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Gender and Internationalization in STEM Graduate Education: Case of the German Excellence Initiative

Ali Sina Önder[1]

Abstract

Are public policies effective in enhancing gender balance and internationalization in science, technology, engineering, and mathematics (STEM) graduate education? Using Germany's Excellence Initiative as an event study, I analyze changes in graduate cohorts in STEM fields and investigate whether public policies that help to create and sustain STEM graduate programs also affect women's participation in STEM graduate studies. and internationalization of STEM studies. Focusing on natural sciences and mathematics PhDs between 2000 and 2014, I find no statistically significant evidence that public funds led to any significant increase in women's participation in STEM studies beyond already existing trends in these fields. I find, however, statistically significant differences between funded and not funded graduate programs in the share of thesis written in English, which can be interpreted as internationalization of STEM graduate studies due to public policies in that direction.

JEL Codes: H52, I23, O32

Keywords: Graduate Education; Public Funding; Gender; Internationalization; Natural Sciences; Excellence Initiative

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I. **Introduction**

Do public policies pay off when it comes to enhancing gender balance and internationalization in STEM graduate education? Doctoral studies constitute an important stage in the education and training of researchers who will be taking jobs in academia (Sinclair et al., 2014, Horta et al., 2018). Academic careers are a leaky pipeline for women (Ooms et al., 2019, Roberto et al., 2020) and doctorate studies often constitute the first rung of the academic career ladder. For instance, women accounted for less than 40% of successful PhD holders, 30% of researchers in untenured or assistant positions, and 15% of full professors in German universities overall between 2000 and 2010 (Gottschall, 2010). In the United States as of 2018, about 48% of all assistant professors were female whereas this ratio decreases to 27% when full professors are considered (AAUP, 2018). In the United Kingdom, female academic staff accounted for about 41% of all academic staff at the 24 Russell Group universities whereas female share among full professors in these institutions was about 19% in 2012 (Santos and Phu, 2019).

Women constitute a smaller share in science, technology, engineering, and mathematics (STEM) fields than in social sciences at almost every academic rank in Germany (Zuber, 2010). Recent research suggests that the observed lack of female representation in math-intense fields is primarily driven by career preferences of women or hiring preferences of departments rather than by other individual characteristic (Ceci and Williams, 2011, Ceci et al., 2014, Kahn and Ginther, 2017). To provide strong incentives for women to choose and remain in STEM carees, and for STEM departments to hire women, there have been public policy implementations in many of the OECD countries. Australian government has been extending higher education loans to eligible female students in STEM; Finland and Poland have been cooperating with the private sector and social initiatives to promote female participation in STEM; the United Kingdom has had several schemes running under the supervision of the Higher Education Funding Council for England to create incentives for a more balanced gender share in STEM (OECD, 2014).

Germany started the Excellence Initiative (EI hereinafter) in 2005 with public funds kicking in 2006. This policy marked the beginning of significant structural changes in German universities with the aim of enhancing international competitiveness of German universities (DFG, 2013). I test two of the targeted outcomes of the EI specifically aimed at enhancing the STEM graduate education, namely, to increase the share of women in STEM PhDs and to internationalize STEM programs. I specifically ask whether public funds to create and sustain STEM graduate programs have led to any significant improvement in achieving gender balance and internationalization among STEM PhDs. I use fine-grained individual level dissertation data to test differences in gender balance and internationalization levels of STEM doctoral programs that received public funding during the first the first wave of the EI and other STEM programs that did not receive such funding.

The first stage of the EI provided 1.9 billion Euros to universities for graduate education, which was labelled as the *graduate school* line of funding, and for inter-disciplinary collaborations within or between universities or research institutes, which were labelled as *excellence clusters* and *futures concepts* lines of funding (Kehm, 2006). The *graduate school* line of funding of the EI aimed at moving graduate programs away from the Humboldtian chair-holder logic to the stream-lined institutional logic where the academic progress of advisees can be closely monitored by drawing on the experience of research-oriented doctoral education in Anglo-American countries (Gottschall, 2010). For the graduate school funding line in the first wave of the EI, there were 253 applications, 83 finalists, and 39 winners, each of which received about one million Euros per year over a five year period (Fallon, 2008).

German Research Foundation (DFG) strictly imposed precursors of its research-oriented standards on gender equality policy for the distribution of all three lines of the EI funds. Best et al. (2013) investigate women's participation in STEM careers at German universities, and they find only partial support for the claim that the EI (all three lines of funding) has fostered women's representation in STEM fields. Although there was no explicit or direct requirement for gender balance among students in EI-funded graduate schools, this aspect was implicitly supported through DFG's gender balance criteria among post-docs and senior teaching staff. To apply for the EI funding, universities were required to "*describe the gender equality situation at the host university/universities within the participating departments using quantitative indicators and referring to the DFG's research-oriented standards on gender equality [... and describe] what measures will be undertaken by the graduate school to achieve its objectives*." (DFG and Wissenschaftsrat, 2015, p.77). By testing differences in the number of male and female PhDs in STEM fields in German universities over time and over the availability of the EI funding, I find no evidence that EI-funded graduate schools caused a statistically significant difference in reaching gender balance above and beyond the already existing trends in German academia.

Another target of the EI funds was to achieve internationalization of funded programs, where internationalization is defined very broadly by the DFG to cover a wide range from international networking to attraction of foreign scientists and students (DFG and Wissenschaftsrat, 2015). I capture the internationalization effects in graduate students' dissertations in terms of increase in the use of the English language in dissertations, as this would indicate either the student is foreign, or some of their advisors are foreign, or the student has strong intention to publish and remain in the academia (as the international publication language is dominantly English) or a mix of all these factors. I find statistically significant differences between internationalization levels of EI-funded STEM graduate programs and other STEM programs.

This study contributes to the line of research that investigates the success and effectiveness of actual policies that aim, directly or indirectly, to promote gender balance in STEM fields. Although the literature is rich in studies that prescribe potentially useful policies to promote gender balance in STEM, there are surprisingly few studies that quantitatively evaluate existing policies, for instance, Best et al. (2013), or Zuber (2010) for the German context as discussed above, Rincon and George-Jackson (2016) for the context of the United States, or Forsberg (2005) for the Swedish context. The rest of the paper is organized as follows: I describe the data in Section II, empirical results are shown in Section III, and Section IV concludes.

II. Data Description

All successfully completed dissertations at German universities are required to be submitted to the German National Library (DNB) according to federal regulations in Germany (BJV, 2008). I obtained data on completed dissertations between 2000 and 2014 from the DNB. There are two phases of the EI *graduate school* funding line, and I focus on the first phase that ran from 2006/2007 to 2011/2012. During the second phase of funding, some graduate schools, which received funding in the first phase, could not obtain any fund; or new graduate schools started to receive funding. Inclusion of the second phase would create a problem for the difference-in-differences analysis for two reasons. First, discontinuity of the graduate school funding at the end of the first phase for some graduate schools would introduce a bias into the analysis, because although funds are not there anymore the culture would probably still remain in place, thus making the analysis biased and effects hard to quantify after the first phase. Second, the first phase of the EI had a shorter announcement period (time between the announcement of the competition and picking the winners) compared to that of the second phase (less than two and more than three years, respectively). This structure gives the first phase of the EI more the nature of a policy shock, which is useful for the analysis of difference-in-differences to claim causality. Hence the time window from 2000 to 2014 is plausible because it has sufficient time window (from 2000 to 2006) to observe existing trends before the EI funding and also sufficient time to have data for PhD students joining at the end of the first phase and graduating until 2014.

Each dissertation record in this dataset contains the name of the successful doctorate graduate, the university where it was submitted to, title of the dissertation, the year of completion, the language it is written in, and subject tags. Dissertations are tagged for subject areas and there is no other indication in the data to reveal under which specific chair, institute, or program the dissertation has run, unless full texts of dissertations are downloaded to look into. A cross-sectional examination of randomly picked samples reveals that subject tags are accurate for the purposes of this study. Gender information is not in the original data, and I ran the gender script that I obtained from *genderize.io* to determine gender of authors based on their first names.

In total, there are eight EI funded graduate schools with focus on natural sciences as classified by the DFG as shown in Table 1. The reason why I focus on these eight graduate school is because they are placed under natural sciences or mathematics faculties of their hosting universities so that their students' dissertations can be identified in the DNB dissertation database using subject tags. Other EI graduate schools in STEM involve interdisciplinary institutes in engineering or collaboration with medical schools so that subject tags of the DNB often fail to identify them or to create a one-to-one correspondence between graduates and their specific fields. Although DNB's subject tags are also an approximation when natural science PhDs are considered, this approximation is sufficiently reliable as revealed by manual cross-section investigation. When EI-funded graduate schools in interdisciplinary engineering or medical sciences are considered, tags become vague and hence the match between PhDs and any specific EI graduate school becomes noisy. To avoid this problem, the analysis is based on EI graduate schools in natural sciences and mathematics. I define the treatment group to be all dissertations that have the relevant subject tag and are affiliated with the respective university or universities. E.g., a dissertation that is tagged for mathematics and is affiliated with the FU Berlin is a member of the treatment group, whereas a dissertation tagged for chemistry and is affiliated with FU Berlin is rather a member of the control group since there is no EI-funded graduate school involving chemistry at the FU Berlin. I provide more detailed descriptive analysis about treatment and control groups as well as their time interactions (before and after 2006/2007) to capture causal effects in the next section.

Table 1. Excellence Initiative-funded Graduate Schools, their fields and assigned universities

Graduate School	*Main subject*	*Hosting universities*
Berlin Mathematical School	Mathematics	TU Berlin, Humboldt, FU Berlin
School of Analytical Sciences Adlershof (SALSA)	Chemistry	TU Berlin, Humboldt
Bonn-Cologne Graduate School for Physics and Astronomy (BCGS)	Physics and Astronomy	U Bonn, U Köln
Heidelberg Graduate School of Fundamental Physics	Physics	U Heidelberg
Heidelberg Graduate School of Mathematical and Computational Methods for the Sciences	Mathematics	U Heidelberg
Karlsruhe School of Elementary Particle and Astroparticle Physics: Science and Technology (KSETA)	Physics	Karlsruhe Institute for Technology
Karlsruhe School of Optics & Photonics (KSOP)	Physics	Karlsruhe Institute for Technology
Materials Science in Mainz (MAINZ)	Chemistry	U Mainz, TU Kaiserslautern

A total of 53,355 earned doctorates successfully graduated in natural sciences from 83 universities in Germany between 2000 and 2014. When first names are assigned to male or female gender, I find that 32,187 (60% of all) graduates are male, 16,897 (32%) are female. About 8% of individuals in the dataset remain genderless as their gender could not be determined by *genderize.io* as well as by the directory-based name recognition algorithm of Conley et al. (2016). Manual check of unidentified names was avoided as this can potentially introduce bias into the analysis. 27,794 (52% of all) dissertations were written in English, 25,561 (48%) were written in German. Distribution of dissertations over subject tags and gender between 2000 and 2014 are shown in Table 2. Total of all subjects adds up to more than 56,850 because 9,135 dissertations have two subject tags and they account for both fields. There is a steady growth in the total number of dissertations from 1,560 earned doctorates in 2000 to 3,471 in 2006 and then 4,340 in 2014. Ludwig Maximilian University of Munich (LMU) has the most number of STEM PhD graduates in most years between 2000 and 2014.

Table 2. Total Number of Doctorates and the Share of Women in the Dataset

Subject Tag	*Total*	*Female (share in total)*
Chemistry	13,425	4,051 (30%)
Physics	14,674	2,307 (16%)
Biology	19,639	9,124 (46%)
Mathematics	4,806	933 (21%)
Geology	4,306	1,321 (31%)

III. Results

III. A. Descriptive Findings

The number of PhD graduates in natural sciences and mathematics has been increasing since 2000, as shown in Figure 1. Chemistry has experienced a sharp decrease between 2002 and 2004 but graduation numbers have recovered until 2014. Biology is the only field for which there has been no EI-funded graduate school (EGS hereinafter) in the first phase of the EI.

Figure 1. Number of PhD Graduates in Chemistry, Biology, Physics, Mathematics over Years

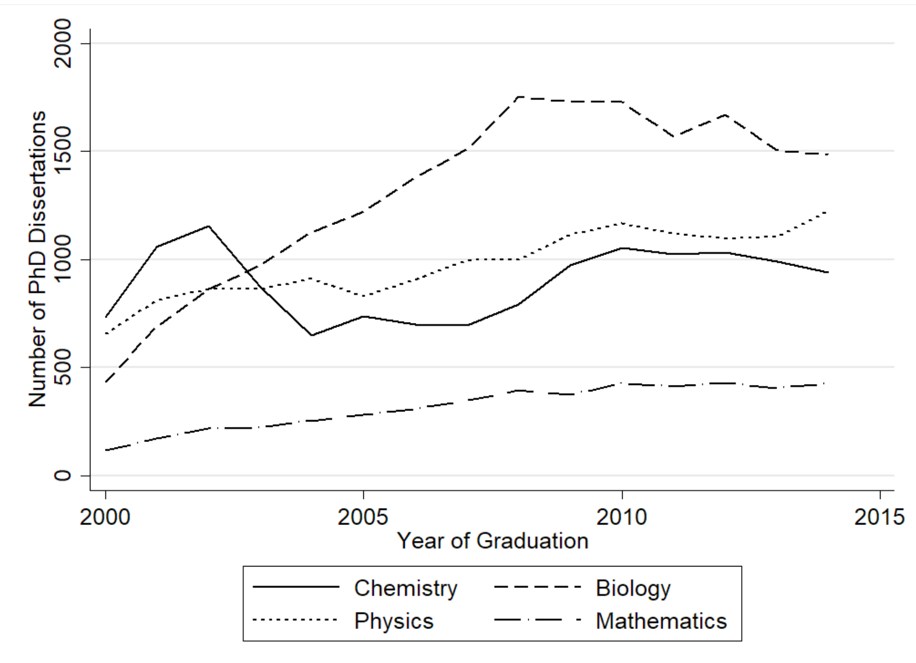
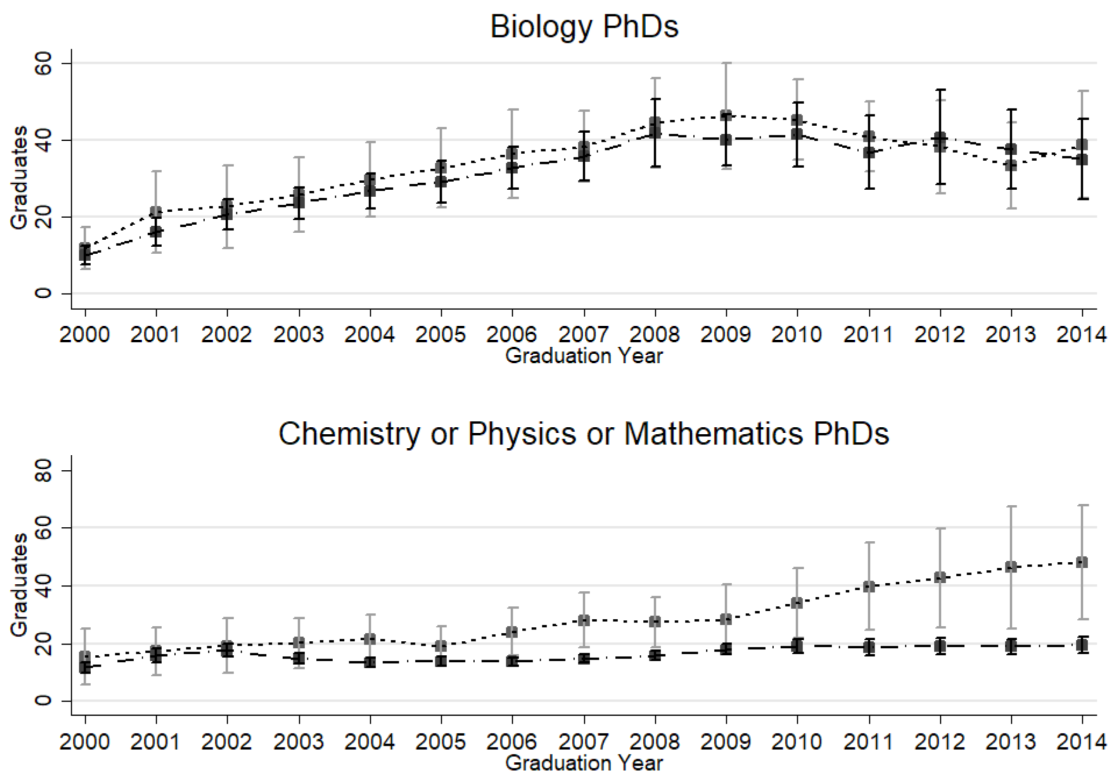


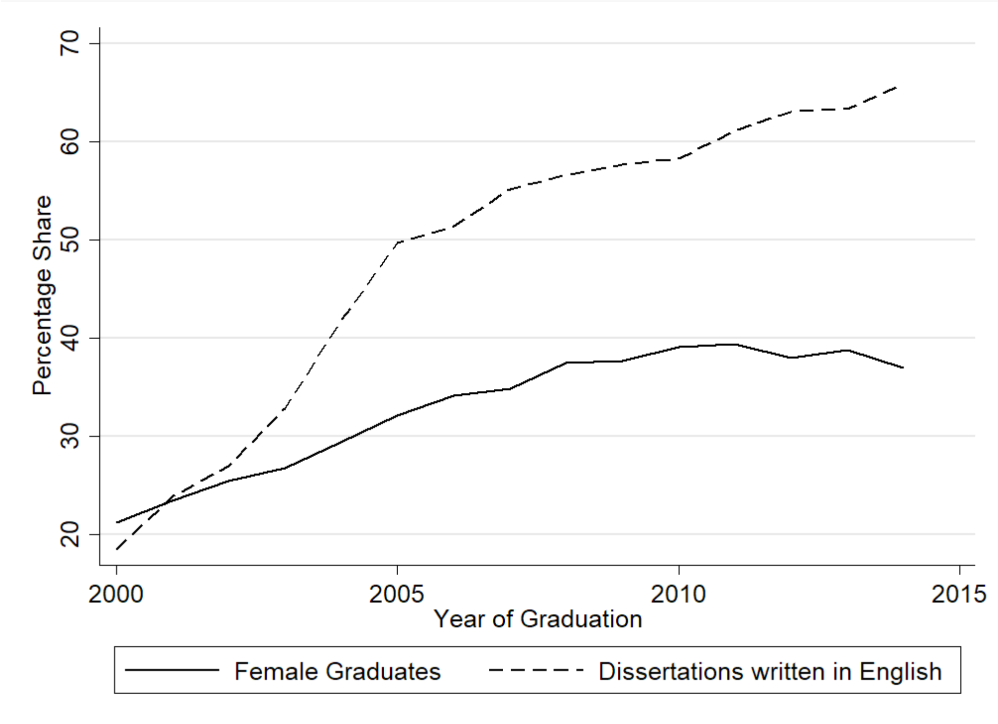
Figure 2. Number of PhD Graduates in Funded and Non-Funded Fields (Note: Dark line is the mean of non-funded universities whereas the gray line is the mean of funded universities, bars indicate 90% confidence interval)



Funded[2] and non-funded universities' PhD graduates in biology are depicted in the upper panel of Figure 2. Since biology is the only field in natural sciences without its own EGS, one should expect no significant difference between funded and non-funded universities' number of biology PhDs under the hypothesis that the EGS funding is causing a difference. This is exactly what is revealed in the upper panel of Figure 2, and there is no significant difference between treatment and control groups when biology is considered. When EGS fields (chemistry, physics, mathematics) are considered, I find the number of PhD graduates to be significantly larger in EGS universities (treatment) compared to non-EGS universities (control) from 2007 until 2014 with exceptions in 2009 and 2010 as shown in the lower panel of Figure 2.

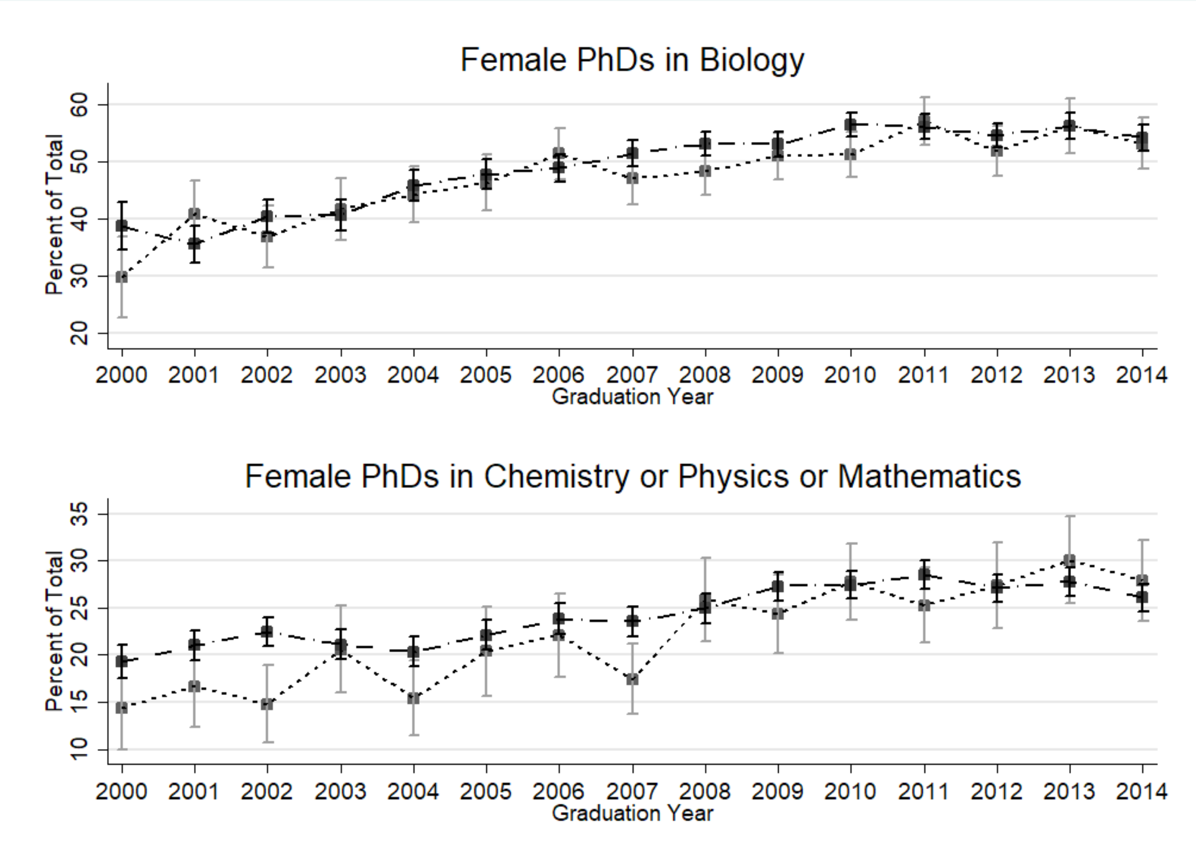
[2] The term *funded university* refers to any university that is listed in Table 1 in Section II.

Figure 3. The Overall Share of Female PhD Graduates and the Share of Dissertations written in English



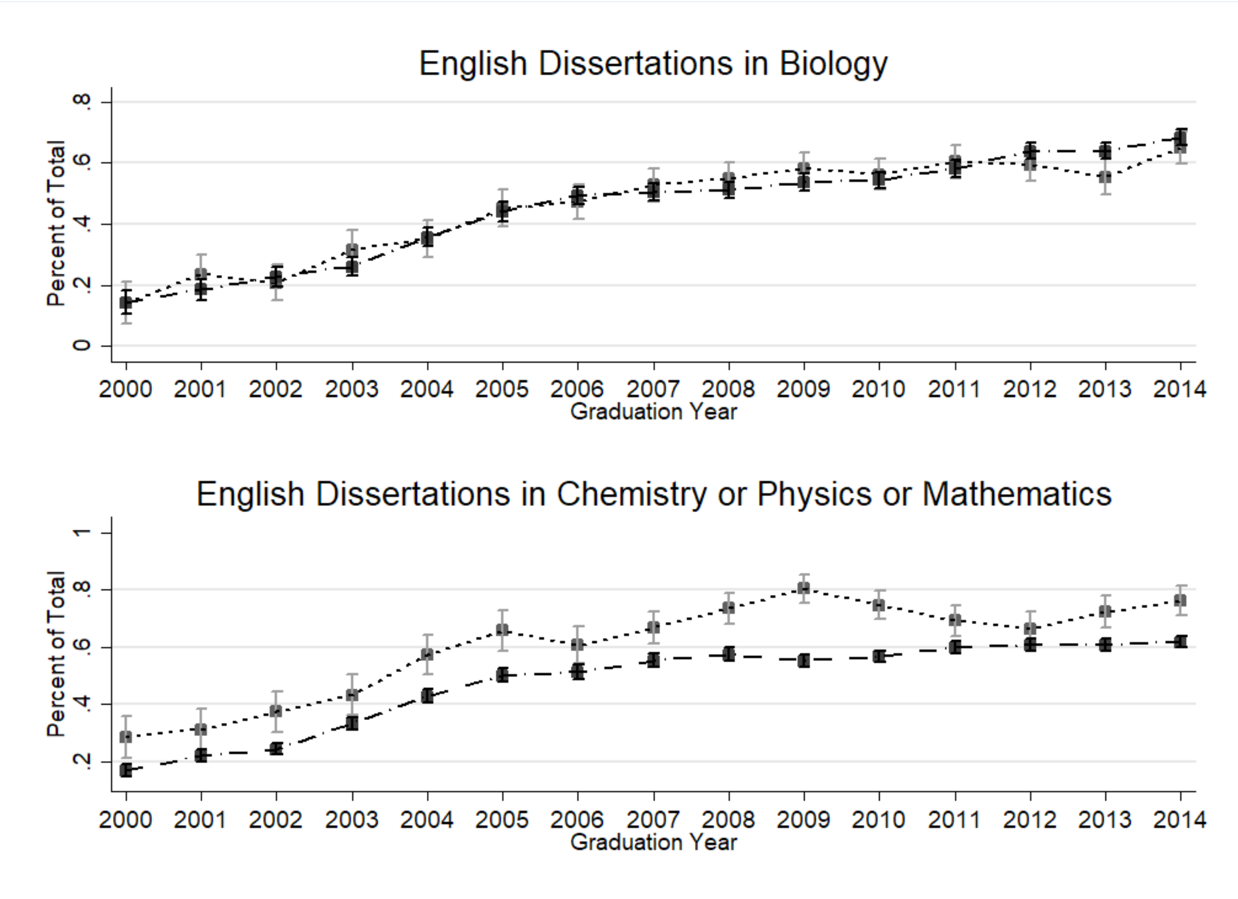
Overall, an increase in the share of female PhD graduates in natural sciences and mathematics in German universities is observed since 2000, as shown in Figure 3. Female graduates made up about 20% of all graduates in the above mentioned programs in 2000. This share increased to 40% by 2010 and leveled there with a slight decline until 2014. Although most of the increase in the share of females seems to have taken place before the era of the EGSs, there may have been significant divergence between trends observed in funded and non-funded universities. This aspect is investigated further in Figure 4. I find no statistically significant difference between the share of female PhD graduates of biology programs in otherwise funded universities and non-funded universities as shown in the upper panel of Figure 4. Furthermore, I find no statistically significant difference in female shares in EGS-funded fields (depicted in the lower panel of Figure 4) between funded and non-funded universities either. Female share increases among PhD graduates and this trend does not seem to be caused by the EGS funding. EGSs may have supported the already existing trends. Interestingly, the share of female PhDs in EGS fields in funded universities was significantly lower than that in non-funded universities before 2003. One may be tempted to claim that the EGS funding helped to close this gap, but the gap was closed in 2003 (with the exception of 2007) before the EGS funding kicked in.

Figure 4. Share of Female PhD Graduates in Funded and Non-Funded Fields (Note: Dark line is the mean of non-funded universities whereas the gray line is the mean of funded universities, bars indicate 90% confidence interval)



As shown in Figure 3, there is an increasing trend in the share of dissertations that are written in English. This is an important aspect because English dissertations can be seen as a strong signal for the internationalization as well as the research strength of EGS programs. If dissertations are meant to be published eventually, then a dissertation written in English can be advantageous, giving students a head start in the publication game. Although the share of dissertations written in English are not different in biology between funded and non-funded universities (upper panel of Figure 5), this share is significantly higher in funded universities when EGS fields are considered (lower panel of Figure 5). Nevertheless, funded universities had already a higher ratio of English-written dissertations before the EGS funding kicked in. Therefore, it is plausible to test whether trends have been changing after 2006 and 2007 in a statistically meaningful way, which follows in the next subsection.

Figure 5. Share of Dissertations written in English in Funded and Non-Funded Fields



III.B. Analysis of Difference-in-Differences between Funded and Non-funded Universities

Using a difference-in-differences setting, I test whether there is a statistically meaningful change in the differences between the number of graduating PhDs in funded and non-funded universities. I use the following specification:

$$Grad_{uft} = \gamma_u + \gamma_f + \gamma_t + \beta(Post2006 \times EGS_{uf}) + \varepsilon_{uft}$$

where $Grad_{uft}$ is the number of PhD graduates of university *u* in field *f* in year *t*. Background and quality is controlled by university, field, and year fixed effects denoted by γ_u, γ_f, and γ_t, respectively. The indicator variable EGS_{uf} is one for fields of universities that are funded by the EGS program. The main variable of interest is the interaction of EGS indicator with timing of the intervention, namely the start of the EGS funding. That way, the treatment is turned on and from that point on, one should observe a positive effect if the treatment works in a way to boost graduate numbers observed across EGSs, meaning that the point estimate of β should be positive and significant. In the first column of Table 3 the interaction term of the treatment group and the post-treatment period is reported. The positive and statistically significant coefficient estimate indicates that the difference between funded and non-funded universities is widening in favor of funded universities. EGS funding has been used towards physics, mathematics, and chemistry, but not biology in natural sciences. Hence it is possible that the result obtained in the first column is driven by biology programs' graduates, for instance, if biology experienced a drop in student numbers. I re-run this analysis without biology graduates in the second column. The interaction term is still positive and significant and the point estimate is even larger. As these are linear regressions, estimated coefficients are interpreted as pure differences, meaning that comparing EGS and non-EGS physics, mathematics, and chemistry graduate programs, EGS ones did produce about 14 graduates more a year, on average.

Table 3. Number of PhD Graduates in German Universities

	Number of Graduates		
	All	without Biology	without LMU
*Post 2006*Grad School*	12.97***	14.30***	13.30***
	(3.170)	(3.087)	(3.189)
Field FE	Yes	Yes	Yes
University FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs.	6225	4980	6150
R-squared	0.539	0.568	0.537

*Note: standard errors in parentheses. *p<0.1 **p<0.05 ***p<0.01*

Another relevant robustness check is to leave Ludwig Maximilian University of Munich (LMU) out of the analysis. LMU is a big university offering large graduate programs in many natural science areas. Although LMU received a lot of EI funding in other categories, they did not receive EGS funding in natural sciences or mathematics. As the inclusion of the LMU may distort estimation results, I re-run the same analysis without the LMU. Coefficient estimation shown in the third column of Table 3 is positive and significant, moreover highly comparable to numeric values obtained in the previous two columns. Hence it is safe to say that the EGS programs experienced a statistically significant increase in the numbers of their graduates after the initiation of the EGS funding.

Next, I investigate whether changes in the female ratio and the share of English dissertations are statistically significant and line up with the commencement of the EGS funding. Hence the question is whether the EGS funding caused an increase of women's participation in and internationalization of STEM programs. The first three columns of Table 4 show coefficients from an individual level regression where a gender indicator (*female* equals one if the individual graduate *i* is female and zero otherwise) is regressed on field of study, number of fields indicated in the dissertation, university and year fixed effects, and an interaction term of treatment and years of treatment. Hence I run the following:

$$Female_i = \beta(Post2006 \times EGS_{uf}) + \alpha(No\ of\ Fields) + \delta[Field] + \gamma_u + \gamma_t + \varepsilon_i$$

Similarly, I investigate whether EGS funding is associated with a statistically meaningful difference in the submission of dissertations written in English in EGS programs, and I estimate

$$English_i = \beta(Post2006 \times EGS_{uf}) + \alpha(No\ of\ Fields) + \delta[Field] + \gamma_u + \gamma_t + \varepsilon_i$$

where the dependent variable $English_i$ is one if the individual graduate *i* wrote their dissertation in English and zero if not.

Table 4. Difference-in-difference Analysis for the Change in Share of Female PhD Graduates and English Dissertations

	Share of Female PhD Grads			**Share of English Diss**		
	(1)	(2)	(3)	(4)	(5)	(6)
*Post 2006*Grad School*	-0.0322*	-0.0159	0.00260	0.0549***	0.0611***	0.199***
	(0.0172)	(0.0172)	(0.0610)	(0.0191)	(0.0180)	(0.0549)
Mathematics		-0.219***	-0.626***		0.189***	0.534***
		(0.00857)	(0.0281)		(0.00887)	(0.0261)
Physics		-0.274***	-0.832***		0.102***	0.284***
		(0.00560)	(0.0191)		(0.00593)	(0.0168)
Chemistry		-0.114***	-0.300***		-0.125***	-0.361***
		(0.00636)	(0.0179)		(0.00601)	(0.0172)
Number of Fields		0.0709***	0.197***		-0.0336***	-0.106***
		(0.00675)	(0.0202)		(0.00653)	(0.0194)
University FE	No	Yes	Yes	No	Yes	Yes
Year FE	No	Yes	Yes	No	Yes	Yes
Obs.	37268	37268	37268	40381	40381	40381

*Note: standard errors in parentheses. *p<0.1 **p<0.05 ***p<0.01*

As shown in column (1) of Table 4, the interaction effect of treatment and the post treatment era (hence the difference-in-differences effect) for women's participation is negative and statistically significant at 10% when no controls or fixed effects are included. This statistical significance fades away with the inclusion of controls and fixed effects, meaning that although the EGS funding correlates with a significantly smaller share of female PhDs, this significance is lost when fields of study are accounted for. The excluded dummy variable for field of study is biology so that coefficients of mathematics, physics, and chemistry must be interpreted in relation to biology. They all have negative and significant coefficients, meaning that there are significantly less female graduates in fields of mathematics, physics, and chemistry compared to biology. The significance observed in the first column cannot be attributed to the existence of the EGS funding but it is rather driven by the difference of gender composition across these fields. I also find that female graduates are more likely to report more than one field in their dissertation, hence being more prone to research areas that are considered interdisciplinary.

Columns (4) to (6) of Table 4 investigate whether there is a statistically significant association between EGS funding and English dissertations. Statistical significance of English dissertations in association with EGS funding does not vanish when field, university, and year controls are included. The difference-in-differences associated with the likelihood of having an English-written dissertation remains positive and statistically significant. Mathematics and physics dissertations are more likely to be written in English compared to chemistry and biology dissertations. Moreover, dissertations that depict several fields are less likely to be written in English. This is an interesting aspect, because one would think that interdisciplinarity is a new and rather Anglo-American aspect, yet such dissertations are more likely to be written in German, indicating probably a more traditional stream of graduate education.

In Tables 5 and 6, I repeat the analysis presented in Table 4 and re-run it without biology (Table 5) and without the LMU (Table 6). Qualitatively similar results to those in Table 4 are obtained in Tables 5 and 6, hence confirming the robustness of findings discussed in the previous paragraph.

Table 5. Robustness: Difference-in-difference Analysis excluding Biology

	Share of Female PhD Grads			**Share of English Diss**		
	(1)	(2)	(3)	(4)	(5)	(6)
Post 2006 x Grad School	-0.00725	-0.00378	0.0163	0.0343*	0.0602***	0.185***
	(0.0174)	(0.0174)	(0.0618)	(0.0194)	(0.0183)	(0.0553)
Field Controls	No	Yes	Yes	No	Yes	Yes
University FE	No	Yes	Yes	No	Yes	Yes
Year FE	No	Yes	Yes	No	Yes	Yes
Obs.	26286	26286	26286	28467	28467	28467

*Note: standard errors in parentheses. *p<0.1 **p<0.05 ***p<0.01*

Table 6. Robustness: Difference-in-difference Analysis excluding the University of Munich

	Share of Female PhD Grads			**Share of English Diss**		
	(1)	(2)	(3)	(4)	(5)	(6)
Post 2006 x Grad School	-0.0282	-0.0132	0.0100	0.0619***	0.0683***	0.218***
	(0.0172)	(0.0172)	(0.0612)	(0.0191)	(0.0180)	(0.0549)
Field Controls	No	Yes	Yes	No	Yes	Yes
University FE	No	Yes	Yes	No	Yes	Yes
Year FE	No	Yes	Yes	No	Yes	Yes
Obs.	35104	35104	35104	38061	38061	38061

*Note: standard errors in parentheses. *p<0.1 **p<0.05 ***p<0.01*

IV. Conclusion

The aim of this study is to provide evidence from Germany's first phase of the EGSs whether public funds that helped to create and sustain STEM graduate programs did actually affect women participation and internationalization in STEM programs. Focusing on natural sciences and mathematics PhDs between 2000 and 2014, I find no evidence that EGSs led to statistically significant trends in women's participation in graduate education in natural sciences and mathematics beyond already existing trends in these fields. EGSs caused an increase in the number of PhDs but not necessarily a significant increase in women's share. Interestingly, EGS-funded universities had a lower share of women PhDs compared to non-funded universities, but they caught up before the EI funds kicked in.

I investigate the internationalization of STEM graduate education using the language of dissertations as an indicator. More dissertations were being published after the mid of 2000s in

English, which signals one or a mix of several of these: Either the student is foreigner, or their advisors are foreigner, or the student aims for academic careers and writes in English to speed up the publication process by being able to submit to academic journals as early as possible. Any of these possibilities would mean that STEM graduate education as well as the STEM research environment is getting more internationalized. Empirical analysis reveals a statistically significant and positive difference in the number of English-written STEM dissertations at EGS-funded universities compared to non-funded universities. This is a strong indication that the EGSs have succeeded in creating an international research environment, no matter how broadly internationalization may be defined in this particular analysis.

Evidently, the EGS funding line has been successful in creating institutes with internationally visible and attractive graduate programs. The EGS line of funding was discontinued after the second phase of the EI. An official evaluation of the EGSs stated that graduate education has shown successful development and most doctorate programs have converged to high international standards in most of the German universities so that the funding line for graduate schools within the EI need not be continued (IEKE, 2016). Gender balance is one of the important policy targets of the DFG, and if the aim was to increase women's share in higher faculty ranks in STEM departments, the first step should have been to increase women's share among STEM PhDs. Nevertheless, EGSs did not affect women's share among PhDs in natural sciences and mathematics fields of STEM and hence did not create a significant positive divergence from already existing trends in German graduate education and academia.

Future research in this area needs to open up two black boxes: First, one can always say that the gender ratio at funded universities may have become worse without the EGSs, and that EGSs may have actually helped funded universities to keep up. This argument is hard to support because the gender ratio of PhDs in funded universities caught up with that in non-funded universities before the arrival of EGS funds. However, it would be interesting to look into the mechanism that made this catch up possible, as this could shed light into why EGSs were not a game changer as far as women's participation in STEM programs is concerned. Second, internationalization is a broad subject, and the mechanisms through which internationalization affects faculty members' or even graduate students' STEM careers remain a black box. Opening of this box would deliver interesting and useful results concerning the indirect effects of public funds on careers of scientists and development of academic institutes in general.

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