Master’s Education in STEM Fields in China: Does Gender Matter?

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1. Research Background & Research Question

1.1. Gender differences in education have been widely recognized as an important policy issue

Although women have made considerable progress in higher education participation, the proportion of women in the fields of STEM, **remains low**

Australia: Women in STEM and Entrepreneurship' Programme

European countries: The Helsinki Group on Women and Science

American: The ADVANCE project

Britain: The Athena Project of the Scientific Women's Academic Network

1. Research Background & Research Question

1.2. The growth of Chinese master education

China started to rebuild its master training system during the 1980s (Regulation of Academic Degrees of P.R.C, 1980)

There are about **2.28 million** master students in 2017 (Ministry of Education, 2018)

Female students' participation is rising during the expansion of master's education

1. Research Background & Research Question

1.2. The rising of females in STEM master education

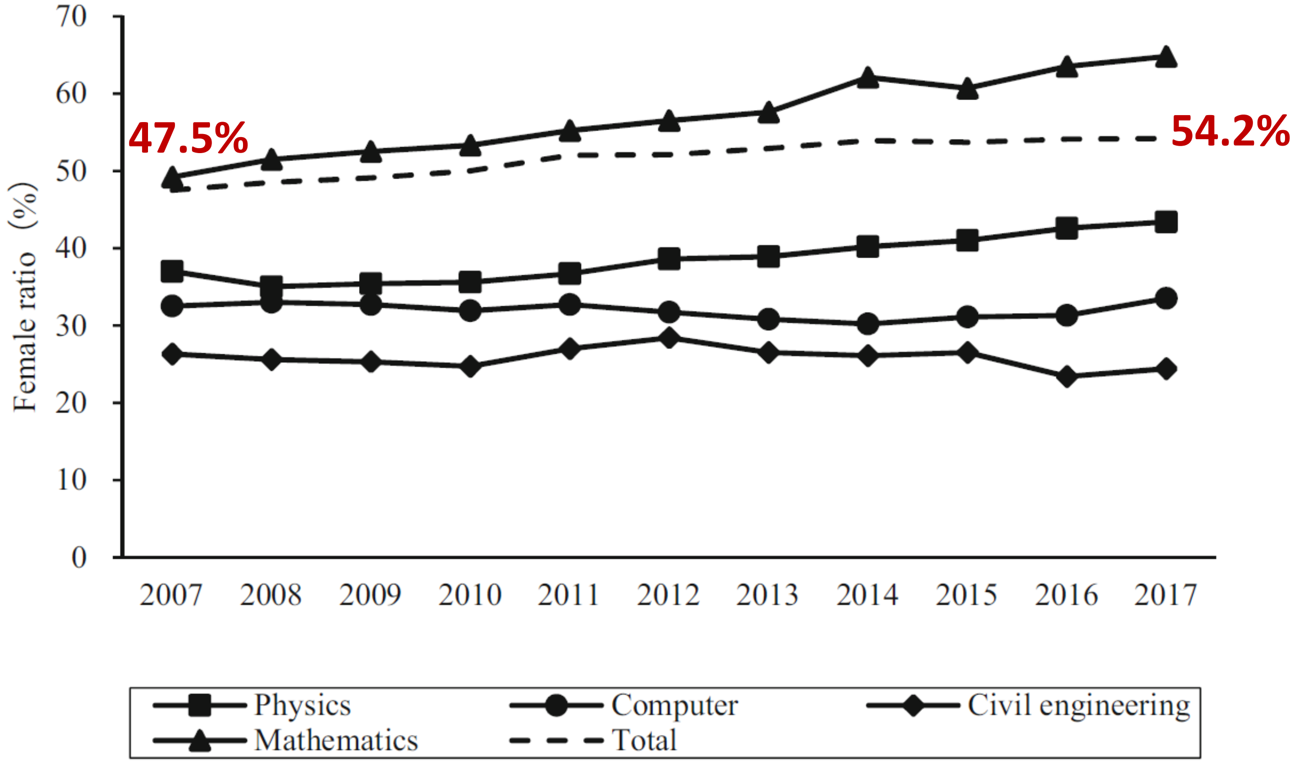


Figure 1. 2007–2017 ratio of female master's student in STEM education in China.
Data Source: Data provided by the Ministry of Education.

1. Research Background & Research Question

1.3. Female suffer from disadvantage during socialization

Compared with **explicit enrolment rates**, **implicit inequality embedded in socialization** is easy to ignore but difficult to change

1. Research Background & Research Question

1.4. Research Questions

(1) What are the differences between female and male master's students in terms of socialization in STEM fields?

(2) Does the gender matching between master's students and their advisors influence socialization in STEM fields?

2. Literature Review

2.1. Gender segregation in graduate education

Horizontal segregation: the underrepresentation of a certain group across domains

Mullen and Baker (2008) investigated gender segregation in mathematics, science and engineering fields in the USA

Vertical segregation: the underrepresentation of a certain group in ranking, such as the differential status

men and women also be segregated across universities that differ in prestige (Weeden et al., 2017)

2. Literature Review

2.2. Gendered socialization of graduate students

Gender inequity becomes more prominent in the **STEM fields** (Britton, 2000; Parson, 2016)

Male doctoral students expressed higher satisfaction in their relationships with advisors compared with female peers in biological sciences and engineering. Hence, male students published more scholarly works than female students (Lubienski et al., 2018)

A qualitative study on female PhD students noted that women doctoral students in the field of mathematics expressed that they did not fit into the male-dominated disciplinary culture (Herzig, 2004)

In aerospace and mechanical engineering field that is dominated by men, socialization of doctoral students was shaped by masculine norms such as being competitive (Sallee, 2011)

2. Literature Review

2.3. Gender matching in graduate education

A male advisor may pose severe **structural barriers** for female students in terms of teacher–student interaction, particularly in a male-dominated department (Kantola,2008)

In the field of chemistry, female doctoral students supervised by advisors of the same gender appeared more productive and more likely to choose academic career trajectories compared with those advised by the opposite gender (Gaule and Piacentini, 2018)

Data from Caltech PhD student cohorts likewise confirmed that a gender dyad consisting of a female student–male advisor published fewer scholarly papers (Pezzoni et al., 2016).

2. Literature Review

2.4. Research Gaps

- The vast majority of research on gendered graduate education is mainly concerned with doctoral students, while few have focused on **master's students**
- Previous studies have been conducted within individual departments, whereas research based on **large national data** is limited
- Qualitative methodologies have been applied in the extant literature, whereas **quantitative** ones have yet to be utilized
- Most of the empirical studies of gender disparities in STEM fields have long been confined to the Western context. What status do female students face within other contexts in different **social dynamics and cultural norms** remains to be explored

2. Conceptual Framework

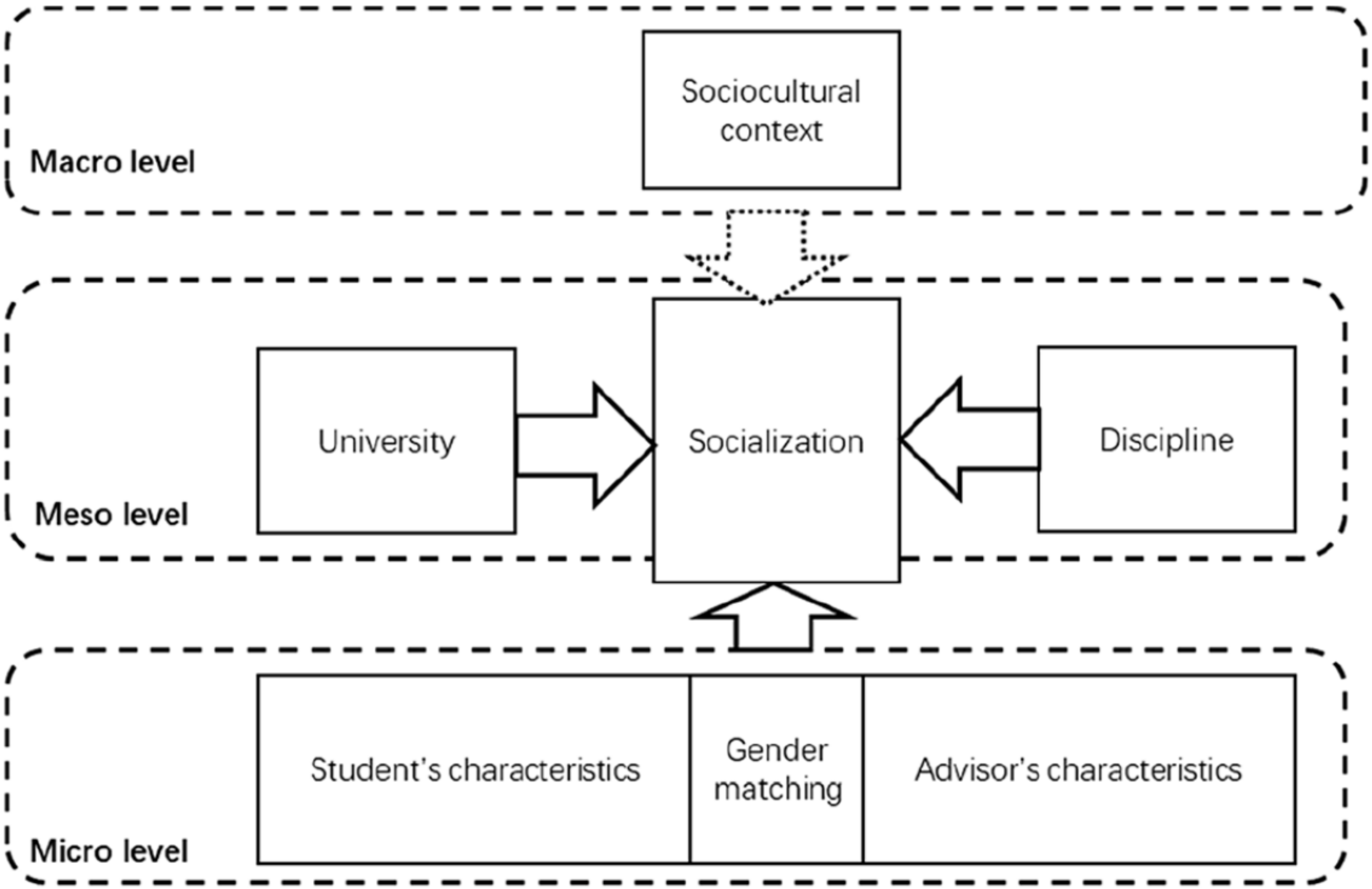


Figure 2. Conceptual framework. *Note*: The solid arrow represents the variables included in the following model, and the dotted arrow represents the variables that are influential but not included.

3. Methodology

3.1. data: national master's education quality survey in 2017

Table 1 Female ratio by field: Comparison between master's students and advisors (%).
Data Source: Population data from the Ministry of Education and surveyed data from authors' survey.

	Master's student (population)	*Master's student (surveyed)*	*Advisor (surveyed)*
Physics	43.40	42.36	19.87
Computers	33.50	32.99	20.60
Civil engineering	24.40	20.30	12.31
Mathematics	64.80	67.63	24.64

STEM fields in China remain male dominated

3. Methodology

3.2. Variables

Table 2 Variables and descriptive statistics (N = 2285).

Variable	*Explanation*	*Mean/ frequency*	*SD/ percentage*
Project participation	Number of research project involvements	2.20	1.56
Academic publication	Number of published journal papers	1.19	1.19
Satisfaction with advisor	Student's assessment, more satisfied, higher score	87.73	17.71
Pursuit of a doctorate	1 if enrolled in a doctoral programme after graduation	394	17.24%
Male	1 = male, 0 = female	1372	60.04%
Gender matching	1 = FF	224	9.81%
	2 = FM	689	30.15%
	3 = MF	216	9.45%
	4 = MM	1156	50.59%
Age	Years from birth	26.29	1.52
Academic motivation	1 = academic, 0 = non-academic	648	28.36%
Advisor's rank	1 if advisor is a full professor	1583	69.28%
Advisor's age	1 if the age of advisor is below 35 years	94	4.11%
Discipline prestige	Score of the fourth round of Chinese discipline ranking	4.65	2.60
University prestige	1 if enrolled in a double first-class university	1778	77.81%

3. Methodology

3.3. Descriptive results

Table 3 Socialization by both gender and field.

	Gender		
	Male	*Female*	*Mean difference*
Project participation	2.37	1.93	–6.76***
Academic publication	1.20	1.17	–0.55
Satisfaction with advisor	86.47	89.62	4.18***
Pursuit of a doctorate (%)	18.88	14.79	6.43**

**$p < 0.05$; ***$p < 0.01$.

Field				
Physics	*Computers*	*Civil engineering*	*Mathematics*	*Mean difference*
1.51	2.09	2.36	2.73	40.25***
1.03	1.46	1.01	1.33	79.32***
91.28	86.10	86.28	87.31	42.00***
23.92	27.51	12.09	8.99	92.41***

4. Research Findings

4.1. Gender and project participation (Negative binomial regression)

	STEM	*Physics*	*Computers*	*Civil engineering*	*Mathematics*
Male	0.255***	− 0.000	0.205**	0.287***	− 0.076
	(0.055)	(0.106)	(0.103)	(0.093)	(0.127)
FM	0.060	0.013	0.095	0.201*	− 0.043
	(0.059)	(0.110)	(0.111)	(0.109)	(0.115)
MF	− 0.093**	− 0.065	− 0.070	− 0.109	0.085
	(0.047)	(0.092)	(0.065)	(0.098)	(0.166)
Age	− 0.006	0.001	0.001	0.002	0.017
	(0.010)	(0.017)	(0.016)	(0.022)	(0.024)
Academic motivation	0.048	0.063	0.176***	0.055	0.077
	(0.033)	(0.058)	(0.052)	(0.065)	(0.097)
Advisor's rank	− 0.003	0.051	0.001	0.055	− 0.086
	(0.032)	(0.063)	(0.051)	(0.055)	(0.099)
Advisor's age	0.067	0.288**	− 0.062	− 0.077	0.130
	(0.068)	(0.122)	(0.108)	(0.142)	(0.207)
Discipline prestige	0.017**	0.010	0.011	0.012	0.001
	(0.007)	(0.014)	(0.010)	(0.012)	(0.019)
University prestige	− 0.025	− 0.072	0.006	0.006	− 0.140
	(0.043)	(0.080)	(0.074)	(0.076)	(0.112)
Constant	0.691**	0.645	0.578	0.568	0.132
	(0.270)	(0.469)	(0.424)	(0.590)	(0.651)
N	2285	458	670	601	556
Pseudo R^2	0.008	0.005	0.008	0.005	0.003
Prob > chi2	0.000	0.419	0.004	0.122	0.706

Robust standard errors are in parentheses.

$^*p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

4. Research Findings

4.2. Gender and academic publication (Negative binomial regression)

	STEM	*Physics*	*Computers*	*Engineering*	*Mathematics*
Male	− 0.055	− 0.047	− 0.080	0.187	− 0.219
	(0.072)	(0.168)	(0.125)	(0.179)	(0.145)
FM	− 0.101	− 0.107	0.124	0.092	− 0.292**
	(0.075)	(0.170)	(0.131)	(0.194)	(0.119)
MF	0.026	− 0.122	0.174	− 0.022	0.280
	(0.071)	(0.155)	(0.116)	(0.111)	(0.222)
Age	0.001	− 0.002	0.021	− 0.027	− 0.006
	(0.012)	(0.026)	(0.017)	(0.028)	(0.023)
Academic motivation	0.033	0.009	− 0.001	0.056	0.018
	(0.046)	(0.087)	(0.081)	(0.086)	(0.107)
Projects participation	0.084***	0.112***	0.029	0.047**	0.130***
	(0.013)	(0.035)	(0.021)	(0.022)	(0.028)
Advisor's rank	− 0.022	− 0.012	0.055	− 0.042	− 0.134
	(0.045)	(0.090)	(0.081)	(0.074)	(0.106)
Advisor's age	0.350***	0.147	0.038	0.715***	0.561**
	(0.100)	(0.150)	(0.190)	(0.166)	(0.236)
Discipline prestige	− 0.038***	− 0.012	− 0.057***	− 0.036**	− 0.023
	(0.009)	(0.021)	(0.016)	(0.014)	(0.022)
University prestige	− 0.202***	− 0.025	− 0.244***	− 0.086	− 0.575***
	(0.055)	(0.122)	(0.086)	(0.112)	(0.122)
Constant	0.318	0.325	− 0.200	0.933	0.665
	(0.313)	(0.707)	(0.456)	(0.761)	(0.612)
N	2285	458	670	601	556
Pseudo R^2	0.020	0.012	0.021	0.022	0.058
Prob > chi2	0.000	0.0806	0.000	0.000	0.000

4. Research Findings

4.3. Gender and satisfaction with advisors (OLS regression)

	STEM	*Physics*	*Computers*	*Civil engineering*	*Mathematics*
Male	− 4.515***	0.355	− 0.572	− 5.970***	− 5.425***
	(1.299)	(3.892)	(3.186)	(2.242)	(1.779)
FM	− 0.633	1.364	4.488	− 5.186**	− 2.790**
	(1.284)	(3.944)	(3.156)	(2.587)	(1.416)
MF	2.163	− 0.261	− 0.515	6.016***	7.684***
	(1.340)	(3.028)	(2.410)	(2.138)	(2.163)
Age	− 0.095	0.541	− 0.532	0.778	− 0.517
	(0.251)	(0.607)	(0.451)	(0.562)	(0.484)
Academic motivation	− 0.028	1.247	− 0.834	0.368	− 0.860
	(0.854)	(1.772)	(1.800)	(1.792)	(1.615)
Projects participation	1.664***	1.320**	2.229***	1.990***	1.892***
	(0.232)	(0.650)	(0.530)	(0.440)	(0.349)
Academic publication	− 0.013	0.813	0.785	− 0.369	− 0.603
	(0.307)	(0.587)	(0.728)	(0.626)	(0.469)
Advisor's rank	0.142	1.884	1.291	− 0.606	− 2.768**
	(0.826)	(2.105)	(1.625)	(1.553)	(1.242)
Advisor's age	0.303	5.658*	2.953	− 8.265*	2.891
	(1.797)	(3.410)	(3.466)	(4.311)	(2.401)
Discipline prestige	− 0.078	− 1.360***	0.085	− 0.015	0.486
	(0.172)	(0.451)	(0.335)	(0.362)	(0.319)
University prestige	− 1.852*	4.033*	− 2.049	− 1.991	− 3.684**
	(0.979)	(2.375)	(2.047)	(2.048)	(1.621)
Constant	90.995***	66.978***	94.068***	69.593***	107.963***
	(6.738)	(17.497)	(12.222)	(15.064)	(12.682)
N	2285	458	670	601	556
R^2	0.032	0.042	0.049	0.058	0.081
Prob > *F*	0.000	0.026	0.000	0.000	0.000

4. Research Findings

4.4. Gender and pursuit of a doctorate (Logistic regression)

	STEM	*Physics*	*Computers*	*Civil engineering*	*Mathematics*
Male	1.391***	1.546	1.116	3.204	2.779***
	(0.934)	(3.447)	(0.555)	(0.630)	(0.301)
FM	1.055	0.845	0.876	2.305	1.066
	(0.352)	(2.652)	(0.466)	(0.364)	(0.240)
MF	0.833	0.673	0.576	0.850	1.190
	(0.517)	(0.512)	(0.254)	(0.247)	(0.173)
Age	1.034	0.930	1.078	1.236*	0.894
	(0.072)	(0.148)	(0.067)	(0.083)	(0.041)
Academic motivation	3.923***	3.924***	4.079***	3.073***	2.669***
	(0.605)	(1.003)	(1.059)	(0.911)	(0.464)
Projects participation	0.866***	1.049	1.047	0.871	0.898
	(0.063)	(0.082)	(0.083)	(0.093)	(0.035)
Academic publication	1.325***	1.298***	1.484***	1.398***	1.314***
	(0.117)	(0.161)	(0.185)	(0.123)	(0.065)
Advisor's rank	1.518***	1.369	1.305	0.841	2.501***
	(0.738)	(0.296)	(0.367)	(0.374)	(0.209)
Advisor's age	1.112	0.309*	1.156	3.027**	1.285
	(0.997)	(1.685)	(0.759)	(0.201)	(0.333)
Discipline prestige	0.984	1.111*	0.912	1.043	1.007
	(0.051)	(0.086)	(0.052)	(0.070)	(0.026)
University prestige	0.946	0.640	1.041	0.590	1.366
	(0.442)	(0.265)	(0.351)	(0.212)	(0.155)
Constant	0.033***	0.536	0.008***	0.000***	0.909
	(1.959)	(0.000)	(0.014)	(1.323)	(0.036)
N	2285	458	670	601	556
Pseudo R^2	0.099	0.126	0.109	0.114	0.130
Prob > chi2	0.000	0.000	0.000	0.000	0.000

5. Discussion and Policy Implication

5.1. Discussion: gender effects

1. female respondents participated in **fewer research projects** during their studies and were **less likely to pursue a doctorate** after graduation (consistent with studies in the Western context)

2. **no significant** gender difference in academic publication, and female students were **highly satisfied** with their advisor (no ‘productivity puzzle’ in STEM master’s education)

3. **One Child policy** ⟶ parents hold equal educational aspirations ⟶ increased educational investment for young girls

5. Discussion and Policy Implication

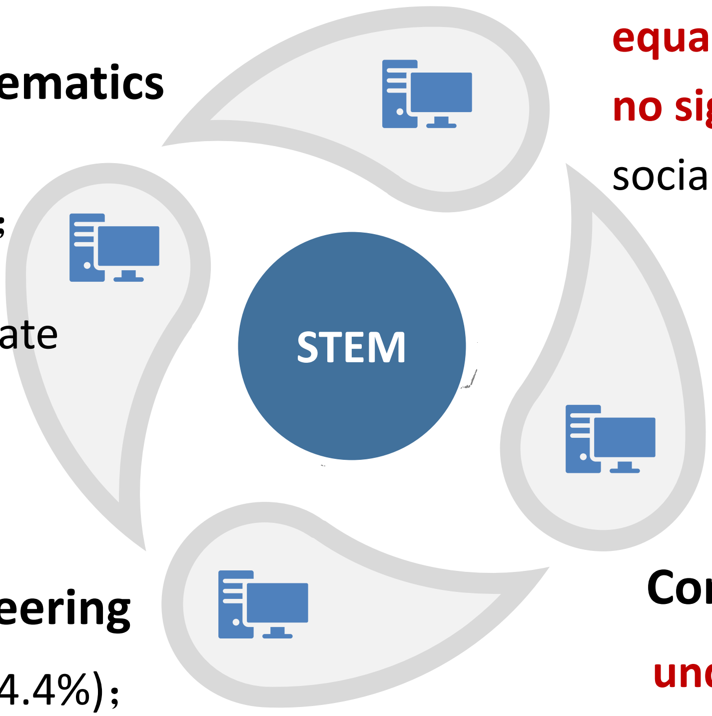
5.1. Discussion: gender effects

Mathematics

well represented (64.8%);
highly satisfied with advisor;
less productive;
less likely to pursue a doctorate

Physics

equal representation (43.4%);
no significant disadvantage in socialization



Civil engineering

low representation (24.4%);
less research opportunities;
highly satisfied with their advisor

Computer

underrepresented (33.5%);
less research opportunities

5. Discussion and Policy Implication

5.1. Discussion: gender-matching effects

1. female students—**female** advisor: **more satisfied**

(mathematics & civil engineering)

2. female students—**female** advisor: **more productive**

(mathematics)

highlight the importance of the same-gender advisor → role model

5. Discussion and Policy Implication

5.2. Policy implication

01 tackling gender disparity in STEM fields at **master's education level**

differential interventions for **distinct subfields** are recommended 02

03 **gender matching** between students and advisors deserves more attention

5. Limitation

- Only measured the **number** of research projects that master’s students participated in and the number of academic papers they published rather than the **quality** of their research involvement

- Only explored in **four fields**, but STEM fields include more

- Mainly considered factors from student themselves, their advisors and institutions where they enrolled. **Other factors** contributing to gendered socialization are not considered

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Thanks for listening

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