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Simply the best? Determinants of achieving the highest grade in a doctoral degree in Germany

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Abstract
In Germany, the final grade of a doctorate is significant for careers inside and outside the academic labor market. Particularly important is the highest grade—*summa cum laude*. At the same time, doctoral grades are constantly subject to criticism. Thus far, however, neither German nor international studies have examined the determinants of doctoral grades. Drawing on Hu's model of college grades, this study develops a conceptual framework for explaining doctoral grades and investigates the impact of doctorate holders', reviewers', and environmental context characteristics on the probability of doctoral candidates graduating with the highest grade, *summa cum laude*. Using logistic regression analyses on data from the German PhD Panel Study, the study confirms that high-performing individuals are more likely to achieve the highest doctoral grade. A learning environment that is characterized by supervision security, high expectations to participate in scientific discourse, and strong support in network integration also increases the chances of graduating with a *summa cum laude* degree. In contrast, being female, having a highly respected reviewer, studying natural sciences, medical studies or engineering, completing an external doctorate, and studying within a learning environment characterized by rigid time constraints are negatively related to the probability of receiving a *summa cum laude* grade. This study is the first to lend empirical evidence to the critical discussion of doctoral grades and offers insights to ensure the validity of doctoral grades.

Keywords Doctorate · PhDs · Grades · Academic success

Introduction

Alongside the trend of the massification of higher education over the last decades, there has also been a worldwide expansion of doctoral education (Auriol, 2010). Doctoral degrees are particularly on the rise in Germany, accompanied by an increasing search for differentiation, which is reflected, for example, in the establishment of structured doctoral programs. At the same time, the doctorate holds a special significance in Germany, as it is

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considered a requirement not only for academic careers but also for attaining elite positions outside academia. Thus, an increasing number of doctorate holders compete for very few but very coveted positions (Rogge, 2017).

In Germany, the quality of the doctorate is assessed via a final grade, which is awarded upon a candidate's successful completion of the doctorate. The final grade of a doctorate should reflect the individual quality of the doctorate in a concise and, as far as possible, comparable manner. Occupying the highest position on the grading scale, a grade of *summa cum laude* should be awarded only to candidates exhibiting outstanding academic achievements. Recent research shows, that doctoral grades, in turn, play a crucial role in shaping the doctoral holders' future career opportunities. A *summa cum laude* can, in particular, foster academic careers. Doctoral holders with *a summa cum laude* degree are more likely to remain in academia after graduation (Jaksztat et al., 2017), and a *summa cum laude* is often a prerequisite for obtaining a professorship. But even outside academia, a *summa cum laude* degree increases the chances of achieving a leadership position (de Vogel, 2020). The declining exclusivity of a doctorate may consequently have led to the doctoral grade becoming a new "employability signal", thus replacing the doctoral degree as an access key to the highest occupational positions. Doctoral grades therefore may, in turn, reinforce or generate new social inequalities.

Despite—or perhaps because of—the importance of doctoral grades, the grading practices for doctorates have been the subject of ongoing critical discussion. As the *summa cum laude* degree is awarded with increasing frequency (Consortium for the National Report on Junior Scholars 2017: 215ff), the quality of the degree is called into question (German Science Council, 2011), and doctoral grades are often addressed in the context of grade inflation (Hornbostel & Johann, 2017). Moreover, the proportion of doctoral holders granted *summa cum laude* degrees varies significantly between subjects and higher education institutions (HEIs) (ibid). This also casts doubt on the comparability of doctoral grades. Lastly, the objectivity of doctoral grades is questioned because candidates' supervisors are usually also the reviewers (German Science Council, 2011).

Against this background, an important question becomes "What factors influence the probability of completing the doctorate with the highest grade, *summa cum laude*?" Much research has recently been conducted on the determinants of study grades (e.g., Gaens, 2018; Grözinger, 2015). To date, however, no firm evidence has identified the factors influencing doctoral grades. Studies exploring doctoral success have thus far examined completion (Visser et al., 2007; Wright & Cochrane, 2000), candidates' dropout intentions (Alfermann et al., 2020) and actual dropout (Jaksztat et al., 2021; Wollast et al., 2018), time-to-degree (Kim & Otts, 2010; Skopek et al., 2020; Stock et al., 2011), and research productivity outcomes (e.g., publications) during the doctoral phase (Jaksztat, 2017). Regarding doctoral grades, the extant literature has thus far identified differences by subject, HEIs, social origin, and gender. However, the existing findings are based solely on descriptive analyses (Enders & Bornmann, 2001) or limited to certain subjects, scholarship programs, or HEIs (Enders & Kottmann, 2009; Lachmann et al., 2018; Röbbecke & Simon, 2001). More recent studies investigating doctoral grades in Germany with representative data are not yet available. I am also not aware of any international studies on this topic to date, which may certainly be due to the fact that only a few countries—besides Germany, for example, Austria, Switzerland, France, and Spain (Kupfer & Moes, 2004)—award doctorates with final grades. The present study aims to fill this research gap by examining the determinants of final doctoral grades in Germany.

To introduce the topic, I first offer an overview of the existing evaluation practices of doctorates in Germany. I then create a conceptual framework that can be used to derive

possible factors influencing final doctoral grades. My analyses are based on data from a German PhD Panel Study. Using a multivariate analysis approach, I present findings that extend existing descriptive observations. Thus, the current study can add sound evidence to discussions regarding the value of doctoral grades.

Doctoral degree evaluation practices in Germany

To successfully complete a doctorate in Germany, doctoral candidates must prove their ability to conduct independent research (German Science Council, 2002) in two exams: a doctoral thesis and an oral examination. The doctoral thesis may be submitted as either a monograph or a cumulative dissertation. The oral examination usually takes the form of a disputation or, less commonly, a *viva voce* ("Rigorosum"). The examination committee consists of the dissertation reviewers (typically, two professors) and additional faculty members.

To evaluate the doctoral thesis, at least two reviewers prepare written reports, which include a request for acceptance or rejection of the dissertation and the recommended grade. The overall grade of the dissertation is calculated from the proposed individual grades. The evaluation of the oral examination takes place immediately after the disputation in a meeting of the examination board. After the candidate passes the oral examination, the final doctoral grade is computed from the grades for the dissertation and the oral examination.

Reviewers often hold further roles during the doctoral process. Most commonly, the reviewers are also involved in the supervision of the doctoral project (Jaksztat et al., 2012). In case the doctorate is pursued within a research assistant position, the reviewer may furthermore be also the doctoral candidate's professional superior.

The grading scheme for doctorates is usually defined in the faculties' doctoral regulations. This alone makes comparability difficult because the grading schemes applied differ between HEIs and even between faculties' within a HEI. In general, the best possible grade is *summa cum laude* (Latin for "with highest praise"). This is usually followed by *magna cum laude* (Latin for "with high praise"), *cum laude* (Latin for "with praise"), *satis bene* (Latin for "satisfactory"), and/or *rite* (Latin for "sufficient"). Failures are graded as *non sufficit* or *non-rite*. Around half of all doctorates in Germany are awarded the grade of *magna cum laude* (German Centre for Higher Education Research and Science Studies 2021). However, *summa cum laude* grades are awarded with increasing frequency.

A conceptual framework for explaining doctoral grades

Just as hardly any empirical studies have examined doctoral grades thus far, the literature also lacks theoretical concepts for explaining doctoral grades. Still, Hu (2005) has established a theoretical framework for college grades, and other German studies examining course and exam grades in higher education (e.g., Grözinger, 2015) have referred to this framework. Unlike the majority of studies on college grading, the multicausal model combines theoretical approaches from economics, sociology, psychology, and education. Therefore, this paper adapts Hu's model to identify possible determinants of doctoral grades. Consistently, I postulate that *doctoral candidates'*, *reviewers'*, and *environmental context* characteristics influence the doctoral grade.

Figure 1 illustrates the conceptual framework I developed to identify determinants of doctoral grades based on existing theories and empirical findings. However, my selection

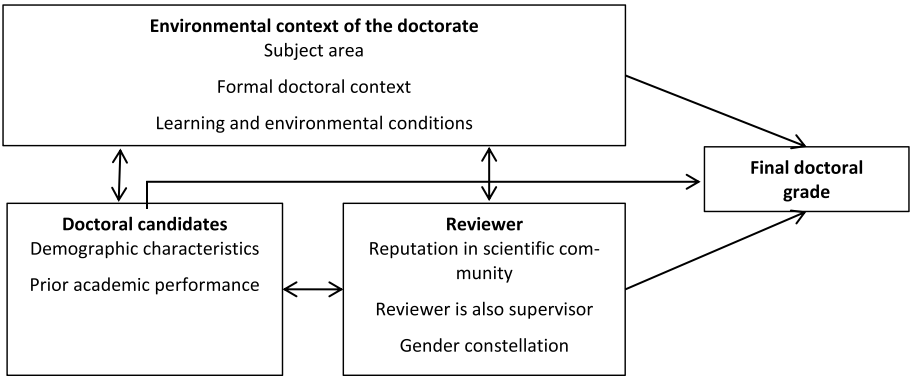

Fig. 1 Conceptual framework for explaining final doctoral grades

of possible determinants was also driven by data availability. Thus, the model does not claim to be exhaustive, and additional factors might be crucial for explaining doctoral grades. Moreover, the determinants should not be considered in isolation; rather, they should be understood to interact with each other.[1]

Characteristics of the doctoral candidates

First, I argue that doctoral candidates commence their studies with pre-entry attributes (Kuh et al., 2006) that are related to their academic performance and/or impact their reviewers' evaluations of their doctoral theses. Numerous studies have shown that *demographic characteristics*, such as gender, parental education, and migration experience, are associated with academic success. The negative effects of having parents without a higher education degree are consistently evident in all educational transitions and success indicators between study enrollment and the doctoral level (Lörz & Schindler, 2016). Theoretically, this can be explained by these individuals' low habitual fit (Bourdieu, 1988) with the higher education system, which might make it more difficult for them to meet the (implicit) requirements of academia. They are furthermore less likely to attend well-reputed HEIs (Duta et al., 2021) and might therefore be less trained in the practical skills and knowledge required for a successful doctorate. Within the life sciences, Lachmann et al. (2018) documented a small effect of social origin on the final doctoral grade. Accordingly, I assume that individuals whose parents have a higher education degree are more likely to complete their doctorates with the grade of *summa cum laude* (hypothesis **H1**). Similar arguments are used to explain why individuals with migration experience face unequal opportunities in higher education attainment (Hinz & Thielemann, 2013; Lörz, 2020). International doctoral candidates face additional acculturation challenges during their doctorate, which, in turn, can even result in dropout of a doctoral program (Laufer & Gorup, 2019). Hence, I expect a candidate's migration experience to produce a negative effect (**H2**). With regard

[1] Subject area and prior academic performance, for example, have been found to impact the choice of doctoral context (de Vogel 2020). The doctoral candidates' attributes and the environmental context in turn may influence how the reviewers are comprised. Recent research on social inequality in higher education suggests that there may be an interaction effect between social origin, gender, and migration experience (e.g., Lörz 2020).

to gender, studies show that females, on average, achieve higher study grades (Sonnert & Fox, 2012) than do males. In the subsequent course of their careers, however, the gender effect appears to reverse. Females are significantly less likely to pursue a doctorate after graduation (de Vogel, 2017) and drop out more often (Jaksztat et al., 2021) than do males. First, this may be because even in relationships among academics, the division of household tasks mostly follows traditional role patterns (Rusconi, 2013) and females take on more housework and care duties than males. Due to the additional workload, female doctoral candidates presumably have less time to dedicate to a doctorate. Another reason may be because females perceive fewer opportunities for promotion and lower levels of support during their doctoral studies than do males (Jaksztat, 2017). At the same time, women in science are subject to an evaluation bias and are rated as less competent than men (Moss-Racusin et al., 2012). I assume that these biases may also impact grading practices and, therefore, that female doctoral candidates graduate less often with *summa cum laude* grades than do males (**H3**).

Prior *school and academic performance* can be seen as an indicator of cognitive ability, knowledge, and effort. As Hambrick (2003) argues, prior knowledge helps an individual to acquire future knowledge. Furthermore, past successes motivate students to work hard in the future (Marsh & Martin, 2011). In Germany, therefore, HEI admission processes have always used school performance as a selection criterion, and students' prior performance has proven to validly predict academic success (Schneider & Preckel, 2017). Individuals with good academic performance are more likely to pursue doctoral studies (de Vogel, 2017) and successfully complete their doctorates (Wright & Cochrane, 2000). Accordingly, I argue that a history of strong academic performance increases the probability that an individual will graduate with the grade of *summa cum laude* (**H4**).

Characteristics of the reviewers

Second, previous research suggests that reviewers' characteristics affect doctoral evaluations (Grözinger, 2015). In case doctoral reviewers *supervise* the same dissertations they review, the reviewers can, during the writing process, direct the progress of the dissertation toward their quality demands. This dual role further implies that the reviewers implicitly evaluate their own performance as doctoral supervisors. Consequently, reviewers who have also served as supervisors likely might not grade objectively and prefer to award the doctorate the highest rating possible. Doctoral candidates whose supervisors were also their reviewers are, therefore, more likely to achieve *summa cum laude* degrees (**H5**).

Previous research finds that the reputations of the awarding HEIs or departments play an important role in grading practices (Lombardi & Ghellini, 2019). In Germany, however, not the entire faculty but only individual lecturers are involved in the grading process. Gaens (2018) suspects that examiners with an already strong *scientific reputation* are more inclined to apply more stringent selection standards; thus, doctoral candidates who complete their doctorates with highly respected reviewers must meet particularly high performance standards to achieve outstanding doctoral grades. Consequently, I assume that a reviewer with a strong academic reputation in his or her scientific community reduces the probability of a candidate obtaining a *summa cum laude* degree (**H6**).

A final reviewer characteristic relevant for doctoral grading may be the *gender constellation of reviewers and doctoral candidate*s. Studies have disproved that a same-gender teacher is advantageous in terms of students' school grades (e.g., Neugebauer et al., 2011). However, research on academic success shows that a same-gender doctoral reviewer

increases the probability that the candidate will successfully complete the doctorate (Main, 2014) and remain in academia (Gaule & Piacentini, 2018). Dissertations supervised by a same-gender lecturer achieve a higher scientific impact (Bu et al., 2020). According to Allen et al. (2005), the positive impact of a same-gender constellation in mentoring relationships can be attributed to the higher level of interpersonal comfort mentees feel in relationships with mentors of the same gender. This, in turn, increases the quality of the mentoring relationship and the support the mentee receives. Furthermore, gender homophily in academia (Kegen, 2013; Kwiek & Roszka, 2021) can also manifest in reviewers perceiving doctoral candidates of the same gender as more capable and productive and, therefore, awarding them better grades than those of the opposite gender. Therefore, I propose that same-gender reviewers increase the probability that candidates will graduate from their doctoral programs with a *summa cum laude* degree (**H7**).

Characteristics of the environmental context of the doctorate

Third, I refer to the environmental context of a candidate's doctoral education and expect the subject area to impact doctoral grades. Examining the distribution of doctoral grades by *subject* reveals that *summa cum laude* degrees are awarded very frequently in some subjects, while hardly at all in other subjects (German Centre for Higher Education Research and Science Studies 2021). In the natural sciences, a *summa cum laude* degree is much rarer than, for example, in economics. In medical studies, moreover, the top grade is hardly ever awarded. Researchers have yet to uncover the mechanisms behind these subject-cultural awarding patterns. I assume that in disciplines, where a doctoral degree is almost the standard qualification, the grade rather than the degree may function as a signal for distinguishing particularly talented graduates. Consequently, I suspect that doctoral candidates in subjects with high doctoral rates receive a *summa cum laude* degree less often than do doctoral graduates in other disciplines (**H8**).

The *formal doctoral context* can also be relevant to doctoral grades for a variety of reasons. On the one hand, doctorates within research assistant positions,[2] external doctorates, scholarship programs, and structured doctorates differ in their recruiting practices. In structured doctorates and scholarship programs, the selection of doctoral candidates is largely based on standardized procedures and objective, performance-based criteria (Lachmann et al., 2020). This is why particularly talented doctoral students may often be found in such contexts (de Vogel, 2017). On the other hand, research assistant positions and structured doctoral programs offer particularly beneficial learning and development conditions (de Vogel, 2020; Lachmann et al., 2020). Furthermore, research assistant positions may be advantageous because the department heads often also assume the roles of supervisor and reviewer, and reviewers may want to reward their staff with high grades. External doctorates stand in stark contrast to other doctoral contexts. External doctoral candidates complete the requirements of the doctorate, usually alongside employment in the non-academic labor market, in their leisure time and cannot benefit from close professional relationships with their reviewers. Access to the doctorate is not formalized, and external doctoral candidates experience the least supportive learning and development conditions (de Vogel, 2020). For the life

[2] In Germany, there is no proper distinction between teaching and research assistant positions, since research assistants are often also involved in teaching.

sciences, it has already been demonstrated that employment outside academia during doctoral studies has a negative effect on the doctoral grade (Lachmann et al., 2018). Consequently, I conclude that *summa cum laude* degrees are less likely in external doctorates than in other formal doctoral contexts (**H9**).

Finally, educational psychologists argue that the *learning environment* is a significant factor in students' educational success. First, scholars have identified the supervision of the doctoral project as a crucial environmental aspect for doctoral candidates' success (Alfermann et al., 2020; Castelló et al., 2017; Jaksztat et al., 2021; Skopek et al., 2020). Indeed, the presence of an experienced scientist at one's side offering professional support and advice throughout the research and writing process is crucial for candidates to successfully complete a doctoral project. Accordingly, the German Science Council (2011) asserts that secure supervision is essential to ensure the quality of a candidate's doctoral project. In contrast, doctoral candidates who are left on their own for parts of the doctoral phase or who must seek a new supervisor during the course of their studies may struggle to achieve excellent academic performance. Thus, I assume that a secure supervision increases the probability of graduating with a *summa cum laude* degree (**H10**). In addition to formal supervision of the doctoral project, the quality of the doctorate can benefit further from evaluation by other peer researchers. Publication-based dissertations already capitalize on this further quality assurance mechanism. Learning environments that place great emphasis on exposing the doctoral project to academic discourse—e.g., through participation in conferences—may, therefore, increase the likelihood of a candidate graduating with a *summa cum laude* degree (**H11**). Studies of academic success also emphasize the importance of academic integration. Jaksztat et al. (2021) demonstrate that doctoral candidates who engage in frequent exchanges with other doctoral candidates are less likely to drop out of their doctoral programs. Contacts in the scientific community may also be relevant for academic achievement because they increase candidates' identification with the academic profession and thus enhance their motivation to perform to the best of their ability. Furthermore, well-integrated doctoral candidates may be more likely to acquire (tacit) knowledge regarding the (implicit) quality requirements that apply in academia. Hence, learning environments that offer support in developing scientific networks should increase the likelihood that candidates will complete their doctorates with *summa cum laude* degrees (**H12**). Existing research consistently finds that completion rates are higher when funding is secure (Kim & Otts, 2010; Skopek et al., 2020; Stock et al., 2011; Visser et al., 2007; Wollast et al., 2018). Doctoral candidates with secure funding are probably better able to focus on their doctoral studies than are those who must constantly seek new income sources or who must pursue side jobs along with their studies. Therefore, more secure funding should also increase the probability of a doctoral candidate receiving a *summa cum laude* degree (**H13**). By contrast, I expect rigid time regulations to have a negative effect on doctoral achievement. Although Stock et al. (2011) find no influence for the length of the doctorate on candidates' success, I believe that doctoral researchers whose program is clearly time-limited are likely to feel strong pressure to finish within the time allotted, and this pressure may have a detrimental impact on the quality of the doctoral project. Thus, I suspect that rigid time constraints reduce the probability of candidates completing their doctorates with the grade of *summa cum laude* (**H14**).

Data and methods

The DZHW PhD Panel Study

To examine the determinants of candidates achieving the top doctoral grade, I employed data from a German PhD Panel Study (10.21249/DZHW:phd2014:4.0.0), which is being conducted by the German Centre for Higher Education Research and Science Studies (DZHW) and funded by the Federal Ministry of Education and Research (BMBF). The target group comprised all doctorate holders who had completed their doctorate at a German higher education institution (HEI) with the right to award doctorates in 2014. The initial survey was conducted in 2015 (about one year after completion of the doctorate) using a paper-and-pencil questionnaire. Subsequently, annual follow-up surveys continue online. The study focuses primarily on the doctorate holders' activities and further career paths within and outside of academia. The initial survey retrospectively requested information on each doctoral graduate's doctoral phase and previous educational history.

The study was designed as a full survey. However, data protection requirements prevented the project team from communicating directly with the doctorate holders; therefore, the team relied on participating HEIs to contact the doctoral candidates. Of the 146 HEIs that had the right to award doctorates in 2014, 80 HEIs fully supported the survey, and 32 HEIs partially supported it (i.e., single faculties or subjects participated) by forwarding the questionnaires to their doctorate holders. Nineteen HEIs had no completed doctorates during the relevant period. Of the 28,147 individuals in the basic population (Federal Statistical Office 2020), the team was able to contact 19,916 (70.8%) via the participating HEIs. Of these, 5,408 doctoral graduates took part in the survey, which corresponds to a response rate of 27%. As an item-nonresponse analysis did not reveal any noticeable missing value patterns, I assume that using complete cases only, at least for the present research question, may not lead to biased results. Subtracting individuals with missing values on the variables relevant to the analyses, my sample thus consists of $n = 3{,}899$ doctorate holders. No systematic biases could be identified at the HEI level—due to non-participation by HEIs—with respect to the type of HEI (e.g., university, university of education, theological university, art academy), number of doctorates, or state. To correct for biases in the sample with respect to the doctorate holders' gender, field of study, and region (East/West), post-stratification-weights provided in the scientific-use-file were included in the analyses.[3]

Variables

Table 1 presents the operationalization of the variables that are the focus of this work and their distributions. The dependent variable is the final grade with which the doctorate holders completed their doctorates. The information was recoded into a variable with two categories, which indicate whether each doctorate was completed with the highest grade (*summa cum laude*) or a lower grade (*magna cum laude*, *cum laude*, *satis bene*, *rite*, or *other/no grade awarded*).

[3] The post-stratification-weights were calculated using the iterative proportional fitting (IPF) raking procedure, which adjusts the marginal distributions of the characteristics gender, field of study, and region in the sample to those in the population. For a detailed description of the weighting procedure, see Brandt et al. (2020).

Table 1 Variable descriptions

Variable	Description	Categories	Total
Summa cum laude	Final doctoral grade	*Summa cum laude*	20.7
		Lower	79.3
Doctoral candidates' characteristics			
Parental education	Parents' highest vocational degree	Parent(s) with doctorate	18.5
		Parent(s) with other HE degree	46.2
		No HE degree	35.3
Migration experience	Doctorate holder is born abroad vs. in Germany	Yes	7.5
		No	92.5
Gender	Doctorate holder's gender	Male	54.9
		Female	45.1
School grade	GPA of HE entrance qualification (Abitur) (1 "outstanding–4 "sufficient"); for multivariate analyses reverse coded and *z*-standardized	Mean (SD)	1.9 (0.6)
Study grade	GPA of HE degree qualifying for a doctorate, e.g., master, diploma, state examination (1 "outstanding"–4 "sufficient"; exception: law school 18 "outstanding"–4″ sufficient"); for multivariate analyses reverse coded (except law school) and *z*-standardized per subject	Law school, mean (SD)	9.2 (3.1)
		Other subjects, mean (SD)	1.6 (0.5)
Reviewers' characteristics			
The main supervisor is also the reviewer	The main supervisor is also formally responsible for reviewing the dissertation	Yes	76.8
		No	23.2
Main reviewer reputation	Reputation of the main doctoral reviewer within the scientific community of his/her field (1 "poor"–5 "excellent")	Mean (SD)	4.0 (0.9)
Gender constellation	Gender constellation between doctoral holder and all his/her reviewers; computed from information on gender and number of reviewers by gender	Only same gender	43.1
		Both genders	29.7
		Only opposite gender	27.3
Environmental context characteristics			
Subject area	Subject area in which the doctorate was completed	Humanities	10.7
		Law	5.3
		Economics, social sciences	7.7
		Natural sciences	36.7
		Engineering	10.7
		Medicine	25.7
		Others	3.2
Formal doctoral context	Formal doctoral context in which the doctorate was primarily pursued	Research assistant position (internally funded)	21.4
		Research assistant position (third-party funded)	30.9
		Structured doctorate	7.3
		Scholarship program	8.8
		External doctorate	31.6
Secure supervision	Perceived security of supervision during doctorate; three-item scale (1 "not at all applicable"–5 "fully applicable")	Mean (SD)	3.9 (1.1)

Table 1 (continued)

Variable	Description	Categories	Total
Discourse participation	Perceived expectation to subject doctoral research to scientific discourse; three-item scale (1 "not at all applicable"–5 "fully applicable")	Mean (SD)	2.8 (1.2)
Network integration	Perceived support in establishing scientific networks; three-item scale (1 "not at all applicable"–5 "fully applicable")	Mean (SD)	2.7 (1.2)
Financial security	Perceived financial security during doctorate; four-item scale (1 "not at all applicable"–5 "fully applicable")	Mean (SD)	3.9 (1.1)
Rigidity of time constraints	Perceived rigidity of time regulations during doctorate; three-item scale (1 "not at all applicable"–5 "fully applicable")	Mean (SD)	2.4 (1.0)
Control variables			
Summa cum laude proportion per subject/HEI	Share of *summa cum laude* doctorates over the years 2012–2014 per subject/HEI; for multivariate analyses *z*-standardized	Mean (SD)	16.3 (13.9)

DZHW PhD Panel Study, $n = 3{,}899$; weighted data

The *doctoral candidates' characteristics* consist of the following demographic information: *gender*, *migration experience*, and *parental education. Prior academic performance* is measured via final *school* and *study grades*. The *reviewers' characteristics* include variables that indicate whether the *main supervisor was also a reviewer*, the perceived *main reviewer reputation* in the scientific community of his or her subject, and the *gender constellation* between the doctoral holder and all his or her reviewers. The *environmental characteristics* account for the *subject area*, the *formal doctoral context*, and the perceived *conditions in the learning environment*. The instrument measuring the perceived learning environment conditions in the doctoral phase includes scales to measure the subjective *supervision security*, perceived expectations to *participate in scientific discourse* during doctoral research, and experienced support in *network integration* (de Vogel et al., 2017), as well as *funding security* and *rigidity of time constraints*.

As a control variable, I calculated the *proportion of summa cum laude doctorates per subject in the respective HEI*. For this purpose, I used information from the Federal Statistical Office on the final grades of completed doctorates by subject per HEI.[4] In some cases, very few doctorates were completed per year by subject/HEI. Hence, I computed the proportion of the completed doctorates from 2012 to 2014.

Analytical approach

To test the hypotheses, I perform a multivariate logistic regression analysis to estimate the probability of completing a doctorate with the grade of *summa cum laude*. Initially, I calculate three separate models displaying the effects of (1) the doctoral graduates' characteristics, (2) the reviewers' characteristics, and (3) the environmental context characteristics. This facilitates conclusions about the explanatory power of the three characteristic groups. Computing an overall model, I then examine whether the effects observed in

[4] The official data on final doctoral grades provided by the Federal Statistical Office were compiled by the German Centre for Higher Education Research and Science Studies (2021) and are accessible at http://www.forschungsinfo.de/promotionsnoten/

the individual models also persist when all other covariates are taken into account. All four models control for the proportion of *summa cum laude* doctorates per subject/HEI. To increase the comparability of the variable effects between models (Mood, 2010), I report average marginal effects (AME). The changes shown represent average predictions for the impact on probabilities to graduate with a *summa cum laude* degree. Because I use weighted data, I calculate robust standard errors. As a robustness check, I repeated the analyses with unweighted data and yield stable results. To assess the goodness of fit of the logistic regression model, I report the McFadden pseudo-R^2. A higher value corresponds to a better model fit. Lastly, I assessed the basic assumptions underlying logistic regression analyses, which are the absence of multicollinearity and influential outliers in the data, and linearity in the relationship between the continuous predictor variables and the logit. The results verified that prerequisites are met.

In a second step, I use the findings from the logistic regression analysis to define profile groups of doctorate holders with high and low risk of obtaining a *summa cum laude* degree. I calculate predictive margins to show how cumulative advantages and disadvantages translate into different probabilities for graduating with the highest grade.

Results

Determinants of a summa cum laude degree

The results of the logistic regression analysis used to estimate the probability of completing the doctorate with the grade of *summa cum laude* are displayed in Table 2. Considering, first, the impact of the *doctorate candidates' characteristics* reveals mixed evidence for the effect of demographic characteristics. Contrary to **H1**, parental education does not have a significant effect. The overall model also yields no significant impact for migration experience (**H2**). However, the likelihood of receiving a *summa cum laude* degree is an average of 5% lower for migrants compared to doctorate holders without migration experience when only the doctoral candidates' characteristics are included. Further analyses reveal that the significant impact occurs when performance indicators are controlled.[5] This suggests that doctorate holders with migration experience are a selective, high-performing group whose migration experience proves to be detrimental when performance is held constant. Supporting **H3**, women have an average of 6% lower probability of obtaining a *summa cum laude* doctorate than do men. Compared to the first model, the gender effect in the overall model decreases by 2 percentage points, indicating that gender differences in the characteristics of the reviewers and the context may contribute to the disadvantage of women. As expected, a history of higher GPAs also exerts a positive effect on the likelihood of a candidate receiving a *summa cum laude* degree (**H4**). Effect sizes remain fairly stable across models.

According to my theoretical assumptions, the *characteristics of the reviewers* also influence the probability of obtaining a doctorate with a grade of *summa cum laude.* The reviewer's scientific reputation has a small negative effect when controlling for all covariates in the overall model only (**H6**), indicating that the representation of reputed reviewers may not be homogenous across all disciplinary fields. The assumed effects of a supervisor who is also reviewer (**H5**) and of the gender constellation between reviewers and doctoral

[5] Results are available upon request to the author.

Table 2 Logistic regression analysis estimating the probability of graduating from a doctoral program with the highest grade, *summa cum laude*

Variable	Categories	M1	M2	M3	M4
Doctoral candidates' characteristics					
Parental education	Parent(s) with doctorate	0.00 (0.018)			0.02 (0.018)
	Parent(s) with other HE degree	0.00 (0.014)			0.00 (0.014)
	No HE degree (ref.)	-			-
Migration experience	Yes (ref.: no)	−0.05 (0.022) *			−0.04 (0.022)
Gender	Female (ref.: male)	−0.08 (0.012) ***			−0.06 (0.019) **
School grade (*z*-stand.)		0.05 (0.007) ***			0.05 (0.007) ***
Study grade (*z*-stand./subject)		0.07 (0.008) ***			0.06 (0.007) ***
Reviewers' characteristics					
The main supervisor is also the reviewer	Yes (ref.: no)		0.06 (0.015) ***		0.02 (0.017)
Main reviewer reputation			0.00 (0.007)		−0.02 (0.007) *
Gender constellation	Only same gender		0.06 (0.015) ***		0.00 (0.023)
	Both genders		0.04 (0.016) *		0.00 (0.019)
	Only opposite gender (ref.)		-		-
Environmental context characteristics					
Subject area	Humanities			−0.01 (0.028)	0.00 (0.027)
	Law			0.07 (0.040)	0.04 (0.038)
	Economics, social sciences (ref.)			-	-
	Natural sciences			−0.10 (0.024) ***	−0.10 (0.023) ***
	Engineering			−0.07 (0.028) *	−0.07 (0.027) **
	Medicine			−0.06 (0.031) *	−0.07 (0.031) *
	Others			−0.08 (0.039) *	−0.05 (0.041)

Table 2 (continued)

Variable	Categories	M1		M2		M3		M4	
Formal doctoral context	Research assistant pos., internally funded (ref.)					-		-	
	Research assistant pos., third-party funded					−0.02 (0.019)		−0.01 (0.018)	
	Structured doctorate					−0.02 (0.029)		−0.02 (0.027)	
	Scholarship program					0.05 (0.028)		0.01 (0.025)	
	External doctorate					−0.15 (0.019)	***	−0.13 (0.019)	***
Secure supervision						0.03 (0.006)	***	0.02 (0.006)	***
Discourse participation						0.05 (0.007)	***	0.05 (0.007)	***
Network integration						0.03 (0.006)	***	0.02 (0.006)	***
Financial security						0.01 (0.006)		0.00 (0.006)	
Rigidity of time constraints						−0.03 (0.007)	***	−0.02 (0.007)	***
Control variables									
Summa cum laude prop. per subject/HEI (*z*-stand.)		0.08 (0.006)	***	0.08 (0.006)	***	0.05 (0.006)	***	0.05 (0.006)	***
McFadden's pseudo-R^2		0.11		0.06		0.14		0.19	

DZHW PhD Panel Study, $n = 3{,}899$; weighted data

AME; robust standard errors in parentheses

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$

holders (**H7**), however, do not prove significant in the overall model. Because they show significant effects in model 2, it is reasonable to assume that the reviewers' characteristics are related to the characteristics of the doctoral candidates or the environmental context. Bivariate analyses indicate, for example, that there are subject-specific differences.[5]

Finally, the results support the expectation that the *environmental context* also determines the probability of a candidate receiving a *summa cum laude* degree. Consistent with **H8**, the chances of obtaining a *summa cum laude* degree differ between subject areas. As expected, the probability of receiving a *summa cum laude* degree is significantly lower in subjects with high doctorate rates (natural sciences 7 percentage points, medicine 10 percentage points) than in economics and the social sciences, where doctorates are less common. However, candidates in the field of engineering are also less likely to earn a *summa cum laude* degree (7 percentage points). In addition, significant differences exist between the formal doctoral contexts (**H9**). The likelihood of receiving a *summa cum laude* degree within external doctoral programs is, on average, 13 percentage points lower than in internally funded research assistant positions. Finally, the learning environment plays a significant role in explaining doctoral grades. As expected, a learning environment that offers a secure supervision (**H10**) and promotes discourse participation (**H11**) and network integration (**H12**) increases a candidate's chances of graduating with a *summa cum laude* degree. However, the findings do not support the hypothesized positive impact of financial security (**H13**). The expected detrimental effect of rigid time constraints is confirmed (**H14**). Overall, the effect sizes of the contextual factors remain relatively stable with and without controlling for doctoral candidates' and supervisors' characteristics.

The McFadden's pseudo-R^2 of 0.19 indicates a good fit of the overall model. Environmental influences appear to play the most important role in achieving a *summa cum laude* degree.

High and low probability profiles

Findings from the logistic regression analysis indicate which factors are beneficial or detrimental to achieving a *summa cum laude* degree. I use this information to compare the chances of graduating with the highest degree between groups with a high respective low probability profile. Figure 2 illustrates the predictive margins for the high and low probability profile groups in *the subject areas economics/social sciences*—a subject area where doctoral rates are low—and the *natural sciences*, where doctoral degrees are very common. I stepwise compose the high probability group as follows: male, high prior academic performance, doctorate within an internally funded research assistant position, and good learning environment conditions during the doctoral phase. The low probability profile is defined as being female, exhibiting low prior academic performance, obtaining an external doctorate, and having a poor learning environment during the doctoral phase.

In the high probability profile group, the probability of males graduating with *summa cum laude* is 25% in economics and social sciences and 14% in natural sciences. If being male is combined with good prior academic performance, the chances increase to 42% respectively 25%. In case the doctorate is furthermore obtained within an internally funded research assistant position, the probability to receive a *summa cum laude* rises to 50% in economics and social sciences and 32% in natural sciences. With a good learning environment during the doctoral phase, the chances of achieving the highest grade ultimately amount to 74% respectively 58%.

Regarding the low-risk probability profile, in both disciplines, women are less likely than men to earn a *summa cum laude* (17% in economic/social sciences, 9% in natural sciences). The probability of receiving the highest grade in a doctorate decreases even

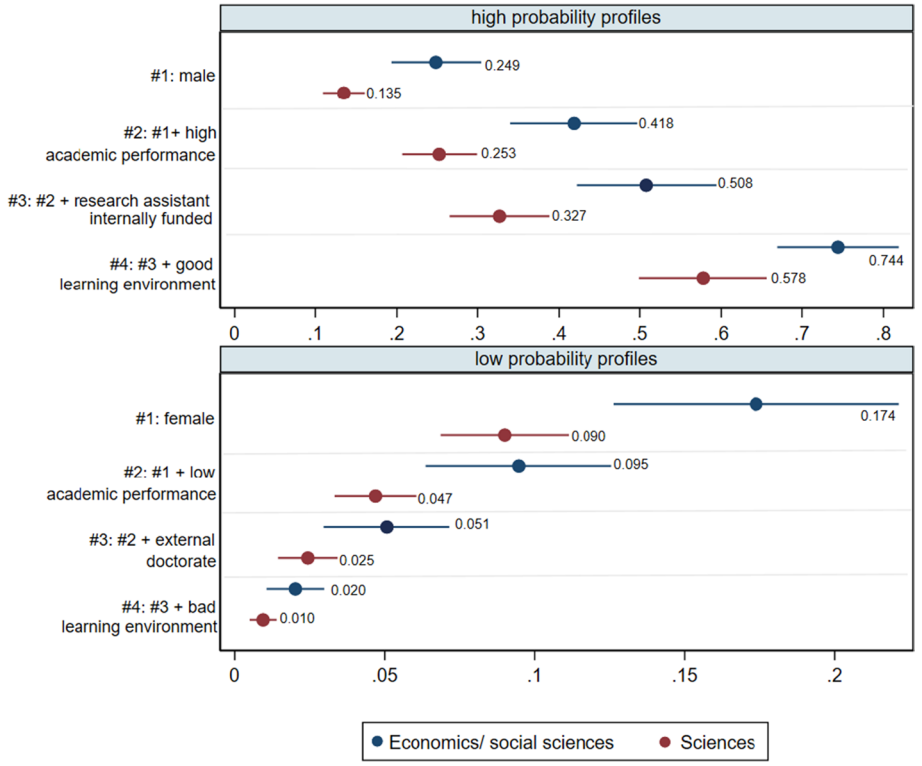

Fig. 2 Predictive margins in high and low probability groups. Predictive margins based on model 4 in Table 2; academic performance: school and study GPAs (high 80th percentile, low 20th percentile); learning environment: secure supervision, discourse participation, network integration (good 80th percentile, poor 20th percentile), rigidity of time constraints (good 20th percentile, poor 80th percentile); unlisted covariates were set to mean values. DZHW PhD Panel Study, $n = 3{,}899$; weighted data

further to 10% respectively 5% if they were comparably low performing in school and previous studies. An external doctorate, accompanied by a poor learning environment during the doctoral phase, makes it almost impossible to achieve a *summa cum laude* in both disciplines.

As this comparison illustrates, the accumulation of (dis-)advantageous factors produces strong differences in the individual probability to graduate with *summa cum laude*.

Discussion

The present study investigated the determinants of doctoral grades in Germany. Its aim was to identify factors influencing the achievement of the highest grade, *summa cum laude*. The conceptual framework was based on Hu's (2005) model for explaining college grades, which I adapted to explain doctoral grades using additional theories and research findings on academic success. My analyses of a nationally representative sample of doctoral graduates show that doctoral grades are the result of an interplay between the characteristics of

the doctoral candidates, the reviewers, and their environmental context. More precisely, the findings suggest that individuals with a history of strong school and study performance are more likely to achieve *summa cum laude* degrees. A learning environment that is characterized by supervision security, high expectations to participate in scientific discourse, and strong support for network integration also increases the chances of a *summa cum laude* degree. In contrast, being female; having a highly respected reviewer; studying the natural sciences, medicine, or engineering; completing an external doctorate; and studying in a learning environment with rigid time constraints are negatively related to the probability of receiving a *summa cum laude* grade.

This study is the first to provide representative findings on the determinants of doctoral grades in Germany that extend beyond descriptive analyses. Its results demonstrate that the prior academic performance of the doctoral researchers is a greatly significant predictor. Indeed, *summa cum laude* doctorates are more often awarded to high-performing doctorate holders. In this respect, doctoral grades appear valid after all. Nevertheless, the often criticized subject-specific practices of awarding grades do prove to be a major factor in explaining *summa cum laude* doctorates. This study also confirms the impact of the reviewers' reputations. Consequently, my results support the ongoing debate about the lack of objectivity and comparability of doctoral grades.

In the context of higher education massification, the present findings are in particular significant if final doctoral grades are understood as a new selection criterion for access to the highest occupational positions (de Vogel, 2020; Jaksztat et al., 2017). Research assistant positions offer the best chances to obtain a *summa cum laude*, but a rising number of doctoral candidates enroll in structured doctoral programs. Along the increasing differentiation of the doctoral landscape, a growing number of doctoral candidates embark on doctorates in many different contexts, which apparently do not provide equal starting conditions for their subsequent careers. Since the choice of formal doctoral context also depends on gender and parental education (de Vogel, 2017), this may be a possible mechanism for reproducing social inequalities.

Even beyond formal doctoral context choices, doctoral grades seem to contribute to gender inequalities to the disadvantage of women and could thus add to the lower participation of women at later academic career stages (Lörz & Mühleck, 2019). Just like migration experience, the study could not find an effect of parental education. One possible reason may be that social disparities primarily emerge at educational transitions (Lörz & Schindler, 2016), such as doctoral enrollment.

However, this study also offers initial guidance on measures that may contribute to a fair grading process and possibly help doctoral candidates to excel. To ensure a more objective assessment of doctoral candidates, it may help to separate the roles of reviewers and supervisors, as recommended by the German Science Council (2011) and already implemented in many structured doctoral programs and other countries. Furthermore, to prevent discrimination—e.g., by gender or migration experience, grading could be completed via anonymous peer-review procedures, such as those applied to the publication of journal articles. Finally, the results suggest that positive learning environment conditions contribute to doctoral success. Ensuring stable supervision and institutionalizing discourse participation and network integration in the doctoral phase may thus improve the quality of doctorates. External doctoral candidates could particularly benefit from this support. Apparently, problems with funding manifest not in decreased performance but in prolonged time-to-doctorate or dropouts (Skopek et al., 2020). Employment contracts and scholarships should therefore be sufficiently long and provide adequate financial resources to enable doctoral candidates to focus on their doctorate.

A major limitation of this work lies in its selection of factors to examine, which was restricted by data availability. As a multi-topic survey on doctorates, the DZHW PhD Panel Study collects information on many (potentially) relevant influencing factors. Still, some information that could be relevant for explaining doctoral grades, such as science-related self-efficacy beliefs or the main reviewer's gender, is missing. Another shortcoming is that the DZHW PhD Panel Study begins its survey after the participants have completed their doctorates. On the one hand, this implies that the survey gathers some information, such as the perception of the learning environment during the doctoral phase, retrospectively. Consequently, these data may be affected by the candidates' doctoral outcomes. For this reason, the analyses also omitted information regarding the candidates' personality traits or initial motives for pursuing the doctorate. On the other hand, the respondents to this survey represent a selective group that includes only successful graduates. Doctoral candidates who experienced poor learning environment conditions, for example, may have dropped out of their doctoral programs and were, therefore, not included in the sample. Uncovering any (potential) bias in this regard would require panel studies that commence with the beginning of participants' doctoral studies. Once it has gathered sufficient longitudinal observations of successful graduates, the DZHW National Academics Panel Survey (NACAPS) will enable causal analyses of doctoral success.

Because doctoral grades are so significant for careers in Germany and are, at the same time, always subject to criticism, it is essential to further investigate the factors influencing doctoral grades. Important are efforts to uncover the reasons behind women's poorer chances of receiving a *summa cum laude* degree. Findings here could contribute significantly to the discussion of gender inequalities in (academic) careers. It would, moreover, be interesting to know what role the reviewers' attributes play in this regard and whether or not they contribute to unequal opportunities for women. The findings of this study suggest that doctoral grades may also be affected by the gender constellations between reviewers and doctoral candidates, his/her scientific reputation, and by the reviewer's simultaneous (or not) position as supervisor. However, these effects appear related—e.g., through moderation or mediation—to the characteristics of the doctoral candidates themselves and/or to the characteristics of the environmental context. Future studies may illustrate the relationships between predictors through structural equation modeling, e.g., multi-group analyses by subject area. In the light of massification and differentiation, path analyses could also be used to investigate the extent to which subjects and formal doctoral contexts exert a direct and indirect effect on doctoral grades and subsequent career success—and thus produce social inequalities. Against the backdrop of increasing proportions of *summa cum laude* grades, there is a need for longitudinal analyses to investigate how these proportions develop and to explore which determinants become more or less important over time. To draw implications beyond Germany, finally, future research should investigate whether these findings can be reproduced in other doctoral grade awarding countries. Particular interesting would be studies carried out in countries where doctorates are less popular and/or have little significance outside the academic world.

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Data availability The dataset analyzed during the current study is available at the Research Data Centre for Higher Education Research and Science Studies (FDZ-DZHW) in the form of a scientific use file (10.21249/DZHW:phd2014:4.0.0). The Stata/SE 17 code is available upon request at FDZ-DZHW.

Declarations

Competing interests The author declares no competing interests.

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