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Gender Disparities in Research Fields in Russia: Dissertation Authors and Their Mentors

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Abstract
This study examines gender disparities in research fields as measured by scientific output in dissertations at two levels within the Russian academic system: PhD and the more advanced Doctor of Science (DS). The data for this study were extracted from over 250,000 dissertations spanning from 2005 to 2016. The chosen data source offers several advantages over bibliometric data for the purpose of this study: a) it provides representative data, including the Social Sciences and Humanities; b) gender disambiguation is straightforward due to the gendered nature of Russian patronyms; c) it allows for easier attribution of text, as there is no need to attribute it to the first author in multi-authored publications; d) it provides insights into the career stage by differentiating between PhD and DS authors, as well as between PhD and DS mentors. The results of this study reveal a gender imbalance across research fields and academic career levels. Furthermore, our observations indicate that male mentors more frequently collaborate with male authors, and female mentors with female authors, exceeding what would be expected by random chance. This gender homophily is evident in most research fields. While the results largely confirm findings from studies conducted in other countries, the four advantages mentioned above make this study an essential extension of studies based on bibliometric data. This research sheds light on the gender structure within research fields in Russia and invites nuanced discussions about achieving gender equality in the context of identified gender homophily.

Keywords gender; PhD; dissertation; mentorship; homophily; research fields.

Introduction

Gender inequalities in academia are widely documented using various data sources, such as bibliometric databases (Larivière et al., 2013; Huang et al., 2020; Nakajima et al., 2023) and dissertation data (Villarroya et al., 2008; Duarte-Martínez, 2022; Sánchez-Jiménez et al., 2023). These studies span diverse countries and disciplines, highlighting gender disparities worldwide, particularly in STEM fields. At the national level, we observe a "gender equality paradox" when increased gender equality in a country is associated with greater gender differentiation between fields (Stoet & Geary, 2018; Thelwall & Mas-Bleda, 2020). However, even when women are relatively equally represented in a field, they are less likely than men to hold higher academic positions (Sheltzer & Smith, 2014; Van Den Besselaar & Sandström, 2016; Holman et al., 2018).

When considering the causes of gender inequality and the limited presence of women in research fields, two potential explanations emerge. The first explanation is that women can encounter various barriers and biases that result in their underrepresentation in fields and academic positions. The "leaky pipeline" hypothesis, suggests that women are more likely to exit certain research fields due to challenges related to work-life balance (Morgan et al., 2021; Zheng et al., 2022), lower funding support and opportunities (Witteman et al., 2019), and gender biases in the hiring process (Clauset et al., 2015; Régner et al., 2019). All of these factors could contribute to the higher likelihood of women exiting academic fields more frequently than men due to various pressures both within and outside academia.

The second explanation focuses on women's initial career choices. This perspective suggests that women's underrepresentation may stem from their comparatively lower likelihood of initially selecting careers in specific fields, opting for others instead. Societal expectations and gender stereotypes (Miller et al., 2015; Hanson et al., 2017; Makarova et al., 2019), limited exposure or encouragement in STEM disciplines, and a lack of female role models (Carrell et al., 2010) are factors that can be associated with initial choice of field. For example, negative stereotypes about women's mathematical abilities, which are socially constructed and can be perpetuated by parents and teachers (Shapiro & Williams, 2012), might contribute to gender imbalances. Also, female students perceive STEM fields as masculine, and a less pronounced masculine image of science could potentially increase the likelihood of having STEM career aspirations (Makarova et al., 2019).

The "leaky pipeline" and "initial choices" explanations are not mutually exclusive, and may collectively contribute to observed gender inequalities within research fields.

Of particular interest among the factors investigated in connection with gender inequality in academia is gender homophily. Gender homophily is the tendency for individuals to form relationships with others of the same gender, and this phenomenon is observed in academia at various levels, such as co-authorship networks (Ghiasi et al., 2015) or research teams (Campbell et al., 2013). Moreover, homophily is characteristic of most research fields – it has been demonstrated in specific disciplines (Hilmer & Hilmer, 2007; Gaule & Piacentini, 2018) as well as in studies examining multiple disciplines (Schwartz et al., 2022). The literature on homophily in mentorship shows how homophily can be associated with publication productivity (Gaule & Piacentini, 2018), satisfaction (Seeber & Horta, 2021), and attrition of women from academia (Shaw & Stanton, 2012).

Among the reasons why homophily is actively researched is that it is one of the possible factors that can influence gender inequality, and this mechanism can be quite contradictory. For instance, homophily is considered as one of the possible instruments for reducing the gender gap: Canaan & Mouganie (2023) found that the presence of a female mentor, rather than a male mentor, in natural sciences significantly increases the likelihood that women will enter and complete college with a degree in STEM. However, at the same time, homophily can be a cause of the reproduction of gender imbalances – when the proportion of women in a field is small, it may discourage women from choosing to enter that field (Haake, 2011). Thus, homophily is a dual phenomenon that can be explained and influenced by a variety of reasons, and it is important to detect and investigate it.

If we talk about previous research conducted on Russian data, it has revealed gender disparities across various aspects of academic engagement, including research productivity, representation in leadership roles, and career prospects. Despite women's broader participation across numerous academic fields, their paper publication rate tends to lag behind that of men. This observation has been supported by the analysis of data from select Russian academic journals (Krasnyak, 2017), investigations into Web of Science data with a focus on the natural sciences (Lewison & Markusova, 2011; Paul-Hus et al., 2015), and studies spanning various disciplines (Pilkina & Lovakov, 2022). These findings collectively suggest that gender imbalances in publications are prevalent within Russian academia, aligning with global trends. Additionally, the proportion of women serving as educators in higher education institutions in Russia has consistently remained high, exceeding 60% in recent years (UNESCO, 2020). However, research also indicates that women in Russia face underrepresentation in higher academic positions and academic leadership roles. Sterligov (2017) demonstrated that women in Russia encounter notable barriers when accessing academic leadership positions, stemming from limited career opportunities and a lack of robust support systems.

To gain insights into the dynamics of gender inequality in both STEM and Social Sciences and Humanities (SSH), we investigate dissertations to provide a comprehensive understanding of gender composition within the Russian academic landscape. It is important to note that SSH fields tend to be underrepresented in existing bibliometric databases, potentially leading to skewed perceptions of gender inequality in academia (Mongeon & Paul-Hus, 2016; Martín-Martín et al., 2018). By examining gender differences in research fields based on dissertation data, we aim to contribute to the existing literature on gender disparities in academic careers in Russia and expand upon the scope of studies focused on utilizing international bibliometric databases. Also, our data allow us to estimate homophily in the context of dissertation mentor-author relationships and explore its potential role in maintaining or overcoming gender inequality. Furthermore, the distinct features of the Russian academic system include two types of dissertations – PhD and the more advanced Doctor of Science (DS) dissertations. This peculiarity of the Russian academic system enables us to evaluate homophily and analyze the representation of women at different levels of the academic career ladder across all research fields.

Thus, this study aims to assess gender imbalances within Russian academia by analyzing two types of dissertations. Specifically, we seek to address the following research questions:

1. What are the existing gender imbalances within the Russian academic environment?
2. Which research fields are more or less affected by gender imbalances?
3. How does gender imbalance vary depending on the type of dissertation and, consequently, the academic career stage?
4. How does gender homophily manifest in academic fields regarding the relationship between authors and their dissertation mentors?

This article is structured as follows: The *Data and Methods* section describes the data source and justifies its selection. It also explains the distinction between the two types of dissertations in Russia, outlines the gender identification algorithm, and presents equations for gender homophily. In the *Results* section, we identify fields that are predominantly female, balanced, or male. Additionally, we examine how these disparities evolve across different stages of academic careers. Our findings indicate a decrease in female representation as academic careers advance. This decline exhibits variation across fields, with notable disparities in STEM. Also, we found gender homophily in most research fields. In the *Discussion* section, we discuss the role of gender homophily in reinforcing the gender gap, analyze the results we obtained and its limitations, with a focus on contrasting our findings with those of prior studies centered on Russian academia, which have been conducted using data from international bibliometric databases.

Data and methodology

The data for this research is drawn from two sources. Initially, we utilized the *Russian Book Chamber* (RBC) website, which serves as the state agency responsible for recording bibliographic and statistical information regarding publications issued in Russia, including dissertations. The website provides information, such as the full names of dissertation authors, fields of research, defense year, and dissertation types. Thus, we have gathered information on 265,135 dissertations (PhD and DS) defended between 2005 and 2016. These RBC data can be considered as the general population of all dissertations. Before 2016, posting on the RBC website was a prerequisite condition, thereby enabling us to encompass individuals in all fields who earned PhD or DS degrees from 2005 to 2016. However, these data lack information on the full names of dissertation mentors, which is crucial for our research. Therefore, we turn to the second source – the *Higher Attestation Commission* (HAC) website, a national agency overseeing the awarding of advanced academic degrees. This source provides PDF files of dissertation cover sheets, which also contain the full name of the mentor and subfield of research. We parsed PDF covers and extracted information for 45,608 dissertations. It is important to note that working with PDFs is more time-consuming, so we limited data collection to PhD dissertations only from 2012 to 2016. For DS dissertations, this period was extended from 2008 to 2016 since the number of annually defended DS dissertations is small, and our aim was to obtain a sufficient number of observations across all research fields. HAC dissertation data forms a representative sample (Guba et al., 2020). Thus, we have RBC data for a longer period (2005-2016) which is close to the general population, and HAC data with a shorter time frame but containing a greater number of variables (Fig. 1).

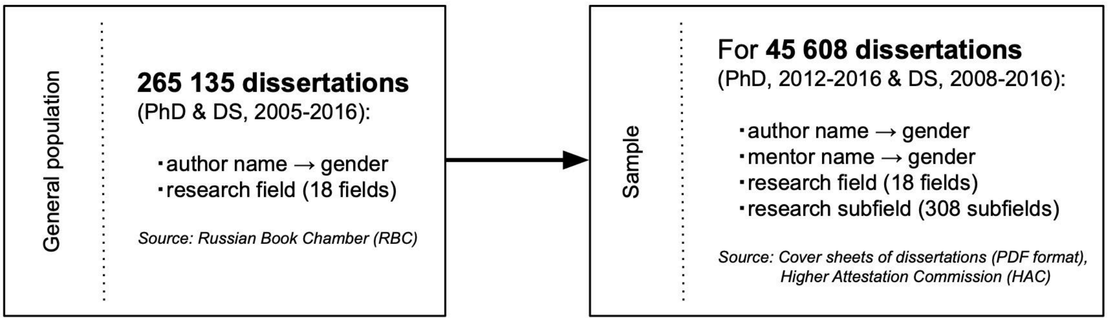

Fig. 1 Data collection process: general population and sample

In the Russian academic landscape, two types of dissertations are prominent: the PhD and the Doctor of Science (DS). The PhD is typically pursued by a larger number of individuals on the academic trajectory. Conversely, DS dissertations carry a higher status and are obtained by fewer individuals who have already completed their PhD. DS dissertations often serve as prerequisites for attaining professorship and advancing to higher administrative roles within academia, such as head of the department. It is essential to emphasize the significant gap in researcher qualification between the PhD and DS dissertation levels. To obtain a PhD, it is necessary to submit a monograph and several papers published in scientific journals (the minimum requirements for the number of papers and the list of journals have changed from year to year). At the DS level, it is required to submit one more monograph and an even broader list of papers. In Russian academia mentors generally offer both scientific guidance and administrative support throughout the dissertation preparation and defending process. Eligibility to become a dissertation mentor usually follows a successful defense of one's own dissertation (Huisman et al., 2018). Figure 2 illustrates the conventional sequence of roles within Russian academia concerning dissertation production.

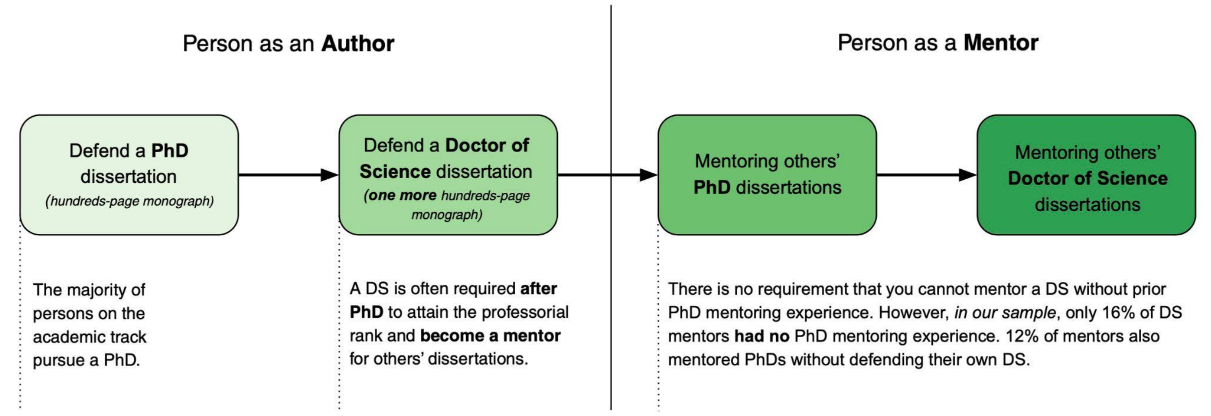

Fig. 2 Two types of dissertation: author and mentor roles in Russian academia

From the RBC data source, we retrieved 233,739 PhD and 31,396 DS dissertations across 18 research fields. Table 1 illustrates that the largest number of dissertations in Russia are found in three fields: Technical Science (16.5%), Economics (15.5%), and Medical Sciences (14.9%). Conversely, the fewest number of dissertations are in Art Studies (0.8%), Culturology (0.9%), and Political Science (1.5%).

Table 1 Dissertation counts by 18 general research fields (2005-2016)

	Field	*PhD dissertation*	*DS dissertation*	*Overall*	
		N = 233 739	N = 31 396	N = 265 135	*Share of total*
1	Technical science	38 822	4 972	43 794	16.5%
2	Economics	37 057	3 963	41 020	15.5%
3	Medical Sciences	33 717	5 762	39 479	14.9%
4	Education	18 435	1 735	20 170	7.6%
5	Biology	14 442	2 285	16 727	6.3%
6	Law	14 474	1 136	15 610	5.9%
7	Philology	13 151	1 502	14 653	5.5%
8	Physics & Math.	12 047	2 539	14 586	5.5%
9	Agriculture	8 443	1 281	9 724	3.7%
10	Earth Sciences	7 320	1 223	8 543	3.2%
11	History	7 306	1 214	8 520	3.2%
12	Chemistry	6 990	967	7 957	3.0%
13	Psychology	5 365	454	5 819	2.2%
14	Philosophy	4 588	876	5 464	2.1%
15	Sociology	3 920	440	4 360	1.6%
16	Political Science	3 625	424	4 049	1.5%
17	Culturology	2 112	365	2 477	0.9%
18	Art Studies	1 925	258	2 183	0.8%

From the HAC data source, we obtained 32,972 Ph.D. and 12,636 D.S. dissertations, extracting the full names of mentors and research subfields (308 subfields grouped into 18 general research fields). For instance, within the general field of Medical Sciences, subfields such as Cardiology, Immunology, and 35 others are included (Table S1). Dissertations with multiple mentors were excluded from the analysis (8.1% of the dissertations).

To determine the gender of authors and mentors, we inferred their gender based on the gender-specific suffixes found in patronymic names (used in addition to the first and last names in Russian). Patronymics with the suffix *'na'* were associated with the female gender, while *'ch'* indicated the male gender. Patronymic names yield highly accurate results and are often absent in international bibliometric data. Therefore, we could assign female/male genders to 95% of the dissertation authors and mentors (Table S2).

The definition of research fields and subfields was rooted in the standard Russian classification – the *Higher Attestation Commission Codification*. During the period under consideration, changes occurred in this classification. For example, in 2006, geological science was considered a separate field, while by 2016, it had become a subfield of Earth sciences. We conducted the unification of fields based on the 2016 classification.

Following the methodology proposed by Schwartz et al. (2022), homophily was measured by contrasting the actual proportion of same-gender mentorships with the anticipated proportion under random pairing. This calculation was performed separately for men and women:

$$homophily_F = Pr(author_F | mentor_F) - Pr(author_F)$$
$$homophily_M = Pr(author_M | mentor_M) - Pr(author_M)$$

Overall homophily was computed as the sum of these values, weighted by the total number of mentorships within each gender group:

$$homophily_{Total} = Pr(mentor_F)*homophily_F + Pr(mentor_M)*homophily_M$$

Positive values indicate a preference for same-gender mentorships, while negative values indicate a preference for cross-gender mentorships. A value of 0 denotes an equal likelihood of authors of any gender being matched with mentors of any gender. Values of homophily were normalized so that 100% means the maximum possible value, given the gender structure of the mentor and author subsets.

It is essential to acknowledge that, when assessing homophily within the general research fields, we took into account the Wahlund effect (Holman & Morandin, 2019). This phenomenon addresses the potential inflation of same-gender mentorship frequencies when the data encompasses disconnected subsets featuring varying gender ratios among authors and mentors. Specifically, when examining homophily within a general field, we considered the gender distribution within its subfields (limited to those subfields with more than 20 dissertations). Furthermore, homophily was computed separately for PhD and DS dissertations, allowing for the differentiation of subsets of individuals at distinct academic career stages.

Results

Gender disparities by research field

Figure 3 depicts the distribution of male and female dissertation authors across 18 general research fields. The representation of female authors among PhDs varies from 27% to 87%. However, this proportion declines among female DSs authors, ranging from 13% to 77%. In the realm of Physics & Math, comprising 5.5% of all dissertations (ranking eighth in Table 1), the most notable gender imbalance is observed in favor of males. On the other hand, Philology exhibits the highest female predominance (also accounting for 5.5% of all dissertations, as shown in Table 1).

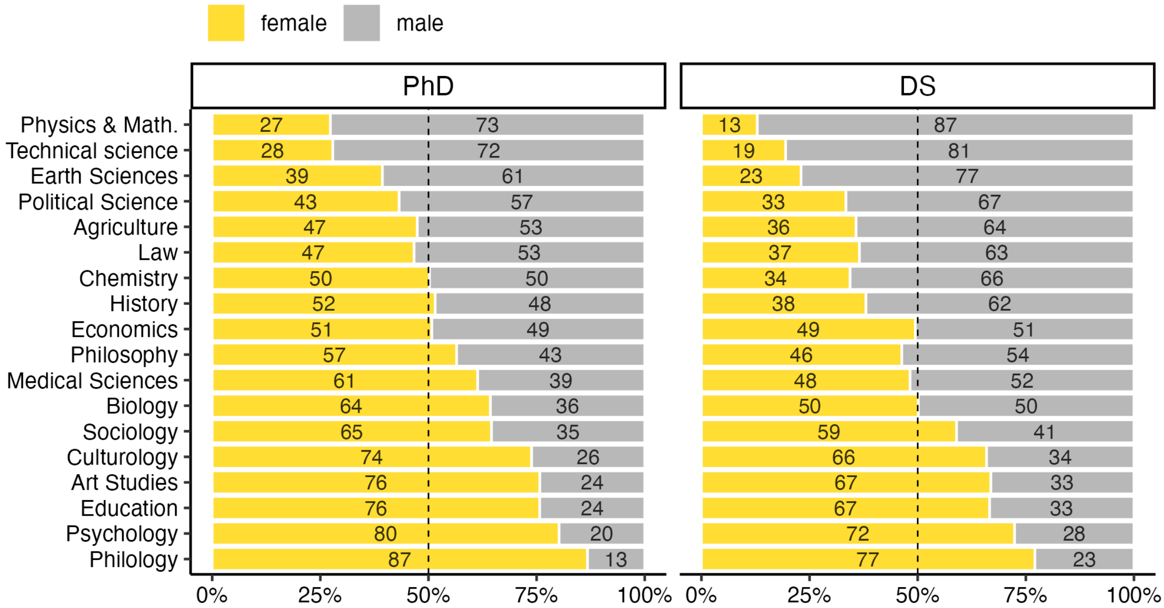

Fig. 3 Share of female and male dissertation authors in 18 general research fields

The extent of the disparity between women defending PhDs and DSs varies significantly across fields. Unsurprisingly, STEM fields exhibit lower female representation. This trend is most pronounced in Physics & Math, Technical Science, and Earth Sciences, which confirm the enduring gender gap in PhD production within these historically male-dominated disciplines. Among both PhDs and DSs, the lowest proportion of women is found in Physics & Math (17% for PhDs and 13% for DSs). Conversely, men are underrepresented in Philology (13% for PhDs and 23% for DSs).

Agricultural Sciences, Law, Chemistry, History, and Economics display nearly equal female and male PhD authorship, maintaining a balanced 47%-51% distribution. However, a shift occurs when considering DS authors. Fields that were initially gender-balanced at the PhD level experience divergence; specifically, Medical Sciences and Biology (48%-50% female authorship rate) become skewed at the DS level, now favoring women. The only exception is Economics, which maintains gender balance at both PhD and DS levels.

Examining trends over a 12-year period (Fig. 4), minimal changes are observed in the gender composition of PhD authors across most fields. No clear trend towards achieving gender balance, feminization of male-dominated fields, or masculinization of female-dominated fields is discernible. The proportion of women among PhD dissertation authors in all STEM fields remains relatively stagnant over the 12-year span. Conversely, some non-STEM fields experience a slight increase, such as Agricultural Sciences (from 46% to 54%; $p < 0.001$, chi-squared) and Political Sciences (from 43% to 50%; $p < 0.001$, chi-squared). Among DS dissertations, the share of female authors slightly rose from 2005 to 2016 in some fields. Significantly increased female representation is observed in STEM fields like Technical Science (from 16% to 24%; $p < 0.001$, chi-squared) and Physics & Math (from 12% to 17%; $p < 0.01$, chi-squared). Biology records a non-significant decline (from 48% to 45%; $p = 0.62$, chi-squared), while Earth Sciences (from 22% to 25%; $p = 0.3$, chi-squared) and Chemistry (from 30% to 44%; $p = 0.87$, chi-squared) display non-significant growth. In Education, the proportion of female DS authors by the study's conclusion matches that of female PhD authors (both types of dissertations reaching 75% female representation). Similarly, the gap in female authorship between PhDs and DSs disappears in Psychology (both converge at around 78%), Philosophy (59%), Economics (54%), and even Engineering (28%).

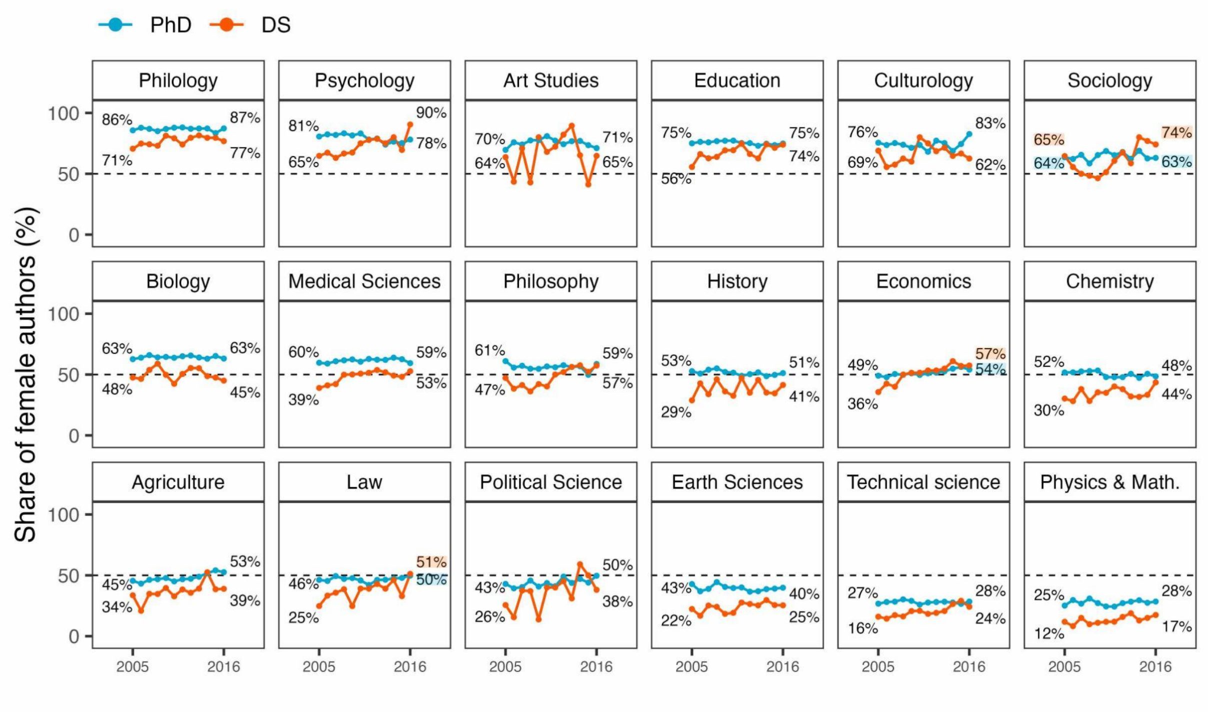

Fig. 4 Dynamics of female dissertation authors: PhDs and DSs (2005-2016)

Representation of women in academic roles by research field

On average, the proportion of women decreases as individuals progress through the later stages of their academic careers. Among authors of PhD dissertations, there is a relatively even distribution, with 49% being women (Figure 5A). Similarly, among authors of DS dissertations, a significant percentage (47%) are women. However, a noticeable gender gap emerges when examining mentors, with only 33% of PhD mentors and 23% of DS mentors being women.

The representation of women varies across research fields, with some fields traditionally regarded as "predominantly male" and others as "predominantly female." Our data uncovers fluctuations in the share of female dissertation authors and mentors across general fields.

However, the proportion of female mentors consistently remains smaller than that of female authors, even in fields traditionally associated with women, such as Education and Philology (Fig. 5B).

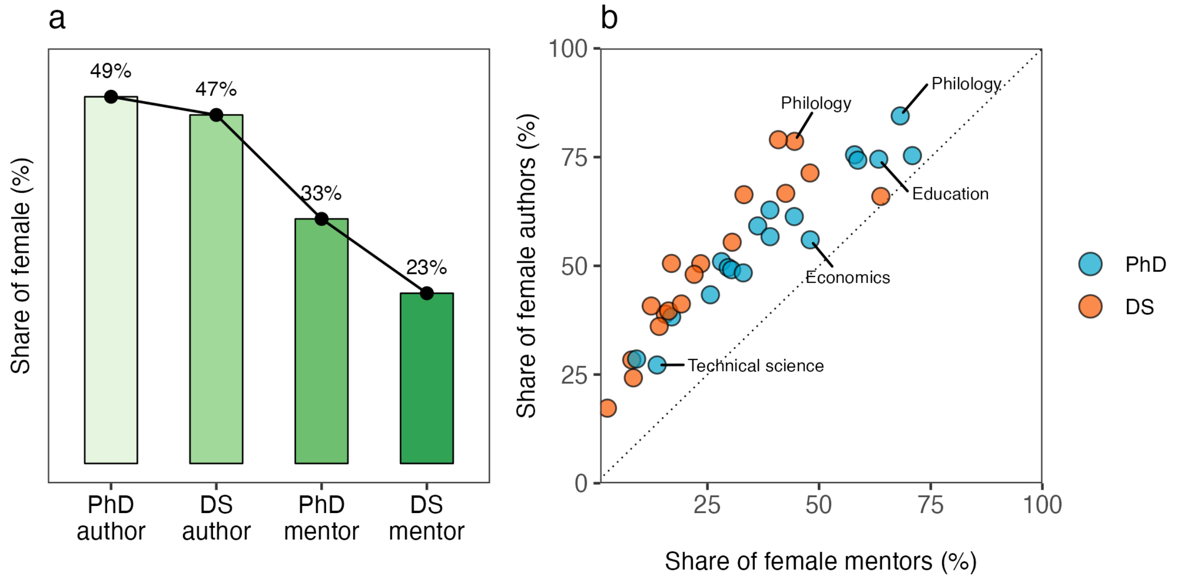

Fig. 5 Women's representation in academic roles (a) and Comparison of the share of women as authors and mentors in research fields (b)

Figure 6 visually illustrates the growing disparities as individuals ascend the academic hierarchy within each of the 18 science fields. Culturology and Art Studies exhibit wide confidence intervals at each stage, making it challenging to definitively establish a declining trend in the representation of women in these fields. Overall, Art Studies maintain a relatively balanced gender distribution, with the proportion of women remaining more stable across all stages compared to other general fields. Psychology and Sociology exhibit an increase in the proportion of female authors at the DS stage compared to the PhD author stage. However, when considering the confidence intervals, these proportions closely align, as observed in fields like Economics. In Philology, a predominantly female field, we observe a decrease in the proportion of women as we progress through the academic roles—84% of PhD authors are women, while only 45% of DS mentors are female. This reveals that the 'glass ceiling' persists even in fields with significant female representation. Art Studies is an exception due to the limited number of defended theses, which hinders confident conclusions about the gaps between stages.

Additionally, in certain fields like Psychology, Sociology, and Economics, we observe an equal or higher proportion of women among DS authors compared to PhD authors. However, when examining the stages of mentorship, the representation of women significantly declines by tens of percentage points. For instance, in Sociology, the proportion of female DS authors surpasses that of PhD authors (63% vs. 61%), but the proportion of female DS mentors dramatically drops to 33%. STEM fields like Physics & Math, and Engineering consistently exhibit a low proportion of women across all academic roles, with the representation of women in the first stage—PhD authors—remaining below 30%. In Physics & Math, the proportion of women among DS mentors plummets to as low as 3%.

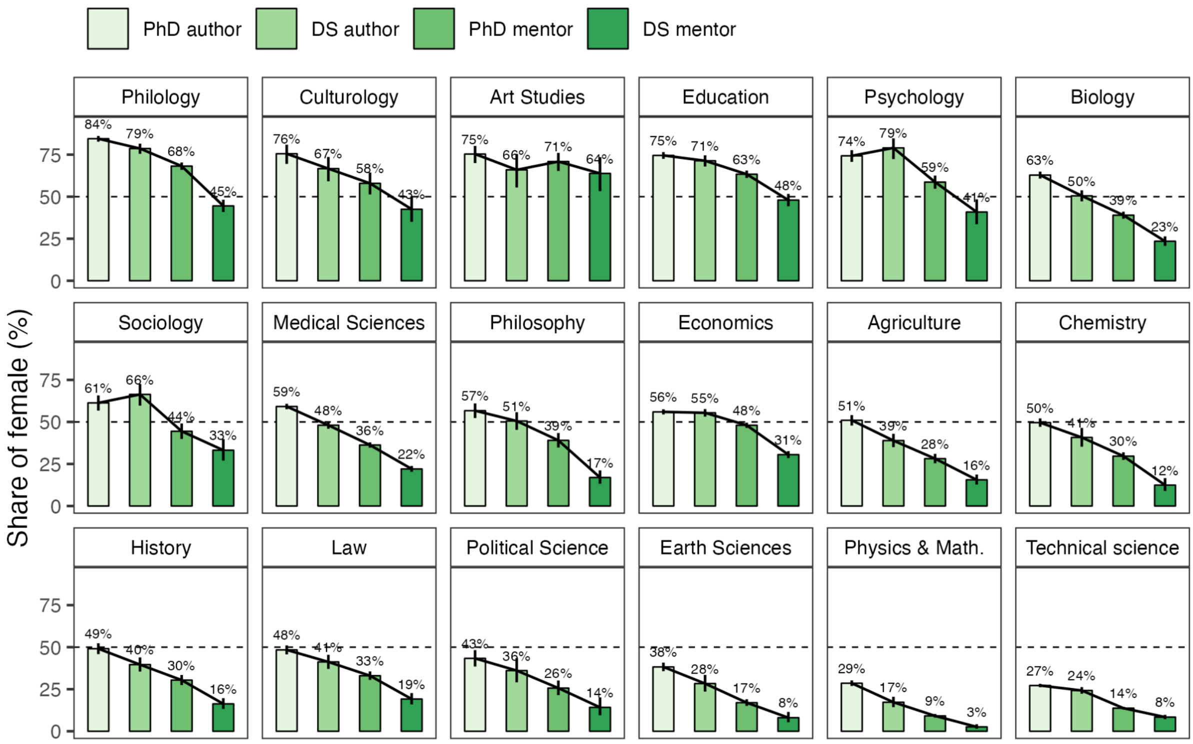

Fig. 6 Women's representation in academic roles by general research field

Overall, our findings illuminate two significant dimensions of gender inequality: the differing representation of women and men across fields and the challenges encountered by women as they progress through the academic career trajectory. These patterns align with prior research, which indicates that although women are well-represented in the initial stages of their academic journeys in Russia, their presence notably diminishes as they advance to later stages.

Our analysis not only underscores gender imbalances across general fields but also reveals distinct distributions within subfields of each general field. Figure 7 provides an illustration of this phenomenon across all general research fields (for instance, in Art Studies, we discern two subfields for PhD dissertations and one subfield for DS dissertations). This discovery emphasizes the existence of diverse gender distributions within specific general fields. For example, while the subfields of Physics & Math appear concentrated in a tiny zone on the graph, the subfields of Medical Sciences sprawl across the axes. In essence, Medical Sciences encompass a wide array of subfields, each with its distinct gender composition. Nevertheless, across all research fields, encompassing both general and subfields, a consistent trend emerges: the proportion of female mentors consistently lags behind that of female authors (evident by the points predominantly positioned above the diagonal line in most instances).

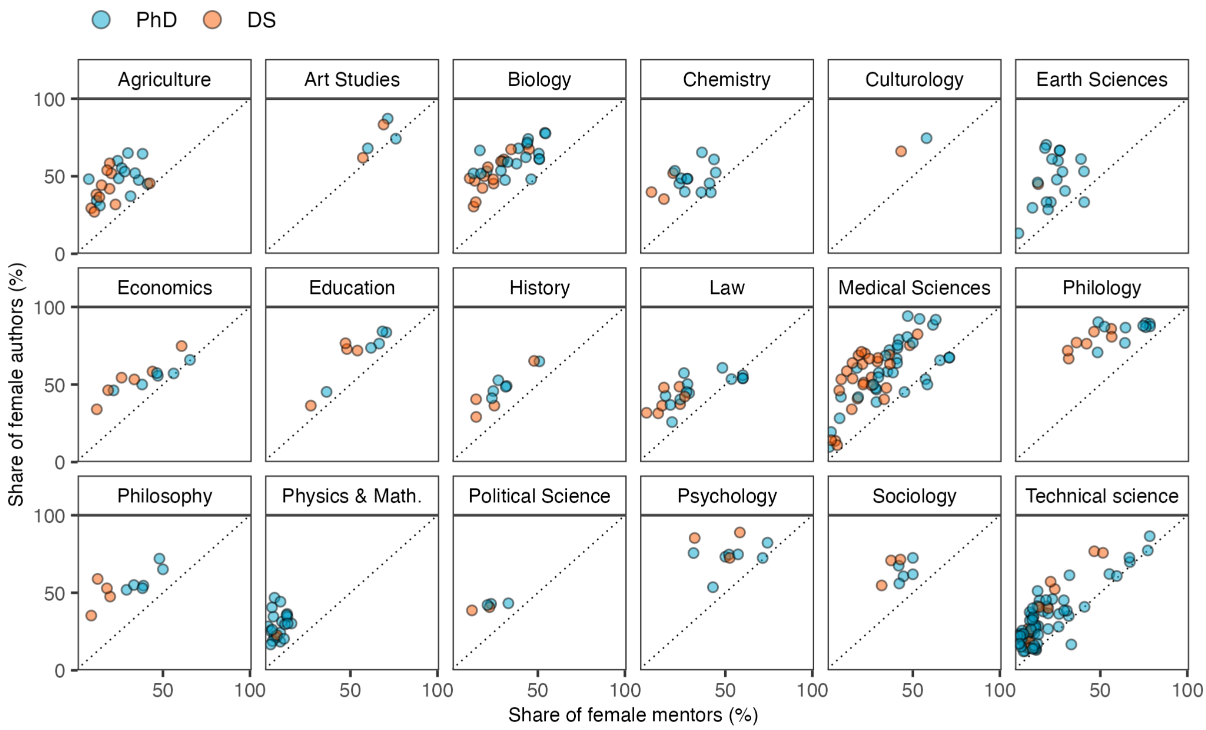

Fig. 7 Comparison of the share of women as authors and mentors in subfields by general research field

Mentorship and gender homophily

In addition to investigating the gender dynamics within research fields, our analysis provides insight into the specific collaborations between women and men during the dissertation production process. A summary of observed collaboration types is presented in Table 2. The least frequent collaboration type is 'male author & female mentor,' accounting for 10% of PhD dissertations and 7.3% of DS dissertations. Conversely, the most common collaboration is 'both male,' constituting 40.8% of PhD dissertations and 45.9% of DS dissertations. It is notable that female mentors predominantly supervise female authors, encompassing 20.8% of all collaborations for both types of dissertations.

Table 2 Distribution of collaboration types in PhD and DS dissertations

Collaboration type	*PhD* N = 32 972	*DS* N = 12 636	*Overall* N = 45 608
Both male	13 458 (40.8%)	5 804 (45.9%)	19 262 (42.2%)
Female author & male mentor	8 702 (26.4%)	3 948 (31.2%)	12 650 (27.7%)
Both female	7 510 (22.8%)	1 957 (15.5%)	9 467 (20.8%)
Male author & female mentor	3 302 (10.0%)	927 (7.3%)	4 229 (9.3%)

The distribution of collaboration types varies across general fields, yet the 'male author & female mentor' type consistently remains the least prevalent (Figure 8, Table S3). Among PhD dissertations, the top three STEM fields display the highest proportion of 'both male' collaborations: Physics & Math (67%), Technical Science (66%), and Earth Sciences (55%).

In contrast, the highest 'both women' collaboration rate is observed in Philology (60%), Art Studies (55%), and Education (52%). For DS dissertations, the percentage of 'both women' collaborations decreases across all fields compared to PhD dissertations (including Physics & Math, where this type is almost absent). In STEM fields, certain subfields demonstrate a more balanced gender distribution (e.g., Biology and Chemistry), while others exhibit greater gender disparity (such as Physics & Math, Technical Science, and Earth Sciences).

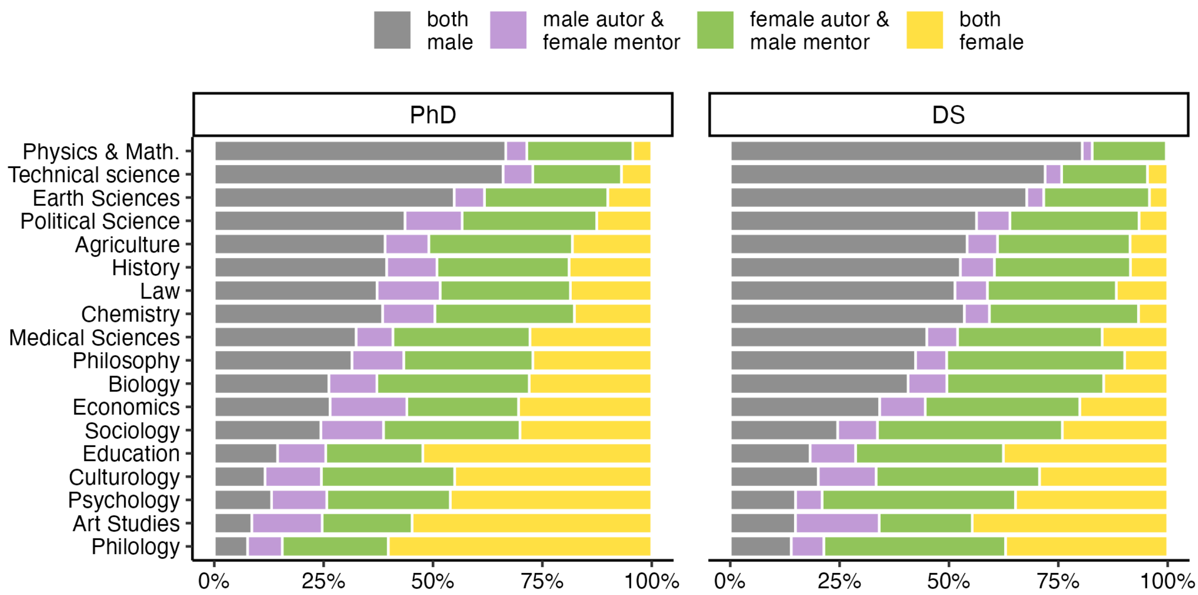

Fig. 8 Collaboration types distribution in 18 general research fields

We quantified gender homophily within research fields using the methodology outlined by Schwartz et al. (2022). As a quick reminder, homophily denotes the inclination of individuals of the same gender to collaborate more frequently than expected, whereas heterophily signifies a stronger propensity for collaboration between individuals of opposite genders. Visualized in Figure 9 (segments b and d), the homophily distribution across subfields illustrates a rightward shift distribution. This indicates that, in most subfields, collaborations between individuals of the same gender occur more frequently than mere chance would suggest. However, certain subfields lie to the left of the dotted red line, indicating a prevalence of heterophily within them.

Transitioning to the general research field level (Figure 9, segments a and c), a tendency emerges: across most disciplines, women tend to collaborate more frequently with other women, and similarly, men exhibit a preference for collaborations with other men. For PhDs, positive values of gender homophily were observed in 17 out of the 18 fields. However, for Art Studies and Sociology, the results yielded confidence intervals that make it uncertain whether gender homophily is present in these two fields. For DSs, our analysis revealed that 16 out of the 18 fields exhibited positive values of gender homophily. We cannot assert that gender homophily is statistically significant (95% CI) in four fields: History, Technical Science, Philology, and Art Studies.

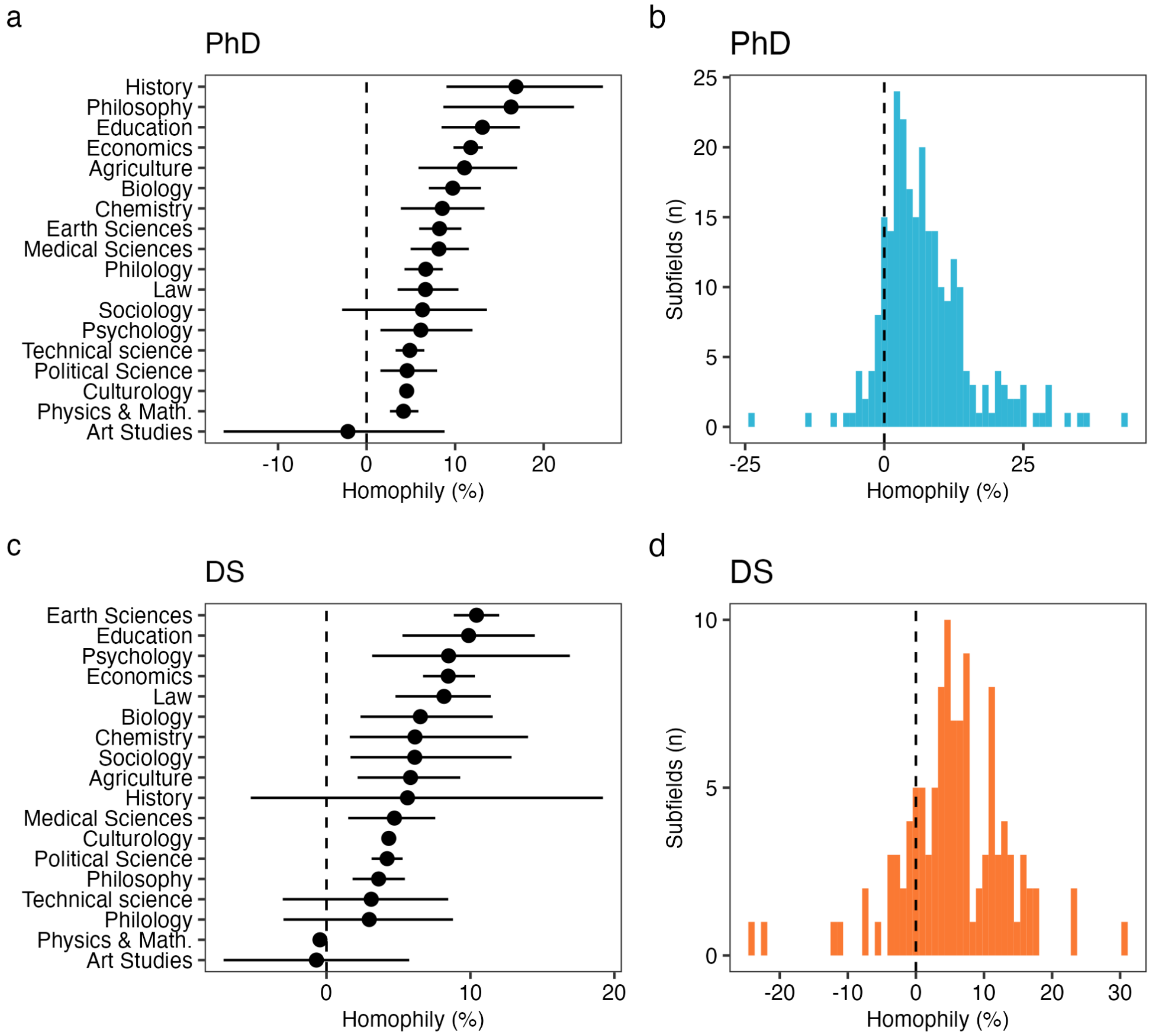

Fig. 9 Gender homophily in 18 general research fields (a, c); and Gender homophily distribution across subfields (b, d)

Discussion

The findings of our analysis illuminate the persistent gender disparities within the Russian academic environment, particularly in relation to PhD and DS dissertation defense rates. Our results indicate that women continue to be underrepresented in specific research fields. We can categorize disciplines into three groups based on their susceptibility to the gender gap: (1) primarily male fields (Physics & Math, Technical Science, Earth Sciences), (2) fields prone to equality (Economics), and (3) primarily female fields (Philology, Psychology, Education, Art Studies, Cultural Studies).

By examining the gender structure of Russian science through the lens of dissertations, we aim to overcome the limitations of research based on bibliometric data. Analyzing publications from databases like WoS and Scopus comes with constraints, as these databases often underrepresent disciplines within SSH, leading to a biased perspective of gender inequality in science that favors STEM. Upon reviewing our results, the fields with the largest number of dissertations are Technical Science (16.5%), Economics (15.5%), and Medical Sciences (14.9%). However, bibliometric studies present a distinctly different field ranking, with STEM fields being prevalent in Russian science. For instance, Pilkina and Lovakov (2022) reported that Economics accounted for less than 1% of all articles authored by Russians in 2017-2019 (with at least one Russian-affiliated author in the WoS database), while *Physics, Math & Space* constituted about 30% of articles. In our dataset, for the *Physics & Math* field (including *Space*), only 5.5% of dissertations were defended. If we exclude Economics, all other SSH fields together constitute less than 2% of all articles authored by Russians (Table S4). Consequently, the structure of fields based on bibliometric data and defended dissertations diverges. Therefore, our research offers an avenue to explore gender representation and inequality in SSH fields, which frequently produce content in national languages and are often underrepresented in international citation databases.

While our study provides insights into the dynamics of gender representation in Russian academia, it is important to acknowledge its *limitations*. One limitation stems from the fact that the defense of a PhD dissertation does not guarantee an individual's sustained presence in academia. In contrast, the defense of a DS dissertation signifies a more robust academic trajectory, as well as assuming the role of a mentor for PhD/DS dissertations. Contextually, in Russia, possessing a PhD degree does not universally translate to being recognized as an academic scientist. Despite the requirement for published scientific papers alongside a dissertation monograph, uncertainties persist regarding the motivations of PhD dissertation authors. For instance, for men, pursuing a PhD might serve as a deferment from military service, possibly introducing an additional incentive. Additionally, it is important to acknowledge the prevalence of practices like plagiarism and the purchase of dissertations, analogous to the landscape of scientific articles (Abalkina & Libman, 2020), which are ongoing issues in Russia. Consequently, when interpreting dissertation data, it is vital to consider these elements that are encapsulated within the dataset. Another crucial limitation of our study relates to the assumption inherent in our homophily calculation formula derived from the approach of Schwartz et al. (2022). We assume that the mentor selects the "mentee" from a pool of potential dissertation authors. However, in reality, this is not the sole mechanism for author-mentor pairing. The reverse practice is also prevalent, where authors independently choose their mentors. Geographical factors, including potential inter-regional mobility, could also wield substantial influence in the Russian context. Furthermore, the phenomenon of academic inbreeding—where individuals opt to pursue a PhD at the same institution where they completed their prior education—introduces an additional layer of complexity. Individuals concentrating on a particular research field within a smaller university might encounter limited options when selecting a mentor.

An additional noteworthy finding from our study is the declining proportion of women as we traverse the academic hierarchy across nearly all fields. This underrepresentation of women is evident not only in STEM fields, as commonly observed across multiple countries (Cardoso et al., 2022), but also within SSH fields. The percentage of women in higher academic positions (PhD/DS mentors) is consistently lower than at earlier stages (PhD/DS authors), holding true for both fields predominantly female and predominantly male. There could be several explanations for that. Women may drop out of academia after obtaining a PhD, or they may remain in it but, for some reason, do not advance to the position of mentor. This could be due to internal decisions and different priorities, as well as institutional barriers they may encounter within academia, preventing them from progressing up the career ladder. Another possible explanation is that we may be observing echoes of past imbalances – it can be assumed that the dropout rate is not so high; it is just that many years ago, the number of women entering PhD programs in certain fields was lower than the number of women entering PhD programs today. It is likely that each of these explanations can contribute to the observed pattern, but when assessing trends over a 12-year period (Fig 4), minimal changes are discernible in the gender composition of PhD authors across most fields, and a slight increase in the proportion of female authors in DS in some fields. So, we can assume that the main contribution can be attributed primarily to the dropout of women from academia or diversion from growth within academia and from mentoring.

We have observed gender homophily in the majority of research fields, meaning that dissertation authors and mentors are more likely to form same-gender pairs than if the pairing occurred randomly. We see this both at the PhD and DS dissertation levels, in most STEM and SSH fields.

The implications of gender homophily can be examined from various perspectives. Same-gender mentorship can play a role not only in attracting young women to academia (Canaan & Mouganie, 2023) but also in reducing their attrition (Shaw & Stanton, 2012; Schwartz et al., 2022). This aspect of homophily can be utilized to shape policies aimed at achieving gender parity in academia. For instance, experimental role model interventions have demonstrated an impact on female students, significantly increasing their likelihood of expressing interest in the field (Porter & Serra, 2020). When discussing a plausible explanation for the effectiveness of same-gender mentorship in reducing attrition, it is suggested that female mentors can serve as essential role models and benchmarks. This empowers young women to navigate their academic paths without sacrificing their careers (Cech & Blair-Loy, 2019) or compromising their ability to successfully balance motherhood and research (Misra et al., 2012).

However, it is important to note the constraints of the implications of gender homophily. Female students may prefer a mentor of a different gender rather than sacrificing mentor quality (Gallen & Wasserman, 2023), but this result has limitations – the experiment was conducted in a top-tier US university, meaning it may not necessarily be generalizable. The national context in this research area is crucial, and results and findings from one country should be applied to others with great caution. For instance, Bu et al., 2022, using Chinese data, demonstrated that dissertations published by both female author-mentor pairs were cited more frequently than other pairs, and in the paper expressing concerns that male authors may lack female mentors. While their findings do not imply causation, their implications differ from studies based on data from other countries.

Another downside of homophily is that, on average, women in academia publish fewer articles, receive less financial support, progress more slowly in their careers, and have fewer networks (Sugimoto & Larivière, 2023). Consequently, one might assume that a more advantageous strategy would be to choose a male mentor. However, this raises the question of what is more beneficial: a higher chance of receiving 6% more citations on average (a criticism of the retracted article by AlShebli et al., 2020) or a greater risk of dropping out of academia altogether.

Conclusion

Our research aimed to overcome the limitations of bibliometric data by analyzing a representative dataset of dissertations spanning all research fields.

We identified a decline in the proportion of women as academic levels progress, both in STEM and SSH fields. The persistent gender disparity exists among PhD and DS mentors, serving as a reminder of the need for initiatives aimed at achieving gender parity in academic leadership roles. Here, we address the phenomenon of gender homophily in mentorship. Without claiming causality, homophily stands out as a notable outcome, emphasizing the importance of exploring this phenomenon. Expanding on this, same-gender mentorship emerges as a potential strategy to counteract the attrition of women from academia. By providing role models and supportive environments, this form of mentorship holds great promise. However, it is important to maintain a balance between the benefits of gender homophily and potential drawbacks.

Declarations

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Supplementary Information Online Supplementary Information is available at https://hellche.github.io/files/SI_paper.pdf

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