Economics of Education Review 29 (2010) 225–235

Contents lists available at ScienceDirect

Economics of Education Review

journal homepage: www.elsevier.com/locate/econedurev

Gender disparities in science and engineering in Chinese universities

Congbin Guo[a], Mun C. Tsang[b,*], Xiaohao Ding[a]

[a] Peking University, China
[b] Columbia University, USA

ARTICLE INFO

Article history:
Received 24 June 2009
Accepted 25 June 2009

Keywords:
Gender inequality
Science and engineering
Higher education
China

ABSTRACT

Gender disparities in science and engineering majors in Chinese universities have received increasing attention from researchers and educators in China in recent years. Using data from a national survey of college students who graduated in 2005, this study documents gender disparities in enrollment and academic performance in science and engineering majors, and explores gender disparities in initial employment experiences of science and engineering graduates. It finds that females lag far behind males in enrollment in science and engineering majors overall. However, females actually are more represented than males in some majors such as mathematics and chemistry though the reverse is true for other science and engineering majors. Also, in science and engineering majors, females perform better than males in both general course grades and in English competency tests. Male science and engineering graduates have a clear advantage over their female counterparts in initial employment after graduation: they have a high employment rate, a higher starting salary, and are more likely to be employed in such jobs as business management and technical specialist. The male advantage in employment rate and starting salary persists even after controlling for other factors.

© 2009 Elsevier Ltd. All rights reserved.

1. Introduction

Since the adoption of Reform and Open policy in People's Republic of China (China) three decades ago, female access to higher education in China has increased along with a rapid expansion of higher education. The proportion of female enrollment in higher education was 23.4% in 1980, 33.7% in 1990, and 45.5% in 2005 (China National Census Bureau, 2007). That been said, the female proportion still trailed the male proportion by 10 percentage points in 2005. In the same year, males accounted for 49.7% of the population in the 18–22 age group (China National Bureau of Census, 2007).

There are multiple reasons for the lower opportunities for higher education for females in China: social status, gender discrimination, and conventional family patriarchal practices, just to name a few. In addition, uneven distribution among academic majors is also a significant factor. Scholars sum it up as the gender bifurcation of higher education: females tend to choose majors in social science, education, and social work while males tend to choose in the line of science, engineering, and technology. And the current structure of majors and admission quota in higher education tend to favor science and engineering. The preferences by female students toward social science and similar majors result in keen competition in these majors and weaken female opportunities in higher education overall (Zhou, 2007). This not only leads to a significantly higher proportion of male participation in higher education, but also a significantly higher proportion of male employment in science and engineering.

Equality is an important foundation of healthy, stable and continuous development of human society. The extent

* Corresponding author at: Teachers College Columbia University, International & Transcultural Studies, 525 West 120th Street, New York, NY 10027, USA. Fax: +1 212 678 8237.
E-mail address: mct27@columbia.edu (M.C. Tsang).

0272-7757/$ – see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.econedurev.2009.06.005

of disparities in access to social resources, especially social resources that are essential to survival such as education and health care, by different social group is one of the most basic measures of social equality. Large disparities in such social resources not only are deemed unfair, but they may also lead to social conflicts and instability. In a modern society, education is often seen as a fundamental right enjoyed by all social groups. And reducing large education disparities between males and females is regarded as a desirable educational and social goal (Wang, 1999).

Gender disparities in science and engineering in higher education are a prominent part of gender inequality in higher education in China today. The purpose of this paper is use primary data to present a recent documentation of such disparities in Chinese higher education and explore their impact on the employment experiences of science and engineering graduates.

The rest of the paper is divided into three sections. Section 2 provides a concise review of the literature on gender disparity in higher education in China and elsewhere, presents a preliminary conceptual framework for addressing four research questions regarding gender disparities in Chinese higher education, and describes the data source. Section 3 presents the empirical findings on the four research questions. Section 4 gives a summary and suggestions for further research.

2. Literature review, conceptual framework, and data

This section reviews research on gender disparities in higher education in China. A quick look shows that many of the studies on China are theoretical and normative in nature. Only a few took the empirical approach. And the limited number of empirical studies focused mostly on the gender disparities on higher education admission and employment.

The study by Chen, Xie, & Zhang (2003) shows that the gap in gender distribution of university-admission has been reduced in recent years. They attribute this improvement to the universalization of compulsory education, the single child policy and the national college-admission test. The three elements combine to reduce gender discrimination from the family, school and society. It evens up opportunities for access to higher education between males and females and improves the quality of female workers in the labor force.

Researchers in China try to analyze and explain gender disparities in China's higher education admission from different perspectives. Wen's analysis (2005) looked into the structuring of majors. He pointed out that female students had higher percentage of enrollment in majors like literature, law, and economics. In literature majors, female even had a higher percentage, accounting for two thirds of all graduates. But the female percentage was substantially lower in majors like engineering and agriculture. In engineering majors, only 20% graduates were female. Since engineering majors are the largest group of majors in terms of admission, which takes about 40% of all university-admissions every year, the substantially low percentage of female admission in engineering no doubt has an adverse effect on the percentage of female admission in higher education overall.

In another study, Song (2005) identified the primary reason for the lower female admission rate: the traditional patriarchal value and the disparity between urban and rural areas. He contended that since parents in cities usually are better educated, they are less influenced by the male chauvinistic value, thus offer their children a better family education environment that is conducive to the healthy and equal development of female children, while the situation in the rural is the opposite. Wang's (1999) study drew the similar conclusion with an added mentioning of differences in social economic status as the causal factor. According to her analysis of the students from the class of 1996 in Xiamen University in Fujian Province, there was only moderate gender disparity among students from the cities or from upper class families, while a significant gender disparity was observed among students from the rural and lower class families. There were 32.2% female among students with parents working in the education, research, and public health systems, 28.4% female among students with parents working in the government or corporate, and only 9.8% among students with parents that are peasants. She argued that, compared to the rural and lower class families, parents in the urban and upper class were not as strongly discriminative against female, paid more attention to education in general, and were also capable of providing adequately for their children's higher education. In addition, some researchers also believed that different expectation to the future economic return (e.g., employment and income) is another causal factor to the gender disparities in higher education opportunities.

As for gender disparities in employment, Zhou's research (2000) revealed that, under the same condition, female graduates only had 87.7% of the employment opportunities that their male counterparts had. Ying and Li's (2007) research showed that the gender factor negatively impacted female on various aspects of employment, including longer time spent on job-searching, lower rate of success employment, lower starting salary, unequal treatment, and less position availability.

Ying and Li (2007) explained the gender disparities in employment with the following factors: the traditional value on gender differences, employer's prejudice toward female, biological and physical differences between genders, and female's attitude toward employment. In addition, because most female students choose majors in literature, law, and economics, where there are relatively fewer employment opportunities offered, and on the other hand, male tend to choose science and engineering majors, where employment opportunities become abundant due to the recent industrial development, male enjoy a higher rate of employment than female (Zhou, 2007).

So far, there is a lack of studies in China that specifically examine gender disparities within science and engineering majors, and compare the employment experiences of male science and engineering graduates with their female counterparts.

The present research is a study of gender disparities in science and engineering majors in China's higher education institutions. It addresses four research questions:

(1) What are the gender disparities in enrollment in science and engineering majors?
(2) Are there gender disparities in academic performance in science and engineering majors?
(3) Are there gender disparities in initial employment status, starting salaries, and job/occupational placement among graduates of science and engineering majors?
(4) What factors influence science and engineering major graduates' initial employment status and starting salaries?

Research on these four questions is guided by the conceptual framework depicted in Fig. 1.

According to Fig. 1, family background, location of residence (rural versus urban), and other pre-college factors influence the choice of college major in China. Employment experiences (including employment status, starting

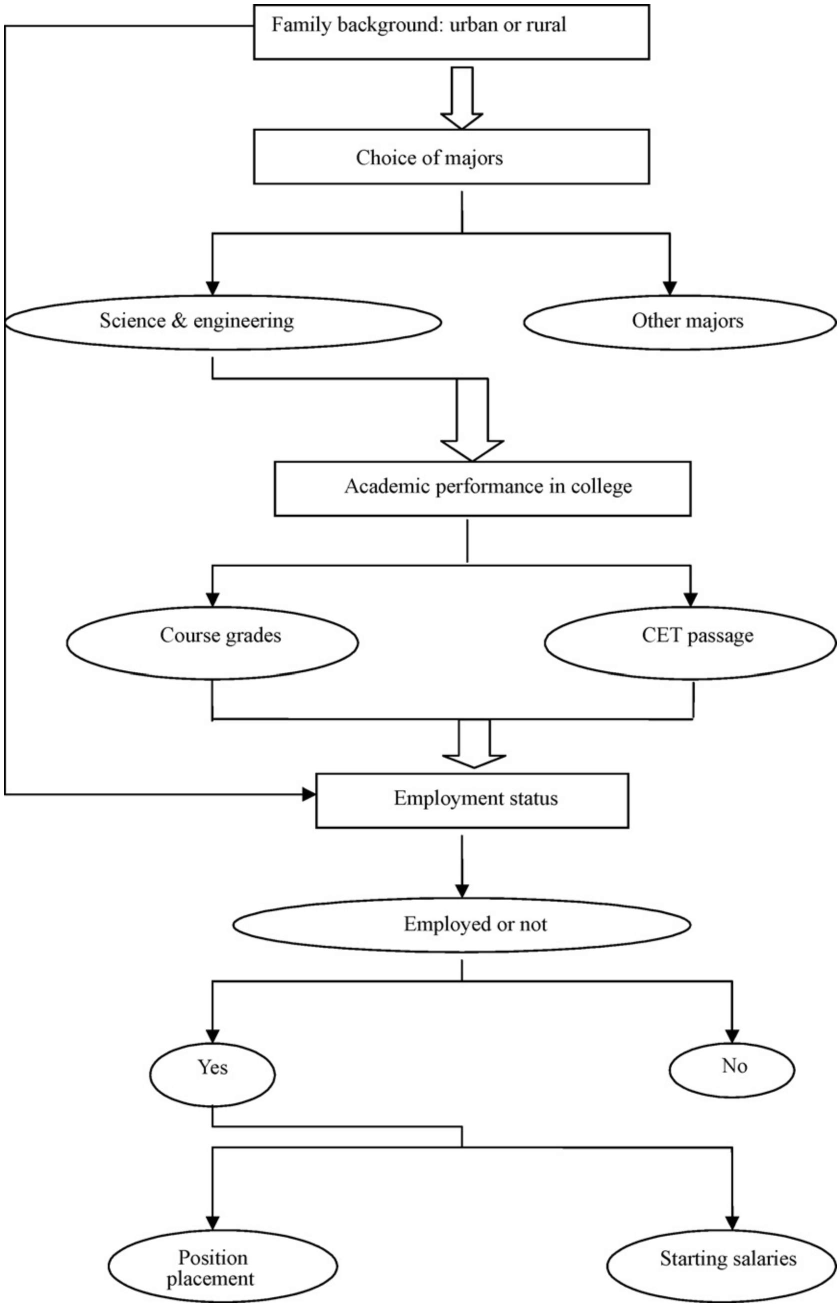

Fig. 1. Conceptual framework of analysis.

salaries, and initial job placement) of college graduates are related to major, academic performance and gender. In this study, academic performance is measured in general course grades and in passing of the Chinese-designed College English Test (CET). In China, college students need to study English as the second language, and are required to take the national Level IV and Level VI CET. Since English proficiency level is expected to have an impact on employment in China, the passing of the CET at Level IV or Level VI is included as a measure of academic performance. Lack of information on pre-college years does not allow the present research to examine relationships in the upper part of Fig. 1.

Data used in this study is the College Graduate Employment Survey collected by Institute of Educational Economics, Beijing University in 2005. Based on a multi-stage sampling strategy this survey covered 34 higher education institutes in 16 provinces from the three regions of china (that is, east, central, and western China): Beijing, Tianjin, Liaoning, Hebei, Shandong and Jiangsu from east-China; Heilongjiang, Jilin, Henan, Anhui, Hubei, and Hunan from central-China, and Shanxi, Yunnan, Guizhou, and Sichuan from west-China. Among the 34 institutes surveyed, 9 are first-tier colleges (that are participants of the National "211" Higher Education Enhancement project), 20 are second-tier colleges, and 5 are associate degree institutes or post-secondary professional schools. Such a sample represents a reasonable representation of the scope and diversity of higher education in China. The survey was conducted just a short moment before the students graduated in 2005. Altogether 21,220 valid responses were received, representing a response rate of over 90%. Among all respondents, 16.6% have associate degrees or professional certificates, 78.5% have undergraduate degrees, 4.1% have master's degrees, and 0.7% has doctoral degrees. 56.7% of them are male, and 43.3% are female. 15,593 of these respondents are college graduates (college students who graduated in 2005), consisting of 8628 males (55.3%) and 6965 (44.7%) females. And among these college graduates, 4958 are in science and engineering majors, with 73.9% male and 26.1% female.

Compared to previous published studies on gender disparities in higher education in China, this study is the first empirical study that focuses on science and engineering majors. It is more comprehensive in analyses in that it considers how such disparities vary by the location of residence (urban areas versus rural areas) and it uses multiple measures of academic performance and employment experiences.

3. Analyses and findings

This section presents the findings of statistical analyses that address the four research questions given in the last section.

3.1. Gender disparities among different majors

Table 1 shows the gender distribution among college students who graduated in 2005 from liberal arts, social science, science/technology, engineering, and other majors. Among all the new college graduates in 2005, 55.3% are male and 44.7% are female. Among the majors, liberal arts have a significantly lower percentage of male students (37.7%). In social science majors, the distribution is generally even with 48.0% male and 52.0% female. On the other hand, male percentage is significantly higher than female in science and engineering majors, with 57.5–42.5% in science/technology and a remarkable 77.3–22.7% in engineering. The rest of the majors studied also feature a majority of male over female (57.8–42.2%). Overall, despite the slight advantage of female over male in liberal arts and social science, the large margin of male majority in science and engineering tilts the balance and creates an overall advantage of male over female.

Due to the large demographic differences between urban and rural areas, the study also divides the sample based on graduates' household registration (rural and urban, as seen in Table 1). The result shows that graduates from rural and urban families have different patterns of gender distribution in higher education majors. In general, urban graduates have a smaller gap between genders, where male only holds a 2.5 percentage point advantage over female. On the other hand, gender distribution among rural graduates shows a significant imbalance, where male students are 25.6 percentage point more than female. Among all majors, rural female graduates have a majority only in liberal arts (while urban female graduates have a majority in both liberal arts and social science). Table 1 also shows that rural graduates have greater gender disparities in both science and engineering majors than urban graduates. The gaps among rural graduates for these two majors are 17.1 and 60.2 percentage point, respectively, while only 13.7 and 51.3 percentage point among urban graduates. One explanation for this difference between urban and rural areas is the Planned Family policy that has been implemented since the 1980s. Under this policy, couples in the urban areas are only allowed one child, while couples in the rural areas are occasionally allowed to have a second child, where they usually have when the first child is a girl. That

Table 1
Gender distribution among majors for college graduates in 2005.

Major	Entire sample		Rural		Urban	
	Number	% Female	Number	% Female	Number	% Female
Overall	15,593	44.7	5480	37.2	10,113	48.7
Liberal arts	2,585	62.4	855	54.0	1,730	66.5
Social science	6,753	52.0	1908	44.3	4,845	55.1
Science and technology	842	42.5	328	41.5	514	43.2
Engineering	4,116	22.7	1791	19.9	2,325	24.9
Other majors	1,297	42.2	598	39.6	699	44.4

Table 2
Gender distribution among college graduates in popular science and engineering majors, 2005.

Major	Overall		Rural		Urban	
	Number	% Female	Number	% Female	Number	% Female
Mathematics	126	54.0	68	58.8	58	48.3
Physics	103	34.0	57	33.3	46	34.8
Chemistry	100	56.0	48	45.8	52	65.4
Biology	222	41.0	61	39.3	161	41.6
Computer	291	37.1	108	54.6	183	27.2
Engineering	4116	22.7	1836	20.3	2280	24.6

created a situation where single child families are more common in urban than rural areas. Also, urban residents generally have a higher level of education and a lower level of gender discrimination, which makes it easier to achieve greater gender equality in urban than rural areas, which in turn leads to a higher college-admission rate of female graduates from urban areas than from rural areas.

Table 1 shows that science and technology majors and engineering majors differ substantially in size and in gender distribution. Science and technology majors account for only 5.4% of all the college graduates while engineering majors account for 26.4%; thus engineering majors are almost five times as large as science and technology majors in terms of graduates. 42.5% of the graduates in science and technology are females while only 22.7% of engineering graduates are females.

Since the focus of this research is on gender disparities among science and engineering majors, Table 2 presents gender distribution for students who graduated in 2005 in the six most popular science and engineering majors in Chinese higher education: mathematics, physics, chemistry, biology, computer science, and engineering.

According to Table 2, females have a higher percentage in mathematics and chemistry: 8% point gap in mathematics and 12% point gap in chemistry. On the other hand, males have a significantly higher percentage in physics, biology, computer science, and engineering. The margin is much larger in physics (33% point) and engineering (55% point). As to geographic differences, for physics, biology, and engineering, males have a higher percentage regardless of geographic origin; for mathematics and computer science, female have a higher percentage in rural areas, but a lower percentage in urban areas; and for chemistry, males have a higher percentage in rural areas, but a lower percentage in urban areas.

Tables 1 and 2 together show that gender disparities vary significantly not only majors, but also between rural and urban areas of residence. Females' remarkably small percentage in physics and engineering majors is a major contributing factor for their overall disadvantage in enrollment in higher education in China. It is important also to note the gender disparities by geographical areas.

3.2. Gender disparity in academic performance in college

There are many potential measures of academic performance in college. Grades should be considered an important measure. In addition, Chinese college students are required to take the CET. Since obtaining a higher level of CET certificate is considered very important for future employment or the pursuit of more advanced degrees in China or abroad, many college students dedicate a significant amount of their time in college to study for CET at various levels. For that consideration, the following analysis will use both grades and CET passage as measurement for academic performance. In the survey, college students who graduated in 2005 were asked to report academic ranking in their class ("Academic Excellence" being the top or "A" ranking) and whether they passed the Level IV or Level VI of the CET.

As shown in Table 3, females generally perform better in science and engineering majors in college. Overall, 51.8% of females reported "A" ranking compared to only 31.5% of males. And a higher percentage of females reported "A" ranking than males in all six majors in science and engineering. Mathematics was the major for which the gender gap was small.

Analysis of other majors also shows that females perform better than males. The percentage of graduates with "A" ranking was 41.6 for females and 29.9% for males in liberal arts and humanities majors, 43.2 for females and 30.7 for males in social sciences majors, and 39.9 for females and 25.6 for males in the rest of the college majors. In short,

Table 3
Gender disparities in academic excellence among science and engineering graduates, 2005.

	No. graduates with "A" ranking	% Graduates with "A" ranking
Overall		
Male	1154	31.5
Female	669	51.8
Mathematics		
Male	21	36.2
Female	26	38.2
Physics		
Male	19	27.9
Female	19	54.3
Chemistry		
Male	12	27.3
Female	21	37.5
Biology		
Male	40	30.5
Female	51	56.0
Computer		
Male	55	30.1
Female	48	44.4
Engineering		
Male	1007	31.6
Female	504	54.0

Table 4
Gender disparities in CET passage among science and engineering graduate, 2005.

	Male		Female	
CET Level IV	2297	47.8%	836	41.3%
CET Level VI	1435	29.9%	893	44.1%
Did not attempt	831	17.3%	202	10.0%
N/A	243	5.1%	93	4.6%

females perform better than males across all the majors. There is no evidence that females in science and engineering majors are different from females in other majors in term of academic performance relative to males.

It should be pointed out that the class ranking was a reported measure, not taken from the respondent's transcript. Thus there might be some measurement error in this measure; especially since the proportion of females reporting "A" ranking was unexpectedly high. Future research should use actual ranking instead of reported ranking to determine whether females actually did better than their male counterparts in science and engineering majors.

However, it is still possible that, despite the measurement error, females had higher academic performance in science and engineering majors. From Table 1, it can be found that 18.5% of females had science and engineering majors and 42.5% of males were also in such majors. Since females usually choose to enroll in non-science/engineering majors, those choosing to enroll in science/engineering majors may be different in their academic ability, personal traits and work habits. Thus, Table 3 may reflect the result of a self-selected process.

Table 4 shows that, in terms of CET result, female students in science and engineering majors also did better than their male counterparts. 44.1% of female graduates in these majors passed Level VI while only 29.9% of males passed the same level. At the same time, only 10.0% female graduates did not sit for the CET, which was clearly lower than the 17.3% among male graduates in the same majors. Male graduates had a correspondingly higher percentage in passing the lower level (Level IV) CET.

3.3. Gender disparities in employment among science and engineering graduates

This study examines three measures of the employment experience of science and engineering students who graduated in 2005: initial employment status, starting salaries, and initial job placement.

3.3.1. Gender disparities in initial employment status

This survey identified 11 distinct employment statuses in 2005 for college students who graduated in 2005: (1) contract signed, (2) offer accepted, waiting for contract signing, (3) offer declined, (4) waiting for offer, (5) without potential employer, (6) planning for self-employment, (7) admission to graduate school by recommendation, (8) admission to graduate school by qualification test, (9) applying for school abroad, (10) applying for unemployment, and (11) other. In the following analysis, these 11 statuses were collapsed into four main categories: 1, 2, and 6 are considered employed; 3–5 and 10 are considered unemployed; 7–9 are considered in-pursuit of advanced degree. Table 5 shows the gender distribution of employment status using the collapsed categorization.

In general, male science and engineering have a higher employment rate than their female counterparts, while female science and engineering graduates have a higher rate of in-pursuit of advanced degrees. Overall in science and engineering, male graduates' rate of employment is 15.3% points higher than female (57.6–42.3%). On the other hand, unemployment rate of female graduates is slightly higher than male (22.1–19.9%). And female graduates have a 13.4% points higher percentage of pursuing advance degrees than male (34.1–21.5%). Since females are less likely to get a job than their male counterparts, a higher percentage of them turn to the pursuit of advanced degrees to avoid unemployment and hope that a higher credential may strengthen their future competition for employment.

Also, Table 5 shows that engineering majors have a much higher rate of employment than science/technology majors, while science/technology majors have a significantly higher rate of pursuing advanced degrees than engineering majors. This pattern is true for both male and female graduates.

It should be pointed out that this survey only identifies the employment status of the new graduates in the year 2005; it does not follow these graduates to find out their employment status in subsequent years.

3.3.2. Gender disparities in starting salaries

Table 6 shows the distribution of starting monthly pay by gender and by major. In general, regardless of gender, engineering graduates are better paid than science/technology graduates. At the same time, regardless of major, male graduates are better paid than female graduates. Specifically, starting salaries average ¥1637.41 per month for male engineering graduates, ¥1542.8 per month for male science/technology graduates; ¥1507.54 per month for female engineering graduates, and ¥1443.04 for female science/technology graduates. For all science and engineering majors, males earn ¥1614.3 per month, which is 9.0% higher than that the ¥1480.9 per month for females.

Table 5
Gender disparities on employment status among science and engineering graduates, 2005.

Employment status	Overall		Science/technology		Engineering	
	No.	% Female	No.	% Female	No.	% Female
Employed	3642	42.3	998	35.1	2644	49.3
Unemployed	1411	22.1	600	19.9	811	24.2
Pursuit for advanced degrees	1735	34.1	873	43.5	862	25.1
Other	77	1.5	30	1.5	47	1.4

Table 6
Gender distribution on starting salaries among science and engineering graduates, 2005.

	Mean	Standard deviation	Coefficient of variation
Overall			
Overall	1587	979	0.62
Male	1614	999	0.62
Female	1481	915	0.62
Science and technology			
Overall	1511	1161	0.77
Male	1543	1257	0.81
Female	1443	948	0.66
Engineering			
Overall	1617	896	0.55
Male	1637	899	0.55
Female	1508	890	0.59

Although science/technology graduates have lower average starting salaries than their engineering counterparts, the former have a larger standard deviation. In order to further understand the pattern of distribution of starting salaries by major and by gender, and to assess the level of dispersion in the salaries distribution, the coefficient of variation (standard deviation divided by the mean) for each group is also computed.

Table 6 shows that compared to science/technology graduates, engineering graduates have a higher average starting salary and a smaller dispersion in salaries distribution. Within science/technology majors, even though female graduates receive lower pay, the salaries distribution is smaller than that of their male counterparts. While within engineering majors, female graduates not only receive lower pay, they also face a larger dispersion in salaries distribution.

3.3.3. *Gender disparities in initial job placement*

The survey places employees into eight categories of jobs which are used in employment reports in China (see Table 7). The science and engineering students who graduated in 2005 fall mostly into four of the eight categories: governmental administration, business management, technical specialist, and technical support. Given the nature of the majors in question, most graduates in this study are employed in the position of technical specialist regardless of gender. Females have a slightly lower percentage of employment into this job (54.3–58.5%). But in the position of technical support, female have a higher percentage (19.9%) than male (17.3%). Table 7 also shows that female has a higher percentage of working in government jobs (12.0–8.2%) and, on the contrary, a lower percentage of working in business management (5.0–7.8%). In China, governmental jobs are seen to have higher job security than other jobs.

Comparing the position distribution among the graduates from different majors, one will find that females in science/technology majors have a higher percentage working in technical specialist positions, and a lower percentage working in technical support positions. And the pattern is reversed among engineering majors, with a higher percentage of females working in technical support, and a lower percentage of females working in technical specialist positions.

Table 7
Gender disparities in initial job placement among science and engineering graduates, 2005.

	All		Science and technology		Engineering	
	No.	%	No.	%	No.	%
Governmental administration						
Male	252	8.2	64	8.4	188	8.2
Female	115	12.0	51	12.7	64	11.5
Business Management						
Male	239	7.8	70	9.2	169	7.3
Female	48	5.0	23	5.7	25	4.5
Technical specialist						
Male	1794	58.5	400	54.9	1374	59.7
Female	519	54.3	242	60.3	277	49.9
Technical support						
Male	530	17.3	127	16.6	403	17.5
Female	190	19.9	56	14.0	134	24.1
Service						
Male	88	2.9	39	5.1	49	2.1
Female	37	3.2	16	2.5	21	3.8
Blue-collar worker						
Male	66	2.2	16	2.1	50	2.2
Female	19	2.0	5	1.2	14	2.5
Agriculture						
Male	6	0.2	3	0.4	3	0.1
Female	3	0.3	1	0.2	2	0.4
Other						
Male	91	3.0	26	3.4	65	2.8
Female	31	3.2	13	3.2	18	3.2

The average monthly pay for the aforementioned four major job categories are clearly different: ¥1943 for business management positions, ¥1699 for governmental administration positions; technical specialist positions are third at ¥1584 for technical specialist positions; and ¥1500 for technical support positions. Among the two management categories, business management positions pay better than governmental positions while among the two technical categories, specialist positions pay better than support positions. Male graduates are more likely to be employed into specialist positions while female graduates are more likely to be employed into support positions. Among graduates who chose to enter management/administration, females tend to enter governmental positions, while male tend to enter business positions. This trend might provide some explanation why male graduates have a higher average starting salary than female.

3.4. Factors influencing employment experience of graduates in science and engineering

3.4.1. Factors influencing initial employment status

The following logistic regression model is used to relate employment status (whether a graduate is employed in 2005) to a number of factors:

$$y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 \sum_{i=1}^{n} X_{4i} + \beta_5 \sum_{i=1}^{n} X_{5i} + \beta_6 \sum_{i=1}^{n} X_{6i} + \mu$$

In this model, y is the variable for employment status (1 for employed, 0 for unemployed), X_1 is dummy variable of gender of graduates (1 for males and 0 for females), X_2 is dummy variable of family residence location (1 for urban and 0 for rural), X_3 is dummy variable of institutional type (1 for "211 project" institutions, and 0 for "non-211" institutions), $\sum_{i=1}^{n} X_{4i}$ are dummy variables of academic performance (lowest ranking graduates as the reference group), $\sum_{i=1}^{n} X_{5i}$ are dummy variables of English test passage (CET Level VI graduates as the reference variable), $\sum_{i=1}^{n} X_{6i}$ are dummy variables of major (biology as reference major). The estimated employment equation is shown in Table 8.

Table 8 shows that gender, institutional type, choice of major have significant influences on the likelihood of employment. It indicates that male graduates' likelihood of being employed is 1.75 times that of female; graduates from "211" project universities (first-tier universities) are 1.19 times more likely to be employed than graduates from "non-211" universities (a credentialing effect). Graduates of mathematics, chemistry, computer, and engineering are respectively 2.73 times, 2.32 times, 3.93 times, and 3.89 times that of biology graduates to be employed. Only physics graduates are not statistically significant from biology graduates in their employment probability.

Four of the five variables related to academic performance (grades and CET results) are found not to be statistically significant. Only one such variable, "Excellent grades" is significant, which indicates that graduates with excellent grades are only 0.511 times as likely as graduates with the lowest grades to be employed. This is probably due to the fact that excellent grade graduates have a much better chance of getting admitted to the competitive advanced degree programs and they can choose between employment and continuing studies as two viable alternatives. Finally, location of residence is not a significant factor after other factors are controlled, even though earlier analyses show that there are access and major-related disparities between urban and rural areas.

Table 8
Factors influencing initial employment status among science and engineering graduates.

Independent variables	Coefficient (SE)
Being male	0.562* (0.071)
From urban	−0.178 (0.063)
"211" universities	0.17** (0.075)
Excellent grades	−0.671* (0.163)
Above average grades	−0.165 (0.161)
Below average grades	0.002 (0.170)
CET Level VI	−0.771 (0.072)
No CET passage	−0.046 (0.090)
Mathematics	1.005* (0.267)
Physics	0.328 (0.285)
Chemistry	0.841* (0.285)
Computer	1.369* (0.317)
Engineering	1.358* (0.190)
Constant	−1.177* (0.256)

Dependent variable: whether or not employed. $N = 6865$; R-square = 0.31.
* Significance at 1%.
** Significance at 5%.

3.4.2. Factors influencing starting salaries

In this study, two models are used to examine the factors that influence the starting salaries of science and engineering students who graduated in 2005. The first model is a one-equation model as follows:

$$y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 \sum_{i=1}^{n} X_{4i} + \beta_5 \sum_{i=1}^{n} X_{5i} + \beta_6 \sum_{i=1}^{n} X_{6i} + \beta_7 \sum_{i=1}^{n} X_{7i} + \mu$$

In this model, y represents the logarithm of starting monthly pay in Chinese Yuan, X_1, X_2, X_3, $\sum_{i=1}^{n} X_{4i}$, and $\sum_{i=1}^{n} X_{6i}$ are defined exactly the same as the previous model, $\sum_{i=1}^{n} X_{7i}$ is the variable of starting position using technical support job as the reference group. The result shows that grades in college have no significant impact on starting salaries after graduation. So we adjusted the model accordingly, dropped grades in college, and added the college entrance exam score into the model. In this model, academic performance variables (college entrance exam score, and the CET dummy variables) may be regarded as proxies for graduates' ability.

After controlling for various factors, gender remains a significant factor. The estimated equation using ordinary least-squares (OLSs) method in Table 9 shows that male graduates earn 7.1% more than female graduates.

Although location of resident is not a significant factor in the employment status equation, it is a significant factor

Table 9
Factors influencing starting salaries of science and engineering graduates, 2005: OLS and TSLS models.

Independent variables	OLS model: estimated coefficient (SE)	TSLS model: estimated coefficients (SE)
Male	0.071* (0.024)	0.099* (0.023)
Urban student	0.080* (0.019)	
"211" universities	0.213* (0.023)	0.270* (0.022)
College entrance exam score	0.001* (0.000)	0.006* (0.001)
CET Level VI	0.082* (0.023)	0.116* (0.023)
No CET passage	−0.108* (0.027)	−0.135* (0.025)
Mathematics	0.207** (0.100)	0.226** (0.10)
Physics	0.282** (0.113)	0.24** (0.113)
Chemistry	0.205 (0.114)	0.172 (0.113)
Computer	0.196 (0.110)	0.099 (0.109)
Engineering	0.310* (0.080)	0.278* (0.080)
Governmental administration	0.042** (0.014)	
Business management	0.046 (0.045)	
Technical specialist	0.050 (0.025)	
Service	0.024 (0.065)	
Agriculture	0.029 (0.067)	
Other occupation	−0.104 (0.065)	
Blue-collar	−0.288 (0.270)	
Social capital		0.020** (0.007)
Constant	6.208* (0.111)	3.727* (0.596)
R-square	0.34	0.42

Dependent variable: natural logarithm of monthly starting salary, $N = 6865$.
* Significance at 1%.
** Significance at 5%.

influence starting salaries; urban graduates earn 8.0% more than rural graduates. The type of institution (a credentialing effect) from which a student graduated also matters: "211" graduates earn 21.3% more "non-211" graduates.

Ability-related variables are also found to be statistically significant. For every 1 point higher in college entrance exam score, starting salaries will increase by 0.1%. Graduates with CET Level VI certificate earn 8.2% more than those with CET Level IV certificate.

The results for the different majors are mixed. Graduates in chemistry and computer majors have no significant difference in starting salaries from biology graduates. But graduates in mathematics, physics, and engineering earn significantly more than biology graduates.

For the seven job placement dummy variables in Table 9, only "governmental administration" shows a significant and positive salary advantage than the reference group of technical support jobs. The other six job positions show no statistically significant difference with the technical support group. This finding is consistent with the common observation of the keen interest of college graduates in government positions in China.

The second model is a two-equation model. One may observe that, in the first model, college entrance examination score is not a good measure of the innate ability of a graduate. This score is obviously shaped by many factors before the graduate gets into college. The second model thus uses a two-stage least-square (TSLS) method. In this model, the first equation relates the college entrance examination score as a dependent variable (CEES) to two factors: a socio-economic index of parents (SEI), and location of residence (urban = 1, rural = 0). The second equation relates the logarithm of starting salaries to six factors: estimated college entrance examination score from the first equation, gender (female as control), institutional type ("non-211" as control), CET dummies (Level IV as control), dummies for majors (biology as control), and a "social capital" dummy (1 if father has a management/administration occupation, and 0 otherwise).

To estimate the first equation, one needs to have a measure of the SEI of parents. This study makes use of the prior research on SEI by Li (2005). In her study, Li relates the SEI of a given occupation (based on a measure of the social reputation of the occupation) to the average education attainment (EDU) and the average monthly income (INCOME) of the occupation. Using national information from a survey of 12 provinces and 73 counties in 2001, Li obtained the estimated equation of $\text{SEI} = 10.868 + 3.496 \times \text{EDU} + 0.589 \times \text{INCOME}$. This estimated equation by Li is used in computing the SEI based on the occupation of the father of a graduate in this current study. The first equation of the second model is estimated to be $\text{CEES} = 529.781 + 0.356 \times \text{FATHER'S SEI} + 18.158\text{URBAN}$. The estimated value of CEES is used in the estimation of the second equation.

In the second equation, this study includes a measure of the "social capital" of a graduate's family, based on whether or not the graduate's father works in management/administrative position. Informal relationship (known as *Guanxi* in China) is an important asset in many aspects of Chinese life, including getting access to desirable jobs. This study assumes that fathers who are managers/administrators in China have more access to social network and resources. The estimated second equation of the second model is given in Table 9.

Table 9 shows that gender, institute type, college entrance examination score, and CET Level VI remain significant factor in the second model for science and engineering graduates: male graduates earn 9.9% more than female graduates, "211" graduates earn 27.0% more than "non-211" graduates, each point in the college entrance examination is associated with an increase of 0.6% in starting salaries, and CET Level VI graduates earn 11.6% more than CET Level IV graduates.

It is instructive to note the change in the size of the estimated coefficient for college entrance examination score. The coefficient of CEES in the second model is six times as large as that in the first model. Apparently, CEES in the second model captures the effect of location of residence as well as the socio-economic background of the family that is not included in the first model.

SOCIALCAPTAL, the new variable added to the second model, is also found to be significant and positive. Graduates with fathers in management/administration earn 2.0% more than those with fathers not in management/administration.

Table 9 indicates that different majors have different impact on starting salaries. Compared to biology, mathematics, physics, and engineering have a significantly positive impact while chemistry and computer have no significant impact.

Finally, R-squares increase from 0.34 in the first model to 0.42 in the second model. Thus, the second model 2 explains a larger proportion of the variation in starting salaries than the first model.

4. Summary and further research

Using a conceptual framework that draws upon previous studies inside and outside China, the study addresses four research questions on gender disparities in science and engineering in Chinese higher education. The purposes of the study are to document recent patterns in gender disparities in higher education in China and to examine the impact of gender on initial market experiences of science and engineering graduates. For each of the four research questions, the study finds that gender matters a lot and males have a clear advantage over females.

Analyses on gender disparities by major (Question 1) show that, overall, science and engineering graduates in 2005 consist of 73.9% males and 26.1% females. However, gender disparities in access vary by specific majors. Compared to males, females have substantially lower access to majors in physics and in engineering (the largest major). Although females are more represented than males in mathematics and in chemistry majors, their substantially lower participation in physics and engineering majors results in their lower participation overall in science and engineering majors. In addition, the analyses show significant variation in enrollment by major between urban graduates and rural graduates.

Analyses on gender disparities by academic performance (Question 2) show that, based on reported grade and CET test result, females are found to perform better than males in science and engineering majors. However, the reason for this finding is not apparent from the available information. There may be measurement error in self-reported academic performance so that the finding is not conclusive. Females may actually perform better than males because of self-selection.

Analyses on gender disparities by initial employment experiences (Question 3) show that, compared to their female counterparts, male science and engineering graduates have a 15.3 percentage point higher initial employment rate, and a 9.0% higher starting salaries. Compared to females, male science and engineering graduates are more likely to be employed in business management and technical specialist jobs but less likely in technical support and government administrative jobs.

Analyses of the factors influencing initial employment experiences (Question 4) show that in science and engineering majors, after controlling to other factors, males are 1.75 times as likely as females to secure initial employment after graduation, and males earn between 7.1% (based on first earnings model) and 9.9% (based on second earnings model) more than their female counterparts. In addition, the analyses find that institutional type (credential effect) and choice of majors have a significant effect on employment status. For starting salaries, institutional type, academic performance, and social capital are also significant factors. The impact of majors on starting salaries is mixed.

This study has thus demonstrated that there are clear gender disparities in enrollment in science and engineering majors in China. It points out that the disparities could be related to a range of socio-economic and family factors. However, it does not conclusively explain the sources of such disparities. In particular, it does not examine the relative influence between socio-economic factors and biological/physiological factors. Also, it does not examine the differential socialization process before college, when students are forming their views about science/engineering versus social sciences/humanities studies. The study does not examine the learning processes and experiences of science and engineering majors at the college level and ascertain whether there are significant gender disparities in such processes and experiences. The study does consider a couple of measures of academic performance but the effort is clearly inadequate. Understanding the sources of gender disparities is important for assessing inequity in education: whether such disparities are due to unfair practices or social biases again females and are thus inequitable or such disparities are a natural outcome of human biology and should not be considered inequitable. Future research may focus on these limitations of this study and of the current literature in China.

To understand the socio-economic consequences of gender disparity in higher education, it is necessary to also study gender disparity in the labor market, especially with respect to employment opportunity and earnings. According to findings in this study, female graduates performed significantly better than male graduates in both general course grades and English proficiency tests, but the initial employment rate after graduation is significantly lower. That in turn leads to a significant number of female graduates choosing to stay in school for advanced degrees so they can better their odds in the future competition for employment.

Among those who secured employment opportunities, female have significant lower average starting salaries than male. This male advantage persists even after controlling for factors such as family background, institutional type, major, academic performance, and job placement. It should be pointed out that the male advantage is found in initial employment, this study does not tell us whether such finding persists in later years. Anyway, there is a need for further research on subsequent employment and on understanding the sources of gender disparity. If such research demonstrates significant discrimination again females, then such disparity is clearly inequitable and should be adjusted. The government should continue on the effort to make and improve its legislation and policies against gender discrimination, and should take sincere interests in the implementation of such legislation and policies. On the other hand, employers should also adjust their perception of and attitude toward female employees and their rights. After all, without the wholesome and effective protection of women's legal rights in education and employment, there is no ground for discussion on the harmonious development of society.

References

Chen, Z., Xie, M., & Zhang, W. (2003). Analysis on China's gender equity in education opportunity and gender disparities in education output. *Higher Engineering Education Research*, *2* (in Chinese).

China National Bureau of Census. (2007). *2006 China national census yearbook*. Beijing, China: China Census Press.

Li, C. (2005). Prestige stratification in contemporary China: Occupational prestige measures and the socio-economic index. *Sociological Studies*, *2* (in Chinese).

Song, T. (2005). A preliminary analysis on the major causes for gender disparities in China's higher education opportunities. *Beijing Science and Engineering Academy Journal*, *9* (in Chinese).

Wang, X. (1999). Female's opportunities in higher education: Issues, causes and solutions. *Jimei University Journal, Philosophy and Social Science Section*, *3* (in Chinese).

Wen, D. (2005). Gender comparison in China's higher education opportunity, process, and employment. *Qinghua Higher Education Research*, *5* (in Chinese).

Ying, S., & Li, L. (2007). An empirical analysis of gender disparity in employment among college graduates. *Soft Science*, *1* (in Chinese).

Zhou, X. (2007). A historical review and reflection on China's gender disparity issue in education. *Shanghai Education Research*, *3* (in Chinese).