholars find that women are usually younger in the early stages of a scientific career than men at the same stage (PhD graduation). However, further along the line, they need more time to attain a 'Habilitation' or to be appointed a professorship (Krimmer et al. 2003). Hillmert (2003) even postulates that scholars in Germany—in comparison to other countries—are 'unreasonably old' when attaining their first tenured professorship. It should be noted, though, that some of these publications are almost two decades old and cannot detect newer dynamics, e.g., the effect of the introduction of the 'Juniorprofessur' as track to tenure.

When looking at research from other countries, findings on the effect of biological age are inconclusive. Whereas some studies show no effect of age on the probability of obtaining tenure in the US (Yang/Webber 2015), other studies find that age is negatively associated with tenure in South Korea (Jung et al. 2022). An explanation the authors offer is, in alignment with the theoretical concept of the *Matthew Principle*, that younger scholars tend to be preferred by the already existing faculty members due to the notion that older scholars exhibit a lower level of research productivity. Some studies also look at subordinate effects, such as income differences between scholars that reached tenure at a younger age and those who accomplished this later. Allgood (2020) finds evidence for an 'age penalty' in Canada: those scholars who obtained their PhD at an older age earn less than those who received their doctorate earlier.[6]

Summing up the above research findings: A *scholar's biological age* and *academic age* are seldom the focus of research on tenure in academia, which—bearing the destandardization of life courses in mind—is quite surprising. Even though we have considered and presented biological and academic ages as somewhat separate entities or determinants of attaining tenure in academia, both are also strongly interlinked. Whereas scholars of different biological ages but with the same academic ages should have equal opportunity for tenure, research suggests otherwise: Chrononormative expectations of how old or young a person should be at what stage of a scientific career are equally influential as stereotypical perceptions of the productivity of specific age groups. Therefore, identifying ageist mechanisms that divert older PhDs from a sustainable academic career is important.

To gain insights into the interacting effects of biological and academic age, we address the following questions: *Do PhD graduates with different biological ages differ in the productivity associated with their academic ages? How does biological age relate to*

6 For Germany, in a study focusing on doctoral graduates, Goldan (2021) finds no statistically significant effect of age on income. It needs to be noted that the German higher education system is only partially comparable to systems in other countries as it presents, as explained earlier, a unique case.

transitioning to a tenured position in academia, and what influence does academic age have on tenure?

5. Empirical design

5.1 Data

We use data from the DZHW PhD Panel 2014 to understand how PhD attainment at 40+ affects integration into the academic labor market through productivity or age discrimination.[7] The panel started in the winter semester of 2013/2014 or the summer semester of 2014 (Brandt et al. 2020b; Vietgen et al. 2020). From 2015 onward, respondents were surveyed annually about their career development until 2020. This timeframe enables us to observe career trajectories over six years, covering most of the postdoctoral academic development and signaling the end of the time that a person can by law remain in a temporary position in academia. In addition, all sampled PhDs belong to the same cohort of graduates, which enables us to compare their different biological ages with a similar academic age.

The gross sample contains 5,408 respondents. We trim this sample in two steps. First, medical professionals and lawyers are excluded. Neither subject adheres to the fundamental elements of PhD training as stated in the Joint Declaration of Doctoral Training in Europe (HRK 2014/2015). Medical and law doctorates do not necessarily prepare for an academic career, with the former closely linked to the profession. In the latter, law doctorates can expect higher incomes outside of academia therefore not only choose to obtain a PhD but also to opt out from academia (Mertens/Röbken 2013).[8] Furthermore, PhD graduates who exit academia despite having the official entrance certificate to take up a tenured position are excluded in this step. However, we allowed respondents who exited but reentered academia during the observation window, into the analysis. This step reduces the initial sample by 63 percent to 2,028 PhD graduates. In a second step, we perform a complete case analysis excluding 5.4 percent of missings for birth date, sex, migration background, PhD grade, difference between end of studies and beginning of PhD, and the goal of remaining in academia. Our remaining net sample encompasses 1,918 PhD graduates with 6,719 observations.

7 We use a beta version of the 2014 PhD Panel 2014. The data will be available in the Research Data Centre for Higher Education Research and Science Studies in 2023. It is currently available for public use until wave 5 (Brand et al. 2020a). The replication files for the analysis can be found at: Ordemann, Jessica & Naegele, Laura (2023): Code/Syntax: "Forty and over the academic hill? Biological and academic age and the race for tenure". Version: 1. GESIS-Datenarchiv. https://doi.org/10.7802/2514.

8 Attaining a PhD as a medical professional or a lawyer corresponds to leaving science (medicine: 60.9 percent, dental medicine: 81.6 percent, veterinary: 67.5 percent, law: 81.6 percent).

5.2 Variables

Dependent Variable: We summarize the concept of the *academic hill* as the integration into three tenured destination states with competing risks: (1) tenured postdoctoral researcher and (2) tenured professorship at a university of applied sciences or (3) at university. The latter appointments to a tenured professorship are straightforward and operationalized by indicating whether the respondent is a professor and tenured at either institution. The first destination state is more complex in its demarcation. It includes all PhDs who will indicate that they have took up a tenured position inside academia. However, we do not have further information on whether the tenured position is situated in an extra-university research institution or at a university (of applied sciences) and what tasks the positions encompass. Therefore, the position will indicate that a person can remain in academia, but we cannot assess if this position will successfully integrate them into a scientific career.

Independent Variables: Biological age at the time of PhD graduation is operationalized by subtracting the graduate's birthday from the graduation date and then categorized as (0) under 40 years of age and (1) 40 years of age and older. The cut-off point of PhD attainment at 40+ is used based on the research of Lutter/Schröder (2014). Following Auspurg et al. (2017), we include academic age as a time-counting variable indicating the number of years after PhD attainment.

Academic Performance Indicators: We include academic performance indicators attained at a specific academic age that also influence the attainment of a professorship. Due to the limited number of cases for older PhDs, we limit these factors to the following determinants: number of publications with peer review, number of other publications, number of books published, number of conferences attained, successful grants, and reviews completed. All indicators reflect the academic performance of a postdoc and are correlated with each other. The highest correlations can be found between conference attendance and other publications (0.50*) or accepted grants (0.43*) and books with other publications (0.50*). Furthermore, they all show a right-skewed distribution and are therefore included as logarithmized variables in the multivariate analysis. All determinants are included as counter variables in the multivariate analysis that reflect the accumulation of resources over time, starting with 0 in the case that no resources were accumulated in the first year.

Control Variables: We furthermore control for sex (0=men; 1=women), migration background (0= none, 1=migration background) and PhD grade (summa, magna, or cum laude/satis bene). We also add the life goal of being in academia as a control variable. To reflect on the life goals, PhD graduates were asked: *"Every person has certain goals that are particularly important. Please indicate how important each goal is to you personally."* We included the answer *"Making a career in science"* that was given on a Likert scale from 1 not at all to 5 yes, certainly. Additionally, we include the time since the attainment of the qualifying degree for starting one's PhD studies in years as a proxy for previous work experience necessary for entering

a professorship at a university of applied sciences. An overview of the variables can be found in the Appendix Table A2.

5.3 Methods

We will first give an overview of the occupational destinations after PhD attainment for those who remain in or reentered academia, and the academic resources they attained before and after, as well as reporting the time until they take up a tenured position as a professor or postdoctoral researcher to gain insight into the phenomena of older PhDs and their integration into the academic labor market. For this purpose, we draw on group comparisons between older and younger PhDs, including t-tests with Bonferroni adjustment for multiple testing and product-limit (Kaplan-Meier) estimation for entry into a professorship at university (of applied sciences) or as a tenured postdoctoral researcher.[9]

Second, we will estimate how biological age and academic age will impact reaching those destinations using a piecewise constant exponential model as we assume different transition rates for the three destinations under observation (Blossfeld et al. 2019). The model estimates how long it takes in years following PhD attainment to reach the multiple destinations or competing risks of attaining a tenured postdoctoral research position or a professorship at a university (of applied sciences). We estimate three separate models (not tenured → tenured postdoctoral researcher; not tenured → professorship at universities of applied sciences; not tenured → professorship at university.[10] All data is left-censored to the year of PhD attainment. We do not have information on all PhD graduates at the end of the observation period regarding whether a person received tenure or not, episodes for graduates without this data are right-censored. In the second analytical step, we look at the impact of the resources acquired following PhD attainment on the speed of reaching a tenured position. However, this approach will only indicate the relationship with the determinants described in the above variables section.

Finally, to better understand the discriminatory relationship of the biological age for reaching a tenured position, we match the groups of older to younger PhDs using entropy balancing (Hainmueller 2012). This matching approach will equalize the mean and variance of all included information (see Appendix A3), allowing us to better understand the influence of biological age and its discriminatory effect on

9 Robustness checks for the sample of all PhD graduates including those who exit academia have shown that those at 40+ exit academia sooner than those under 40 years of age but remain for longer in a 'Juniorprofessur' or similar.

10 Models which include exiting academia, as robustness checks have shown that those aged 40+ exit academia earlier, a pattern offset by the time that they remain as postdoctoral researchers. However, in the balanced model, the biological age effect does not remain. All other effects in this model remain similar except that PhD graduates that are older also have a higher probability of attaining a professorship at university.

attaining a tenured position in academia. However, the conditional correlations of our balanced model do not imply causality.

6. Findings

Descriptive: Academic performance and the pathway into tenure

Before assessing our first question of whether PhD graduates differ in the productivity associated with their academic age, we first look at who remains in or reenters academia. Overall, 1,918 PhD graduates remain in academia or reenter during the observation period, 6.8 percent of whom are aged 40+. Overall, PhD graduates in our sample remain in academia for 3.9 years before exiting to a tenured position either within or outside of academia, with no significant differences between those under 40 years of age and those aged 40+ (4.0 vs. 3.4 years).

Table 1: Accumulated resources following PhD attainment (absolute numbers)

	Total	PhD attainment		|t|-test
		under 40	aged 40+	
Publications				
Peer Review	9.2	9.3	7.5	1.419
Other publications such as contributions to anthologies	2.8	2.7	3.9	4.057***
Books	0.4	0.4	0.6	-4.215***
Conference Attendance	9.4	9.3	10.9	-2.765**
Successful Grant Application	1.1	1.1	0.8	2.653**
Peer Reviews	3.7	3.7	3.8	-0.149
n(observations)	6,719	6,313	406	

Note: N is based on the controlled sample of the multivariate analysis. * p<0.05; ** p<0.01; *** p<0.001.
Source: DZHW PhD Panel 2014 (2014–2020, beta), author's own estimations based on N=1,918.

In the years following the doctorate, PhD graduates mature as scholars and acquire different resources that qualify them for tenured positions in academia. Table 1 shows that during this period, PhD graduates invest their time publishing and presenting work in peer-reviewed publications and conferences. On average, they publish 9.2 articles that have gone through a peer-review process during the observation period that they remain in the sample. PhD graduates who were younger at the time of their doctorate are more likely to publish (12.3 publications) in peer-reviewed journals than those aged 40+. On average, they publish only 7.5 articles that have gone through a peer review process. However, they invest more time in other publications, such as contributions to edited volumes or transfer publications

(3.9 vs. 2.7 articles). Both age groups write few books, yet there is a significant difference here, and PhD graduates aged 40+ at the time of their doctorate publish more books (0.6 books) than those who are younger (0.4 books). Furthermore, PhD graduates aged 40+ attend conferences more often (10.9 conferences) than younger PhD graduates (9.3 conferences). Finally, on average, PhD graduates of both groups write one (accepted) research proposal in the first six years after the doctorate and review 3.7 and 3.8 articles, respectively, in peer-review procedures. The descriptive analyses indicate significant differences between PhD graduates who were younger at the time of their doctorate and those who were 40+ years old. However, there is no clear pattern: Although PhD graduates aged 40+ are generally more productive, they are on average behind the number of younger PhD graduates in one core indicator—peer-reviewed publications.

Let us turn to our second question about the relationship between biological age and tenured positions in academia: The descriptive overview in Table 2 indicates that older PhD graduates are more often found in tenured positions such as that of postdoctoral researcher (aged 40+: 41.2 vs. younger: 30.8 percent), or professor at universities of applied sciences (11.5 vs. 2.5 percent) or universities (3.8 vs. 1.2 percent) during the observation window after PhD attainment.

Table 2: Positions in academia, universities of applied sciences, or universities by temporary and tenure (in %)

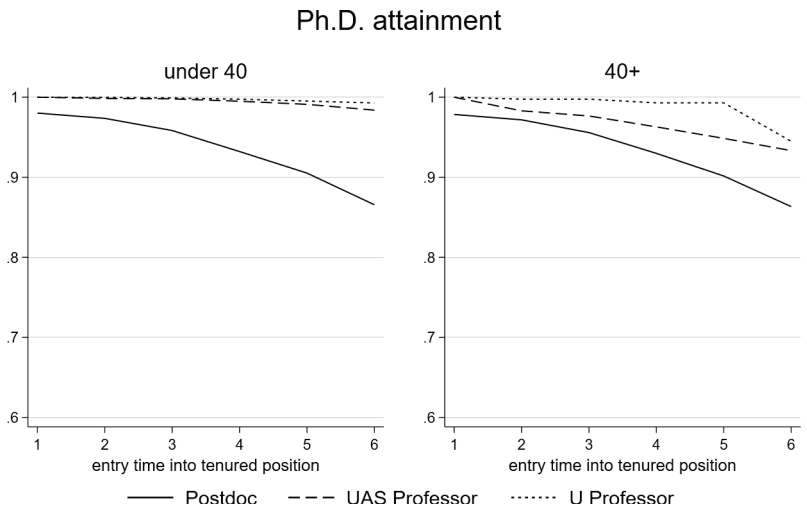
			PhD attainment	
	N	Total	under 40	aged 40+
Postdoctoral researcher (temporary)	1,228	64.0	65.5	43.5
Postdoctoral researcher (tenured)	605	31.5	30.8	41.2
Professorship UAS	60	3.1	2.5	11.5
Professorship U	26	1.4	1.2	3.8
	1,918	100	100	100

Note: Due to rounding errors, percentages do not always equal 100 %. Chi² = 50.789***.
Source: DZHW PhD Panel 2014 (2014–2020, beta), author's own calculations based on N=1.918.

Over time and increasingly so, more PhD graduates who remain in academia enter a tenured position (see Figure A1 in the Appendix), and after six years, only 31.7 percent remain on temporary contracts. PhD graduates who earned their doctorates aged 40+ transition more quickly to permanent positions after their third year in the academic job market. Less than 2 percent of the original sample remain in nontenured positions at the end of the observation period, while 30 percent of the younger PhD graduates remain untenured at the end of the observation

window. However, a potential widening gap between PhD graduates aged 40+ and younger graduates with respect to attaining a permanent position is not underlined by the statistics of the Wilcoxon test (Wilcoxon test=32.7***) which are sensitive to differences at the beginning of the survivor function, and the Log-Rank test (30.6***), highlighting increasing differences over the observation window. Both remain approximately the same but indicate a slight narrowing of the gap.

Figure 2: Survivor function for attaining a tenured postdoctoral research position, a university of applied sciences (UAS), or university (U) professorship by PhD attainment under 40 and aged 40+



Source: DZHW PhD Panel 2014 (2014–2020, beta), author's own estimates based on N=1.918.

However, the faster transition to tenured positions in academia varies between job types. The mapping of the survivor function in Figure 2 illustrates the temporal aspect of the transition of PhD graduates under 40 years old and aged 40+ into a permanent position. The attainment of a professorship at universities of applied sciences is faster for graduates aged 40+ than for those who earned a doctoral degree at a younger age. Two years into their postdoctoral research, more of them have entered tenured professorships at universities of applied sciences. In the latter group of younger PhDs, we see more dynamics once they reach the end of the observation window, that is, six years in academia (see the section on the German academic labor market).

Multivariate: Academic age, biological age, and their relationship with tenure

Bringing together the different variations behind the *biological age* and *academic age* of the PhD graduates and their accumulated resources, we estimate exponential

transition rate models with multiple destinations (competing risks) for entry into a tenured position as a postdoctoral researcher, and into a professorship either at universities of applied sciences or universities. In total, 1,918 PhD graduates who remain in academia enter the analysis with 6,719 observations. The results in Table 3 on the left side (unbalanced results) show that we do find an indication of discriminatory age effects over the time frame under observation. However, those effects are only partially expected. When looking at tenured postdoctoral researchers, we find no relationship between *biological age* and attaining a permanent position at this academic level. Not only do those graduates who attained their doctoral degree aged 40+ less often enter a tenured position as postdoctoral researchers, but the time after graduation—their academic age—influences the attainment negatively. Similarly, the attainment of a professorship at a university of applied sciences does not show a relationship with the *biological age* of a person. Finally and under the control of the academic performance indicators, a professorship at a university is more visible for PhD graduates aged 40+, over the first six years after PhD attainment. At the same time, their *academic age* does not increase the probability of attaining a professorship at university.

Furthermore, our results on the left side of Table 3 indicate that academic age—the time that has passed since the doctorate was completed—is filled with academic productivity in the race for tenure; performance indicators such as publications, conference attendance, and writing reviews relate to the attainment of a professorship. In contrast, these activities do not relate to taking up a tenured position as a postdoctoral researcher. This may be due to the imprecise definition of this group, which is based on the data situation and for which no further information is available. For example, scholars in extra-university institutions or scientific employees in science management could fall into this group, potentially offsetting the individual effects. Finally, the time as a doctoral student retains an effect over the PhD grade: a PhD grade lower than the summa cum laude positively influences attaining a tenured position as a postdoctoral researcher.

To sum up, over the first six years following PhD attainment, we find a positive influence for PhD graduates who attained their PhD aged 40+ for entering a professorship at universities. However, as our descriptive and multivariate analyses have shown, the resources of the graduates vary between those who attained a PhD aged 40+ and those who attained it at a younger age. To find out whether there is any sign of a discriminatory age effect or if PhD graduates aged 40+ invest their time in resources that divert them from academia, we apply a methodological trick —entropy balancing—and equalize all distributions of resources and socioeconomic background variables for each academic year. As a result, there is no, or rather a very low, mean difference between the academic resources of PhD graduates aged 40+ and those who are younger (see Appendix Table A3). The weights operationalized in this way allow us to crystallize the residual *biological age effect* in the case of equal starting conditions on entry into the academic career (PhD grade) and

the subsequent developments in their academic career. It furthermore minimizes inequalities that might occur due to the gender or migration background of the PhD graduates.

Table 3: Regression results of attaining a tenured position in academia, exponential transition rate models, unbalanced and balanced (in coefficients)

	unbalanced Results			balanced Results		
	Tenured Postdoc	UAS Professor	U Professor	Tenured Post-doc	UAS Professor	U Professor
Biological age 40+ (ref. under 40)	0.179	0.874	1.585*	0.404**	1.942***	0.363
Academic age (ref.: 1 year)						
2 years	-1.070***	16.678	13.974	-0.969***	18.328	16.496
3 years	-0.421**	15.378	13.974	-0.425*	17.267	16.127
4 years	-0.295	16.395	14.180	-0.317*	18.240	17.276
5 years	-0.518**	16.238	14.528	-0.523***	17.871	17.173
6 years	-0.589**	16.391	14.283	-0.547***	18.100	17.413
Women (ref. men)	-0.264**	-0.409	-0.090	-0.494***	-0.196	-1.130
Migration background (ref. none)	0.034	-2.124*	1.527*	0.137	-1.307	4.504*
PhD grade (ref. summa cum laude)						
Magna cum laude	0.290**	-0.286	-0.714	0.558*	-1.364	1.448
Cum laude	0.395**	-0.302	-0.037	0.321	-0.667	0.441
Distance to pre-doctoral degree	0.023	0.091**	-0.034	0.002	0.112*	-0.237
Future in academia	-0.134***	0.025	0.459*	0.016	0.446	-0.755
Publications						
Peer review	-0.007	-0.202	-0.251	0.096	-0.679	-0.409
Other	-0.009	0.484**	0.129	-0.312**	0.692	-0.696
Books	-0.033	0.044	0.535	-0.356	-0.477	3.063*
Conference attendence	0.117	-0.379*	0.263	0.259*	-0.324	0.111
Grant application	-0.041	0.495*	-0.049	0.038	0.255	1.307
Reviews	-0.070	0.085	0.900***	-0.340	0.282	0.654
_cons	-2.014***	-20.541	-23.188	-2.109***	-22.782	-22.495
AIC	3132.651	473.590	218.332	2786.705	411.598	219.896
N		1,918			1,918	

Note: * p<0.05; ** p<0.01; *** p<0.001. Postdoc stands for postdoctoral researcher, UAS stands for university of applied sciences, and U for universities.
Source: DZHW PhD Panel 2014 (2014–2020, beta), author's own estimations based on 6.710 observations.

Turning to the results of the balanced exponential transition rate estimations in Table 3 on the right side (balanced results), we find that the previous effect of the biological age changes its significance. While the *biological age* now relates to becoming a tenured postdoctoral researcher or professor at a university of applied science, there is no significant relationship with being a university professor. We interpret this as a positive discriminatory age effect. PhD graduates aged 40+ bring different resources to the race for tenure that enable them to attain a professorship faster than those who graduated at a younger age from their PhD studies—albeit at universities of applied sciences or as a tenured postdoc. However, biological age does not remain significant for (faster) entry into a university professorship. This effect may occur due to the short duration of six years.[11] Over a longer observation period, younger PhD graduates might offset the resources of those aged 40+ with their 'Habilitation' or 'Juniorprofessur'.

In particular, since academic age has a negative impact on attaining a tenured postdoctoral researcher position, meaning the longer PhD graduates stay in academia, the less likely they are to take up a tenured position as a postdoctoral researcher. The effects of the PhD grade and the performance variables indicate a high degree of selectivity among the group of postdoctoral researchers; over the observed period successful PhD graduates who stay in academia are probably more likely to aim for a professorship than a position as a tenured postdoctoral researcher. However, the group of tenured postdoctoral researchers is very diverse and includes highly competitive researchers who work in extra-university research institutions and those who hold nonacademic positions within universities of applied science or universities. The findings for this group should therefore be treated with caution. Although our main focus was on the different effects of biological and academic age, it is interesting to note two further findings that become apparent when balancing our data. First, the mean differences in the control variables beyond the determinant of age change once they are tailored to the full multivariate model (see Appendix A3); while in the first step, this also underlies the unbalanced multivariate findings, these distributions go beyond the multivariate findings presented above. Younger PhD graduates have greater academic resources than those aged 40+. Especially when looking at their peer-reviewed publications, conference attendances, and grant applications, it becomes clear that they are more active than scholars aged 40+. However, grant applications and conference attendances have no impact on tenure. Books, though, are a different matter. They have a positive effect on the entry into a university professorship. This might indicate potential subject-specific cultures that include the necessity of a 'Habilitation' for a university professorship.

11 Robustness checks based on an exponential model including the academic age as metric and metric^2 term show an increasing influence of the academic age that levels off after time. Additional calculations have shown that the tipping point is approximately 10 years after PhD attainment and therefore not in our observation window.

Finally, a note on the model fit using likelihood ratio tests and comparing the AIC. Looking at the socio-economic background, the PhD grade, and the goal of remaining in science, in addition to biological and academic age increases the goodness of model fit for the risk of attaining a tenured postdoctoral researcher position (LRT=44.44***). However, the academic performance indicators do not increase the model fit (LRT=5.37). This finding is also reflected in the high AIC. To achieve a university of applied science professorship including both socio-economic background and motive (LLT=13.31*) and academic performance indicators (LRT=31.38***) increases the goodness of fit. The same holds for the attainment of a professorship at the university (LRT=30.60*** and 38.40***). These statistics strengthen our argument that the group of tenured postdoctoral researchers should be looked at with caution due to their heterogeneity. Models such as those used are more suitable for estimating the race for tenure at a professorship.

7. Discussion

The central focus of the above paper was the different impacts of the *biological age* and *academic ages* of PhD graduates in reaching a tenured position in academia. We were especially interested in looking at the differences between the importance of the accumulated resources after the doctorate—the productivity of the PhD graduates—as part of the process of aging academically and the implications of the biological age by ways of discriminatory mechanisms. Using data from the DZHW PhD Panel 2014, we first provided a descriptive overview of the differences between younger PhD graduates and those aged 40+ in their retention rate, the resources they gather as they age academically, and the different temporal processes until they enter a tenured position. Secondly, we analyzed the effect of the biological age and academic age along with the socioeconomic background variables, and the resources that PhD graduates attain after graduation on attaining a tenured postdoctoral research position or a professorship at a university (of applied science).

Various findings can be derived from the study. From a descriptive perspective, the resources that graduates accumulate after their doctorate differ by age group and those aged 40+ enter more quickly into tenured positions than do younger PhD graduates. Our multivariate analysis then revealed that age has a subordinate role for tenure during the six years after PhD attainment. However, PhD graduates aged 40+ experience a significantly positive effect on attaining a professorship at a university of applied science or as postdoctoral researcher. PhD graduates aged 40+ are, according to these results, subjected to age discrimination, albeit in a positive way. Their life trajectories into academia and the academic resources they gather there seem to qualify them better than younger PhD graduates for professorships at universities of applied sciences.

Being 40+ years old when starting an academic career does not automatically equate to being 'over the hill', that is, not being suitable for tenure in academia anymore,

but rather to taking alternative and sometimes even *faster paths to the peak* (tenure). Although the debate about which type of tenure, university vs. university of applied science, is more prestigious is seemingly as old as time, being appointed a professor at a university for applied science has become a valid and often-pursued career track, especially for those older; both in regard to the academic and the biological age. Acquiring life and practical work experience before starting on or parallel to an academic track seems to be something of a competitive advantage for candidates who pursue a career path towards a professorship at a university of applied science, probably as they are more likely to fulfil the practical experience requirements. In addition, our data suggest that instead of aiming to become a professor, a tenured position as a postdoctoral researcher, close to research but outside of the junior faculty system, is also proving to be a good alternative for achieving tenure. It should be noted, however, that not much is known about the group of tenured postdoctoral researchers and what the working conditions and career development opportunities in these jobs are.

In addition, when we look at these different academic tracks, we find a notion of track-specific publication cultures. Whereas writing a book will foster an academic career toward a professorship at the university, there is no clear pattern for appointments as professor at a university of applied science. This publication culture—if unknown to an aspiring scholar—can become a hindrance when climbing the academic ladder if, for example, a scholar has a personal preference for one specific track, but their publication record does not align with the track-specific publication culture apparent in our study. Furthermore, it could be argued that publication cultures that favor specific publication types (e.g., peer-reviewed papers over books or edited volumes) might disadvantage scholars from disciplines or areas of research where either those publication types or outlets to publish them are less common, or the resources to produce them are less available.

The study has various limitations. First, our dataset represents a specific subset of the German academic labor market and is insufficient to investigate those who work in extra-university research. While PhD graduates from extra-university research institutions are sampled in the DZHW PhD Panel 2014, the questionnaire does not reflect the opportunities for careers within these institutions. As scholars and research output from these research institutions have become an essential pillar of German academia (Powell/Dusdal 2017), it is crucial to investigate and better understand academic career pathways and their associated working conditions within these organizations. Second, the study focuses on selected scientific outputs and does not go into much detail with respect to the disciplinary details or life trajectories that foster the attainment of a professorship at universities (of applied sciences). Prospective research could benefit from investigating whether different clusters of academic productivity emerge during the race for tenure and how discipline-specific publication cultures and the achievement of an academic with respect to third-party funding or participation in administrative tasks ('Gremienarbeit')

could affect tenure. Third: The family contexts and work-study-work trajectories of PhD graduates could shine light into the mechanisms of attaining tenure. Although the DZHW PhD panel currently covers the longest period after doctoral attainment in Germany, the period is still not long enough to reflect delays caused, for example, by parental leave or by appointment processes. Further research on a temporary position in science is needed once the data has matured further. Finally, it should be recognized that the described inequalities—be it on the basis of gender, migration background, or age—should not be seen as separate cleavages but as linked to one another. The low number of PhD graduates aged 40+ prevents an in-depth analysis of these intersectional inequalities. However, with better data, future research should focus on a more intersectional perspective to gain a more conclusive picture of the obstacles (older) scholars might face when racing for tenure.

References

Allgood, Sam (2020): Age discrimination and academic labour markets. *Journal of Economic Behaviour & Organization* 169: 70–78. https://doi.org/10.1016/j.jebo.2019.10.024

Allison, Paul D. & Stewart, John A. (1974): Productivity differences among scientists: evidence for accumulative advantage. *American Sociological Review* 39 (4): 596–606. https://www.jstor.org/stable/2094424

Allison, Paul D., Long, J. Scott & Krauze, Tad K. (1982): Cumulative advantage and inequality in science. *American Sociological Review* 47(5): 615–625. https://doi.org/10.2307/2095162

Aronson, Elliot, Willson, D. T., Akert, Robin M. & Sommers, Samuel R. (2021): *Social Psychology, Global Edition*. Pearson Education Limited: London.

Arunachalam, Subbiah (2003): Information for research in developing countries – Information technology, a friend or foe? *The International Information & Library Review* 35(2–4): 133–147. https://doi.org/10.1080/10572317.2003.10762596

Astin, Helen S. (1984): The meaning of work in women's lives: A sociopsychological model of career choice and work behavior. *The Counseling Psychologist* 12(4): 117–126. https://doi.org/10.1177/0011000084124002

Auspurg, Kathrin, Hinz, Thomas & Schneck, Andreas (2017): Berufungsverfahren als Turniere: Berufungschancen von Wissenschaftlerinnen und Wissenschaftlern. *Zeitschrift für Soziologie* 46 (4): 283–302. https://dx.doi.org/10.1515/zfsoz-2017-1016

Authoring Group Educational Reporting (2022): *Bildung in Deutschland 2022*. Ein indikatorengestützter Bericht mit einer Analyse zum Bildungspersonal. Bielefeld: wbv media.

Bahr, Amrei, Eichhorn, Kristin & Kubon Sebastian (2022): *#IchBinHanna Prekäre Wissenschaft in Deutschland*. Berlin: Suhrkamp.

Backes-Gellner Uschi & Schlinghoff, Axel (2010): Career incentives and "publish or perish" in German and U.S. Universities, *European Education*, 42(3): 26–52. https://doi.org/10.2753/EUE1056-4934420302

Bal, Anne C., Reiss, Abigail EB, Rudolph, Cort W. & Baltes, Boris B. (2011): Examining positive and negative perceptions of older workers: A meta-analysis. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences* 66(6): 687–698. https://doi.org/10.1093/geronb/gbr056

Berlingo, Laura, Girault, Aude, Azria, Elie, Goffinet, Françoise & Le Ray, Camille (2018): Women and academic careers in obstetrics and gynaecology: aspirations and obstacles among postgraduate trainees – a mixed-methods study. *An International Journal of Obstetrics and Gyneacology* 126(6): 770–777. https://doi.org/10.1111/1471-0528.15574

Berryman, Sue E. (1983): *Who Will Do Science? Minority and Female Attainment of Science and Mathematics Degrees: Trends and Causes*. New York: University of Texas.

Bilecen, Başak (2012): How social support works among the best and the brightest: Evidence from international PhD students in Germany. *Transnational Social Review* 2(2): 139–155. https://doi.org/10.1080/21931674.2012.1082073

Blossfeld, Hans-Peter, Rohwer, Götz & Schneider, Thorsten (2019): *Event history analysis with Stata. Second edition*. New York: Routledge.

Brandt, Gesche, Briedis, Kolja, de Vogel, Susanne, Jaksztat, Steffen, Kovalova, Iryna, Lapstich, Anne-Marie & Teichmann, Carola (2020a): *DZHW PhD Panel 2014. Data collection: 2014–2019. Version: 4.0.0.* Data Package Access Way: On-Site-SUF. Hanover: FDZ-DZHW. Data Curation: Lange, K., Scheller, P., Vietgen, S., & Wallis, M. Hannover: FDZ-DZHW. https://doi.org/ 10.21249/DZHW:phd2014:4.0.0

Brandt, Gesche, de Vogel, Susanne, Jaksztat, Steffen, Lapstich, Anne-Marie, Teichmann, Carola, Vietgen, Susanne & Wallis, Marten (2020b): *DZHW Promoviertenpanel 2014. Daten- und Methodenbericht zu den Erhebungen der Promoviertenkohorte 2014 (Befragungswelle 1–5), Version 3.0.1.* Hannover: FDZ-DZHW.

Butler, Robert N. (1969): Age-ism: Another form of bigotry. *The Gerontologist* 9(4): 243–246. https://doi.org/10.1093/geront/9.4_Part_1.243

BuWiN (2021): *Bundesbericht Wissenschaftlicher Nachwuchs 2021*. Statistische Daten und Forschungsbefunde zu Promovierenden und Promovierten in Deutschland. Bielefeld: wbv Media.

Cebola, Maria Manuela Jacob, Nuno Rebelo dos Santos, and Andreia Dionísio (2021): Worker-related ageism: a systematic review of empirical research. *Ageing & Society* (online first). https://doi.org/10.1017/S0144686X21001380

Cole, Stephen (1979): Age and Scientific Performance. *American Journal of Sociology,* 84(4): 958–977.

Dirnagl, Ulrich (2022): #IchbinHannah and the fight for permanent jobs for postdocs. How a fictious postdoc (almost) triggered a fundamental reform of German academia. *EMBO Reports*, 23: e54623. https://doi.org/10.15252/embr.202254623

Enders, Jürgen & Bommann, Lutz (2001): *Karriere mit Doktortitel? Ausbildung, Berufsverlauf und Berufserfolg von Promovierten*. Campus Verlag: Frankfurt/New York.

Engel, Ole (2021): *Professoren mit Migrationshintergrund: Benachteiligte Minderheit oder Protagonisten internationaler Exzellenz*. Springer VS. doi 10.1007/978–3–658–32411–7

Evans, Linda (2014): A changing role for university professors? Professorial academic leadership as it is perceived by 'the led'. *British Educational Research Journal*, 41(4), 666–685. https://doi.org/10.1002/berj.3163

Fassinger, Ruth E. (1990): Causal models of career choice in two samples of college women. *Journal of Vocational Behavior* 36: 225–248. https://doi:10.1016/0001-8791(90)90029-2

Feichtinger, Gustav, Grass, Dieter, Kort, Peter M. & Seidel, Andrea (2021): On the Matthew effect in research careers. *Journal of Economic Dynamics & Control* 123(5): 104058. https://doi.org/10.1016/j.jedc.2020.104058

Fitzgerald, Louise F., Fassinger, Ruth E., & Betz, Nancy E. (1995): Theoretical advances in the study of women's career, in Bruce W. Walsh & Samuel H. Osipow (edts.), *Handbook of Vocational Psycology.* Theory, research, and practice. Hillsdale, NJ: Erlbaum. 67–109.

Freeman, Elizabeth (2010): *Time Binds: Queer Temporalities, Queer Histories.* Durham: Duke University Press. https://doi.org/10.1215/9780822393184

Gasser, Courtney E. & Shaffer, Katharine (2014): Career Development of Women in Academia: Traversing the Leaky Pipeline. *The Professional Counselor* 4(4): 332–352. http://dx.doi.org/10.15241/ceg.4.4.332

Gewinner, Irina (2020): Work-Life Balance for native and migrant scholars in German academia: meanings and practices. *Equality, Diversity and Inclusion. An International Journal* 39(5): 497–512. https://doi:10.1108/EDI-02-2019-0060

Goldan, Lea (2021): Explaining the gender pay gap among doctoral graduates: analyses of the German labour market. *European Journal of Higher Education* 11(2): 137–159. https://doi.org/10.1080/21568235.2020.1835516

Goldan, Lea, Jaksztat, Steffen & Gross, Christiane (2022): Beruflicher Verbleib und Erfolg von Promovierten. *Beiträge zur Hochschulforschung* 1: 30–50.

GWK (2020): Chancengleichheit in Wissenschaft und Forschung. 24. Fortschreibung des Datenmaterials (2018/2019) zu Frauen in Hochschulen und außerhochschulischen Forschungseinrichtungen (No. 69). Bonn.

Hainmueller, Jens (2012): Entropy balancing for causal effects: A multivariate reweighting method to produce balanced samples in observational studies. *Political Analysis* (20): 25–46. https://doi.org/10.1093/pan/mpr025

Heuchemer, Sylvia & Birgit Szczyrba (2016): Lehrkompetenz und „pädagogische Eignung" im Verhältnis. *Teaching Skills Assessments*. Wiesbaden: Springer. 219–237. https://doi.org/10.1007/978-3-658-10834-2_12

Hillmert, Steffen (2003): Altersstruktur und Karrierewege der Professorinnen und Professoren in der deutschen Soziologie. *Kölner Zeitschrift für Soziologie und Sozialpsychologie* 55: 116. https://doi.org/10.1007/s11577-003-0006-8

HRK (2014/2015): *Joint declaration on Doctoral Training in Europe*. Hochschulrektorenkonferenz: Bonn. https://www.hrk.de/resolutions-publications/resolutions/beschluss/detail/joint-declaration-on-doctoral-training-in-europe-1/

Hüther, Otto & Krücken, Georg (2018): *Higher Education in Germany – Recent Developments in an International Perspective*. Springer, Cham. 223–255. https://doi.org/10.1007/978-3-319-61479-3

Iversen, Thomas Nicolaj, Larsen, Lars & Solem, Per Eerik (2012): A conceptual analysis of ageism. *Nordic Psychology* 61(3): 4–22. https://doi.org/10.1027/1901-2276.61.3.4

Jaksztat, Steffen, Brandt, Gesche, De Vogel, Susanne & Briedis, Kolja (2017): Gekommen, um zu bleiben? Die Promotion als Wegbereiter wissenschaftlicher Karrieren. *WSI-Mitteilungen* 5: 321–329.

Jansen, Dorothea, Wald, Andreas, Franke Karola, Schmoch, Ulrich & Schubert Torben (2007): "Drittmittel als Performanzindikator der wissenschaftlichen Forschung." KZfSS Kölner *Zeitschrift für Soziologie und Sozialpsychologie* 59(1): 125–149. https://doi.org/10.1007/s11577-007-0006-1

Jung, Hyejin, Yang, Joeng-Mo & Oh, Young Sam (2022): Influence of government-funded postdoctoral fellowships on tenure-track appointments of scholars in the social sciences and the humanities. *Asia Pacific Education Review* (online first). https://doi.org/10.1007/s12564-022-09758-5

Jungbauer-Gans, Monika & Gross, Christiane (2013): Determinants of Success in Universtity Careers: Findings from the German Academic Labor Market: Erfolgsfaktoren in der Wissenschaft – Ergebnisse aus einer Habilitiertenbefragung an deutschen Universitäten. *Zeitschrift für Soziologie* 42 (1): 74–92. https://doi.org/10.1515/zfsoz-2013-0106

Keil, Maria (2018): Zur Reproduktion sozialer Ungleichheit im Feld der Wissenschaft. Berliner Journal für Soziologie, 28: 457–478. https://doi.org/10.1007/s11609-019-00379-1

Kohli, Martin (2003): Der institutionalisierte Lebenslauf: ein Blick zurück und nach vorn, in: Jutta Allmendinger (Ed.), *Entstaatlichung und soziale Sicherheit. Verhandlungen des 31. Kongress für Soziologie in Leipzig*. Opladen: Leske + Budrich. Pp. 525–545.

Krais, Beate (2002): Academia as a profession and the hierarchy of the sexes: Paths out of research in German universities. *Higher Education Quarterly*, 56(4), 407–4 418. https://doi.org/10.1111/1468-2273.00227

Krimmer, Holger, Stallmann, Freia, Behr, Markus & Zimmer, Annette (2003): *Karrierewege von ProfessorInnen an Hochschulen in Deutschland. Projekt Wissenschaftskarriere*. Universität Münster: Institut für Politikwissenschaft.

Lackner, Hendrick (2020): 50 Jahre Fachhochschulen, in: Jingmin Cai, Hendrik Lackner & Qidong Wang (Eds.), *Jahrbuch Angewandte Hochschulbildung 2018*. Wiesbaden: Springer. Pp. 149–168. https://doi.org/10.1007/978-3-658-27273-9_10

Lapour, Anne Scott & Heppner, Mary J. (2009): Social class privilege and adolescent women's perceived career options. *Journal of Counseling Psychology* 56(4): 477–494. https://psycnet.apa.org/doi/10.1037/a0017268

Laudel, Grit & Gläser, Jochen (2008): From apprentice to colleague: The metamorphosis of Early Career Researchers. *Higher Education* 55(3): 387–406. https://doi.org/10.1007/s10734-007-9063-7

Leppel, Karen, Williams, Mary L. & Waldauer, Charles (2001): The impact of parental occupation and socioeconomic status on choice of college major. *Journal of Family and Economic Issues* 22(4): 374–394. https://doi.org/10.1023/A:1012716828901

Lörz, Markus & Schindler, Steffen (2016): Soziale Ungleichheiten auf dem Weg in die akademische Karriere. Sensible Phasen zwischen Hochschulreife und Post-Doc-Position. *Beiträge zur Hochschulforschung*, 38: 14–39.

Löther, Andrea (2012): Wissenschaftlerinnen und Wissenschaftler mit Migrationshintergrund. *Die Hochschule* 21(1): 36–54.

Lutter, Mark & Schröder, Martin (2014): Who becomes a tenured professor, and why? Panel data evidence from German sociology, 1980–2013. *Research Policy* 45(5): 999–1013. https://doi.org/10.1016/j.respol.2016.01.019

Lynch, Karen Danna (2008): Gender roles and the American academe: A case study of graduate student mothers. *Gender and Education* 20(6): 585–605. https://doi.org/10.1080/09540250802213099

Marchiondo, Lisa A., Gonzales, Ernest & Ran, Shan (2016): Development and validation of the Workplace Age Discrimination Scale. *Journal of Business and Psychology* 31(4): 493–513. https://psycnet.apa.org/doi/10.1007/s10869-015-9425-6

Marques, Sibila, Mariano, João, Mendonça, Joana, De Tavernier, Wouter, Hess, Moritz, Naegele, Laura, Peixeiro, Filomena. & Martins, Daniels (2020): Determinants of Ageism against Older Adults: A Systematic Review. International Journal of Environmental Research and Public Health,17: 2560. https://doi.org/10.3390/ijerph17072560

McDowell, John M. (1982): Obsolence of knowledge and career publication profiles: Some evidence of differences among fields in costs of interrupted careers. *The American Economic Review* 72(4): 752–768. https://www.jstor.org/stable/1810015

Mertens, Anne, Röbken, Heinke (2013): Does a doctoral degree pay off? An empirical analysis of rates of return of German doctorate holders. *Higher Education* 66:217–231. https://doi.org/10.1007/s10734-012-9600-x

Merton, Robert K. (1968): The Matthew Effect in Science: The reward and communication systems of science are considered. *Science* 159(3810): 56–63. https://doi.org/10.1126/science.159.3810.56

Merton, Robert K. (1973): The normative structure of science, in: Norman W. Storer (Ed.), *The Sociology of Science*. Chicago, London: University of Chicago Press. Pp. 267–278.

Merton, Robert K. (1988): The Matthew effect in science, II. Cumulative advantage and the symbolism of intellectual property. *ISIS* 79(4): 606–623. https://www.jstor.org/stable/234750

Milojević, Staša (2012): How are academic age, productivity and collaboration related to citing behavior of researchers, *Plos One* 7(1): e49176. https://doi.org/10.1371/journal.pone.0049176

Möller, Christina (2013): Wie offen ist die Universitätsprofessur für soziale Aufsteigerinnen und Aufsteiger? *Soziale Welt* 64(4): 341–360.

Musselin, Christine (2005): European labor markets in transition. *Higher Education*, 49: 135–154. https://doi.org/10.1007/s10734-004-2918-2

Naegele, Laura, De Tavernier, Wouter & Hess, Moritz (2018): Work Environment and the Origin of Ageism, in: Liat Ayalon & Clemens Tesch-Römer (Eds.): Contemporary Perspectives on Ageism. International Perspectives on Aging. Cham: Springer. Pp.73 – 90.

Ng, T. W. H., & Feldman, D. C. (2012): Evaluating six common stereotypes about older workers with meta-analytical data. *Personnel Psychology*, 65(4), 821–858. https://doi.org/10.1111/peps.12003

Neusel, Aylâ, Wolter, Andrä, Engel, Ole, Kriszio, Marianne & Weichert, Doreen (2014): *Internationale Mobilität und Professur Karriereverläufe und Karrierebedingungen von Internationalen Professorinnen und Professoren an Hochschulen in Berlin und Hessen. Kurzfassung ausgewählter Ergebnisse aus dem Forschungsprojekt „Internationale Mobilität und Professur (MOBIL)"*. Berlin: Humboldt Universität zu Berlin.

Ordemann, Jessica (2019): *Studium ohne Abitur. Bildungserträge nichttraditioneller Hochschulabsolventen im Vergleich*. Wiesbaden: Springer.

Ordemann, Jessica, Buchholz, Sandra & Spangenberg, Heike (2023): Von direkten und alternativen Wegen ins Studium: Eine quantitative Analyse zum sozialen Phänomen der beruflich-akademischen Doppelqualifizierung von Studienberechtigten, in Ordemann, Jessica, Peter, Frauke & Buchholz, Sandra (Eds.): *Vielfalt von hochschulischen Bildungsverläufen. Wege in das, durch das und nach dem Studium*. Wiesbaden: Springer.

Pichler, Edith & Prontera, Grazia (2012): Kulturelles Kapital auf dem Weg zur Professur. Unterschiedliche Ausgangslagen von Wissenschaftler/innen mit Migrationshintergrund. *Die Hochschule* 21(1): 91–101.

Powell, Justin J. W. & Dusdal, Jennifer (2017): Research organizations' contribution to publications in science and technology disciplines in Germany, France, Belgium, and Luxembourg. *Minerva*, 55, 413–434. https://doi.org/10.1007/s11024-017-9327-z

Reskin, Barbara F. (1977): Scientific productivity and the reward structure of science. *American Sociological Review*, 42(3): 491–504. https://www.jstor.org/stable/2094753

Rossiter, Margaret W. (2003): *Der Matthäus Matilda-Effekt in der Wissenschaft*. Bielefeld: Transcript Verlag. https://doi.org/10.1515/9783839401187-008

Primack, Richard B., Ellwood, Elizabeth, Miller-Rushing, Abraham, Marrs, Rob & Mulligan, Adrian (2009): Do gender, nationality, or academic age affect review decisions? An analysis of submissions to the journal of Biological Conservation. *Biological Conservation* 142(11): 2415–2418. https://doi.org/10.1016/j.biocon.2009.06.021

Schröder, Martin, Lutter, Mark & Habicht, Isabel M. (2021): Publishing, signaling, social capital, and gender: Determinants of becoming a tenured professor in German political science. *Plos One* 16(1): e0243514. https://doi.org/10.1371/journal.pone.0243514

Schneijderberg, C., Götze, N. & Müller, L. (2022): A study of 25 years of publication outputs in the German academic profession. *Scientometrics* 127, 1–28 (2022). https://doi.org/10.1007/s11192-021-04216-2

Scott, W. Richard. (2005): Evolving professions: An institutional field approach. *Organisation und Profession*. Wiesbaden: Springer. Pp. 119–141. https://doi.org/10.1007/978-3-322-80570-6_5

Solga, H., Rusconi, A., & Netz, N. (2023). Professors' gender biases in assessing applicants for professorships. European Sociological Review, jcad007. https://doi.org/10.1093/esr/jcad007

Springer, Kristen W., Parker, Brenda K. & Leviten-Reid, Catherine (2009): Making space for graduate school parents: Practice and politics. *Journal of Family Issues* 30(4): 435–457. https://doi.org/10.1177/0192513X08329293

Statistisches Bundesamt (2021a): Frauenanteile nach akademischer Laufbahn. Wiesbaden: Destatis.

Statistisches Bundesamt (2021b): Bildung und Kultur. Studierende an Hochschulen. Sommersemester 2021. Personal an Hochschulen 2020. Fachserie 11 Reihe 4.1.Wiesbaden: Destatis.

Statistisches Bundesamt (2022): Bildung und Kultur. Statistik der Promovierenden 2021. Wiesbaden: Destatis.

Statistisches Bundesamt (2022): Special analysis H21 – Hochschulpersonalstatistik. Wiesbaden: Destatis.

Stypińska, Justyna & Nikander, Pirjo (2018): Ageism and age discrimination in the labour market: A macrostructural perspective, in: Liat Ayalon & Clemens Tesch-Römer (Eds.), *Contemporary Perspectives on Ageism*. Cham: Springer. Pp. 91–108.

van Dalen, Hendrik. P. (2021): How the publish-or-perish principle divides a science: the case of economists. *Scientometrics* 126: 1675–1694. https://doi.org/10.1007/s11192-020-03786-x

Vietgen, Sandra, Vogel, Susanne de & Brandt, Gesche (2020): DZHW-Promoviertenpanel. Datenbeschreibung, Analysepotential und Zugangswege. *Soziale Welt* 71: 507–524. https://doi.org/10.5771/0038-6073-2020-4-507

Wanka, Anna & Grit Höppner (2021): Un/doing Age. Eine de/konstruktivistische Analyse von Alter an Übergängen im Lebenslauf, in Birgit Blättel-Mink (Hg.) 2021: *Gesellschaft unter Spannung. Verhandlungen des 40. Kongresses der Deutschen Gesellschaft für Soziologie 2020.*

Wanka, Anna (2020): Chrononormativität im Lebenslauf – Die sozialen Praktiken der Herstellung und De/Stabilisierung temporaler Normalität in der Lebensphase Alter, in: Elisabeth Schilling, Maggie O'Neill (Eds.), *Frontiers in Time Research – Einführung in die interdisziplinäre Zeitforschung*. Wiesbaden: Springer. Pp. 133–161. https://doi.org/10.1007/978-3-658-31252-7_7

Will, A. K. (2019): The German statistical category "migration background": Historical roots, revisions and shortcomings. *Ethnicities*, 19(3), 535–557. https://doi.org/10.1177%2F1468796819833437

WissZeitVG: *Gesetz über befristete Arbeitsverträge in der Wissenschaft* (Wissenschaftszeitvertragsgesetz – WissZeitVG). 25.05.2020. https://www.gesetze-im-internet.de/wisszeitvg/BJNR050610007.html

Yang, Lijing & Webber, Karen L. (2015): A decade beyond the doctorate: the influence of a US postdoctoral appointment on faculty career, productivity, and salary. *Higher Education* 70(4): 667–687. https://doi.org/10.1007/s10734-015-9860-3

Zimmer, Lena M. (2018): *Das Kapital der Juniorprofessur: Einflussfaktoren bei der Berufung von der Junior-auf die Lebenszeitprofessur*. Wiesbaden: Springer.

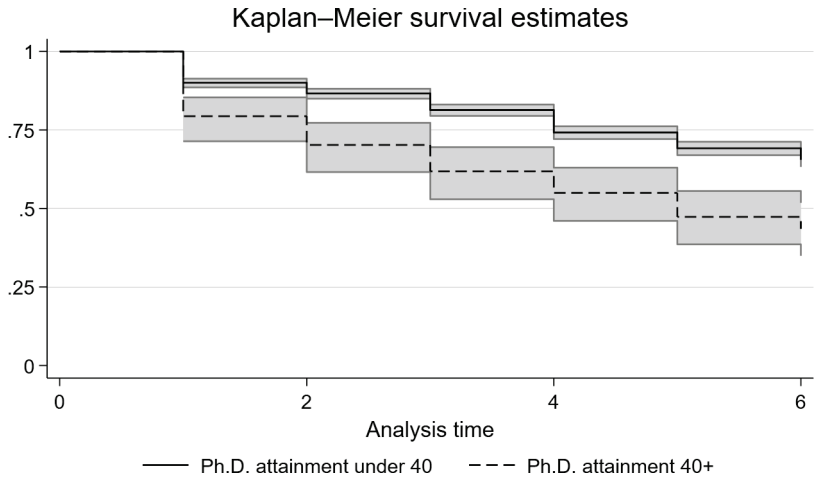
Zimmer, Lena M. (2021): Bildungsaufstieg in der Wissenschaft. Zur Nicht-Reproduktion sozialer Ungleichheit beim Übergang von der Junior- auf die Lebenszeitprofessur. *Zeitschrift für Soziologie* 50(5): 415–433. https://doi.org/10.1515/zfsoz-2021-0025

Zuckerman, Hariette (1977): *Scientific Elite: Nobel laureates in the United States*. New York: Free Press.

Zuckerman, Harriette & Merton, Robert K. (1972): Age, aging, and age structure in science, in: Mathilda White Riley, Marilyn Johnson & Anne Foner (Eds.): *A sociology of Age Stratification, Vol. 3*. New York: Russel Sage. Pp. 292–356.

Online-Appendix

Figure A1: Product limit estimation (Kaplan-Meier) of remaining in a temporary position in academia by PhD attainment under 40 and 40+



Source: DZHW PhD Panel 2014 (2014–2020, beta), author's own estimation based on N=1.918.

Table A1: Overview of legal age limit to attain a professorship by German state

Federal state	Age limit	Legal act
Baden-Württemberg	47, 52 if previously employed as civil servant	Landeshaushaltsverordnung § 48.2 and § 48.5
Bavaria	52, exception in special cases	Article 10 Bayrisches Hochschulpersonalgesetz
Berlin	50	§ 53.5 Gesetz über die Hochschulen im Land Berlin
Brandenburg	50	§ 43.3 Brandenburgisches Hochschulgesetz
Bremen	55 exception possible	§ 48.1,2 Landeshaushaltsordnung
Hamburg	50	Letter from the University of Hamburg regarding the age limit of professors
Hessia	50 exceptions until age of 60	§ 11 HLV Hessische Laufbahnverordnung
Mecklenburg-Vorpommern	50	§ 117 Beamtengesetz für das Land Mecklenburg-Vorpommern
Lower Saxony	50	§ 27.2 Niedersächsisches Hochschulgesetz
North Rhine-Westphalia	50	§ 39.a Gesetz über die Hochschulen des Landes Nordrhein-Westfalen
Rhineland-Palatinate	50	§ 1 Landesverordnung über die Höchstaltersgrenze für die Berufung von bestimmten Hochschulbediensteten in ein Beamtenverhältnis auf Lebenszeit
Saarland	55	§ 49 Saarländisches Hochschulgesetz

Federal state	Age limit	Legal act
Saxony	52	§ 7 Abs. 1 Sächsisches Beamtengesetz, § 1 Altersgrenzenverordnung
Saxony-Anhalt	52	§ 8a Landesbeamtengesetz
Schleswig-Holstein	52	§ 48.1 Gesetz über die Hochschulen und das Universitätsklinikum Schleswig-Holstein
Thuringia	52	§ 97.7 Thüringer Hochschulgesetz

Source: Author's own compilation of state laws.

Table A2: Descriptive statistics from the (pooled) estimation samples 2014–2020 by PhD attainment under 40 and 40+ (mean (SD)/rel. freq.)

Variables	N	total	PhD attainment	
			under 40	40+
Making a career in science	6,719	3.1 (1.23)	3.1 (1.2)	3.1 (1.1)
Sex				
Men	3,336	49.7 %	50.1 %	43.4 %
Women	3,383	50.4 %	49.9 %	56.7 %
Migration background				
No	6,086	90.6 %	90.8 %	9.2 %
Yes	633	9,4 %	87.4 %	12.6 %
PhD grade				
Summa cum laude	2,168	32.3 %	33.3 %	17.2 %
Magna cum laude	3,895	58.1 %	58.2 %	55.4 %
Cum laude/satis bene	547	9.6 %	8.5 %	27.4 %
Time distance to predoctoral degree	6,719	1.8 (3.0)	1.4 (1.8)	8.9 (6.4)

Note: Variables described in the section 'Findings' are not included in this table.
Source: DZHW PhD Panel 2014 (2014–2020, beta), author's own estimation based on N=1.918.

Table A3: Summary of conditioning variables by PhD attainment under 40 and 40+ (Example for wave 6)

	Mean		Mean Difference	Mean under 40*
	under 40	aged 40+		
Women (ref. men)	1.518	1.649	0.131	1.628
Migration background (ref. no migration background)	1.090	1.081	-0.009	1.083
PhD grade (ref. summa cum laude)				
Magna cum laude	0.337	0.243	-0.094	0.256
Cum laude	0.585	0.541	-0.044	0.540
Future in academia	3.080	3.108	0.028	3.112
Publications				
Peer review	2.138	2.042	-0.096	2.064
Other publications	0.925	1.722	0.797	1.638
Books	0.157	0.339	0.182	0.322
Conference attendence	2.384	2.489	0.105	2.485
Successful grant application	0.554	0.491	-0.063	0.501
Reviews	1.084	1.163	0.079	1.165
N		6,710		

Note: Presented means differ from the descriptive findings in Table 2 since this analysis was restricted to the full multivariate model. *after entrophy balancing.
Source: DZHW PhD Panel 2014 (2014–2020, beta), author's own estimation based on N=1.918.