The Effects of Sibship Structure on the Decision of STEM Curriculum Track in Senior High School

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Abstract

This study tries to combine two lines of literature─the STEM education and the effect of sibship structure on educational attainment, and to investigate how sibship sex composition influences individual's decision of curriculum track. Using the Taiwan Education Panel Survey (TEPS) (N=8,039), the preliminary findings show that the effect of math achievement for girls is significantly higher than that for boys, and the positive effects of individual's educational aspiration on choosing STEM track is only present among girls, but not boys. Moreover, the students with opposite sex siblings incline to follow traditional gender values. Having sisters increases boys' probability to choose the STEM education, while having brothers decreases girls' probability to enter the STEM track. These results imply that the gender asymmetric influence of sibship sex composition on individual's educational opportunity might transfer from vertical stratification─educational attainment─into horizontal differentiation─STEM curriculum track.

keywords: STEM education, sibship sex composition, gender inequality

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Introduction

The majority of those who choose the STEM related curriculum track in senior high school are boys although the gap of math achievement between girls and boys declines overtime, as well as in Taiwan (Blickenstaff 2005; Chen and Weko 2009; Chen2013; Ma 2011; Xie et al. 2015). This gendered decision of curriculum tracking further influences sex segregation in college major and then in the occupational choice in the labor market. Previous studies regard gender as a personal characteristic which determines the way individuals are treated in the family or in school and discuss how family or school, as a gatekeeper of traditional values, practices the traditional gender expectation on children/students. Parental expectation influences children's decision of their major and occupation, and this expectation differs regarding children's gender. Peng and Hsung (2011) finds that parents have higher expectations for sons, while they tend to practice a "looser" way to educate their daughters. In school, teachers inclines to provide more feedbacks and supports to male students with higher expectation for their math achievement (Jussim and Eccles 1992).

However, gender is a dynamic "doing" process in daily lives rather than a static characteristic. The effects of individual's gender on choosing STEM track will interact with the environment they are situated. Some studies have considered the interaction between students' gender and gender environment in school. The female STEM role models in high school increase girls' incentive to choose STEM education (Bottia et al. 2015; Chen 2013). Chen(2013) find that students taught by female math teachers during junior high school are more likely to break the traditional gender belief "natural science is a male domain", that is, girls are more likely to select the STEM program, while boys are less likely to choose the STEM program. Moreover, Booth et al. (2014) state that same sex learning environment in school reduces girls' exposure to gender-stereotypical environment and hence encourages them to make decision of college majors beyond the traditional gender norms. Yet, less literature (except Brenøe, A. A. 2017 and Oguzoglu and Ozbeklik 2016) discusses the role of family in the process of choosing the STEM track regarding the interaction among individuals, parents, and siblings.

In the line of literature about the effects of sibship structure on educational attainment, in society with Confucian influence, such as Taiwan, filial piety stipulates that sons should maintain the fame of a family (Yeh and Beford 2003), and thus parents have more incentive to invest greater resource or have higher aspiration to their sons (Greenhalgh 1985). Empirical studies have found the gender-based transfer of intra-family resources in the countries where follow the Confucian tradition of son preference. Parish and Willis(1993), Yu and Su (2006), Chu et al. (2007), and Chang and Li (2016) have shown that women with younger siblings have lower educational attainment. Moreover, Chang and Li (2016) find that the positive effects of having an additional older sisters on educational attainment tend to disappear once social norm no longer support son preference, such as low fertility and higher education expansion. The literature of sibship sex composition emphasizing the interaction of individual's gender and their siblings' gender in the family mainly focuses on the effects on educational attainment, but does not consider the horizontal differentiation of education which is thought an important determinant of gender gap in earnings in the labor market (Shauman 2006).

In this study, I try to contribute to two lines of literature─the STEM education and the effect of sibship sex composition on educational opportunity. On the one hand, I would like to bring "the dynamics of family" into the literature of the STEM education. How parents treat their children does not just depend on children's gender, but also other siblings' gender. Mixed sex children reinforce parental gender stereotypical parenting behaviors (Oguzoglu and Ozbeklik 2016). Parents will have higher expectation for their sons and might encourage sons to choose STEM education, while they tend to follow the traditional gender values and not to inspire their daughters to STEM education. Also, children construct their self-identity during the process of interactions with their parents and siblings. Girls who are more exposed to the gender-stereotypical environment within the family are less likely to choose STEM, while boys under the same situation will have higher incentive to select STEM education. On the other hand, this study aims to extend the effects of sibship sex composition from educational attainment to the decision of STEM program. It is especially meaningful in the context of son preference in Taiwan. The effects of sibship sex composition on educational attainment will disappear once education is no longer scarce resource (Chang and Li 2016), but parents might manipulate son preference or traditional gender values in subtle ways and then maintain the gender inequality in the labor market.

Method

Data and Variables

The data for this study come from the senior high school students sample of the Taiwan Education Panel Survey (TEPS) which is a multistage stratified probability sample of the higher student in Taiwan. After listwise deletion of individuals with data missing from any variables, the analytic sample includes 8,039 individuals.

The dependent variable in this study is the decision of STEM curriculum track (the STEM track=1, natural science program; the non-STEM track=0). The main independent variables is sibship sex composition-- whether the respondent has opposite sex shiblings-- constructed from the survey question, “how many elder/younger brothers/sisters do you have?” Other independent variables are the math achievement and educational aspiration (whether the respondent expects themselves to attend graduate school=1). Control variables include gender (female=1), parents' highest education (years of schooling), family income, private school.

Method

In this study, I estimate logistic regression model to predict individual's decision of STEM curriculum track, and add the interaction term of gender and independent variables in this study, including having opposite sex siblings, math achievement, and high educational aspiration. In future analysis, I will further discuss how father's occupation influences children's decision of STEM education and whether this effect differs by children's gender and the sex composition of children.

Results

To begin with a description of the sample (summary statistics in Table1) . The majority of boys choose the STEM related curriculum track in senior high school (64%), while only 29 percent of girls enter the STEM curriculum track. Boys are much more likely to choose STEM. More than 70 percent of girls have brothers, whereas 57 percent of boys have sisters. This gender difference appears to result from a slight son preference in childbearing behaviors such that parents of daughters tend to have more children (especially sons) than parents of sons.

Table 2 shows the estimates of gender differences in individual's decision of entering the STEM track. Model 1 presents the effects of independent variables without interaction terms, and Models 2 to 5 further add the interaction terms of gender and the independent variables, including math achievement, educational aspiration, and the sibship sex composition, to investigate the gender differences in choosing STEM track.

In Model 1, students with better math achievement and high educational aspiration are more likely to choose STEM related curriculum track, but the effect of having opposite sex siblings is not significant. Model 2 shows that the effect of math achievement for girls is significantly higher than that for boys, that is, girls only when they have particularly outstanding performance in math will choose the STEM track. Additionally, the positive effects of individual's high educational aspiration on choosing STEM track is only present among girls, but not boys. Boys always have higher probability to choose STEM track regardless of their educational aspiration. In Model 4, the students with opposite sex siblings incline to follow traditional gender values. Having sisters increases boys' probability to choose the STEM education, while having brothers reduces girls' probability to enter the STEM track. These results suggest that although we have found that son preference in educational investment will likely disappear when education is no longer rare resource , especially in the current low fertility and higher education expansion contexts in Taiwan (Chang and Li 2016), the forms of the practice of son preference within the family might change. The gender asymmetric influence of sibship sex composition on individual's educational opportunity might transfer from vertical stratification ─educational attainment─ into horizontal differentiation ─STEM curriculum track.

References

Blickenstaff, Clark, J. (2005). Women and science careers: leaky pipeline or gender filter?. *Gender and Education,* 17(4), 369-386.

Booth, A., L. Cardona-Sosa, and P. Nolen (2014). Gender differences in risk aversion: Do single-sex environments affect their development? Journal of economic behavior & organization 99, 126-154.

Bottia, M. C., E. Stearns, R. A. Mickelson, S. Moller, and L. Valentino (2015). Growing the roots of stem majors: Female math and science high school faculty and the participation of students in stem. Economics of Education Review 45, 14-27.

Brenøe, A. A. (2017). Sibling Gender Composition and Preferences for STEM Education.

Chang, Yi-Chun, and Jui-Chung Allen Li. (2016) Changing educational effects of sibship sex composition in Taiwan. *Chinese Sociological Review* 48(2), 83-107.

Chang, Yi-Chun, and Thung-Hong Lin. 2015. "How does the Expansion of Higher Education Reproduce Class Inequality? The Case of Taiwan." *Taiwan Journal of Sociology of Education* 15(2): 85-129.

Chen, X., & Weko, T. (2009). Students who study science, technology, engineering, and mathematics (STEM) in *Postsecondary Education: U.S. Department of Education NCES 2009–161.*

Chen Wan-chi. (2013) Causes and consequences of high school curriculum-track selection: gender, belief, teacher's gender, and cognitive development. *Taiwan Sociology* 25, 89-123.

Chu, C. Y. Cyrus, Yu Xie, and Rouh-rong Yu. (2007). Effects of structure revisited: evidence from intra-family resource transfer in Taiwan. *Sociology of Education* 80, 91-113.

Greenhalgh, S. (1985). Sexual stratification: the other side of ‘Growth with Equity’ in East Asia. *Population and Development Review* 11: 265–314.

Jussim, L., &Eccles, J. S. (1992). Teacher expectations: II. Construction and reflection of student achievement. *Journal of Personality and Social Psychology*, 63(6), 947-961

Ma, Y. (2011). Gender differences in the paths leading to a STEM baccalaureate. *Social Science Quarterly,* 92(5), 1169-1190.

Oguzoglu, U. and S. Ozbeklik (2016). Like father, like daughter (unless there is a son):Sibling sex composition and women's stem major choice in college. IZA DP No. 10052.

Parish, W. L., and R. J. Willis. (1993). Daughters, education, and family budgets taiwan experiences. *The Journal of Human Resources* 28: 863–98.

Peng, Li-Hui & Ray-May Hsung. (2011) Gender beliefs in choosing college majors and occupations in Taiwan. *Review of Social Sciences*, 5(1), 85-138.

Shauman, K. A. (2006). Occupational sex segregation and the earnings of occupations: What causes the link among college-educated workers?.*Social Science Research*, 35(3), 577-619.

Xie, Y., Fang, M., & Shauman, K. (2015). STEM education. *Annual review of sociology*, 41, 331-357.

Yeh, K.-H., and O. Bedford. (2003). A test of the dual filial piety model. *Asian Journal of Social Psychology* 6: 215–28.

Yu, Wei-Hsin, and Kuo-Hsien Su. (2006). Gender, sibship structure, and educational inequality in Taiwan: son preference revisited. *Journal of Marriage and Family* 68:1057-1068.

Table 1. Descriptive Statistics (by gender)

	Male		Female		Total	
	mean	sd	mean	sd	mean	sd
STEM Track	0.64	0.48	0.29	0.45	0.46	0.50
School in the City	0.63	0.48	0.61	0.49	0.62	0.48
Private School	0.27	0.44	0.25	0.43	0.26	0.44
Female	-	-	-	-	0.51	0.50
Math irt-score	2.50	1.04	2.30	0.94	2.40	1.00
Parents' Year of Education	13.28	2.87	13.18	2.86	13.23	2.86
Family Income	73592.72	42643.75	71418.77	41634.31	72489.12	42145.72
Self Educational Expectation (graduate school)	0.56	0.50	0.58	0.49	0.57	0.50
Having Opposite Sex Siblings	0.57	0.50	0.71	0.45	0.64	0.48
N	3958		4081		8039	

Table 2. Gender Differences in the Effects of Sibship sex composition on Choosing STEM Curriculum Track

	Model1	Model 2	Model 3	Model 4	Model 5
School in the City	-0.069	-0.075	-0.071	-0.073	-0.080
	(0.053)	(0.053)	(0.053)	(0.053)	(0.054)
Private School	-0.254***	-0.247***	-0.249***	-0.251***	-0.241***
	(0.060)	(0.060)	(0.060)	(0.060)	(0.060)
Female	-1.511***	-2.092***	-1.700***	-1.361***	-2.034***
	(0.051)	(0.153)	(0.080)	(0.084)	(0.172)
Math irt-score	0.601***	0.513***	0.604***	0.602***	0.526***
	(0.029)	(0.036)	(0.029)	(0.029)	(0.036)
Parents' Years of	0.032**	0.031**	0.032**	0.032**	0.031**
Education	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Family Income	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Self Education	0.217***	0.216***	0.066	0.218***	0.099
Expectation	(0.052)	(0.052)	(0.071)	(0.052)	(0.071)
Having opposite	0.049	0.049	0.049	0.153*	0.146*
Sex Siblings	(0.053)	(0.053)	(0.053)	(0.071)	(0.070)
Interaction with					
gender					
Female* Math		0.233***			0.207***
		(0.057)			(0.058)
Female* Self			0.321**		0.257*
Edu Expectation			(0.103)		(0.104)
Female*Opposite				-0.234*	-0.225*
Sex Siblings				(0.105)	(0.106)
_cons	-1.371***	-1.144***	-1.296***	-1.427***	-1.163***
	(0.141)	(0.150)	(0.143)	(0.143)	(0.153)
N	8039	8039	8039	8039	8039