GENDER INEQUALITY IN COLLEGE ENROLLMENT AND STEM MAJOR IN U.S. 1980-2013: A FAMILY RESOURCE PERSPECTIVE

By

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ABSTRACT

GENDER INEQUALITY IN COLLEGE ENROLLMENT AND STEM MAJOR IN U.S. 1980-2013: A FAMILY RESOURCE PERSPECTIVE

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The goal of this dissertation is to understand the gender gap in college enrollment and participation in STEM majors, considering changes in family size and mothers' labor force participation. Different types of family resources and gender-specific family contexts that affect children's college enrollment and STEM participation were explored. I employ a three-article format to examine the links between (1) the trend in the number of siblings, family resources, and the transition into college; (2) the relationship of sibling configuration, sibship-gender composition, and family resource allocations to college enrollment; and (3) the effect of married mothers' employment on children's participation in STEM related majors.

My first article shows that females' advantage in college enrollment is associated with number of siblings and family resource allocation. This female advantage in college enrollment strengthens over time and widens between smaller and larger families.

My second article draws from the resources dilution model and gender development literature to identify new advantages in college enrollment emerged from smaller families, daughters in the sibling gender majority position, and families with greater socio-cultural resources. The third article examines the effect of married mothers' employment, found that mothers with full-time or high prestige jobs had a positive effect on children's participation in STEM in the most recent cohort. School achievement, math self-efficacy, and parents' expectations are linked to mothers' role and schooling processes. Taken together, these results demonstrate that the presence of specific family contexts, family resources, and mothers' roles may exert a net positive effect on

children's college opportunities and STEM interests. In investigating these three linkages I show how the number of siblings, sibling composition, maternal employment, and family resources affect female advantage in college enrollment and STEM participation.

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CHAPTER ONE

THE FAMILY ADVANTAGE IN THE TRENDS OF SIBLING SIZE:EXAMINING THE RELATIONSHIP BETWEEN FAMILY RESOURCES AND COLLEGE ENROLLMENT

Introduction

In the United States, the proportion of women obtaining a college degree or higher has reached an apex (DiPrete & Buchmann, 2013). This female advantage in college attainment has increased since the 1980s (NCES, 2014). Yet, the female advantage in college attainment remains significant, despite a substantial demographic change: the growing importance of mothers in the labor market and household. Whether or not the demographic changes associated with increased family resources have contributed to the female advantage remain underexplored.

Several explanations have been suggested for the increasing gender gap in college enrollment, including the occupational incentive, attitudes towards gender roles, and the growth of educational returns and family expectations (Cho, 2006; Goldin, Katz, &Kuziemko, 2006; Jacobs, 1996; Sweeney, 2002; Flashman, 2013). However, little is known about whether families preserve the family advantage by differential fertility (Vogl, 2016) and parental investment in children's education (Lareau, 2003; Steelman& Powell, 1989). The increasing number of college-educated mothers and their decision about the number of children may facilitate the preservation of the family advantage and daughters' opportunities to attend a four-year or selective college (Mare & Maralani 2006). To fill the gap, this study examines the extent to which potential factors influence the female advantage in college enrollment in the context of demographic changes over two decades. This study aims to answer the following research questions: (1) has the female advantage in college enrollment changed over time? (2) has the female advantage in four-year college enrollment widened compared to two-year college enrollment? (3) has the female advantage in

4-year college enrollment widened over time? (4) has change in the female advantage in college enrollment diverged between small and large families? (5) to what degrees do family resources explain the female advantage in two-year and four-year college?

The goal of this study is to examine the relationship between sibling size, family advantage and the gender gap in college enrollment using three cohorts of high school seniors in the High School and Beyond 1980 (HS&B), the National Education Longitudinal Study 1988 (NELS 88), and the Education Longitudinal Study of 2002 (ELS02). These three datasets are nationally representative surveys and are consistent with the birth cohort after 1965-66, which has been identified as a period of children who grew up during a time period when women began to outpace men in college enrollment and graduation rates.

Background

The Shifting of Family Culture and Investment in Children College Education

Women's participation in the labor force and college education has increased since the 1980s. Increasing numbers of women have earned college degree and economic independence over time (Oppenheimer, 1994, 1997; Sweeney, 2002). According to Oppenheimer both women and men tend to postpone marriage and parenthood because of higher education and career uncertainty. When women and men postpone marriage and parenthood after obtaining a college degree, they are more likely to enter a marriage and have a stable job, compared to those without a college degree. According to this argument, families with college educated parents may have more family resources in terms of better human resources, marital disposition and stable jobs.

College-educated mothers are less likely to have children outside marriage and are more likely to have smaller number of children at home than less educated married mothers and cohabiting mothers (McLanahan & Percheski, 2008; Sweeney & Raley, 2014). In contrast, less-educated women are more likely to bear children outside of marriage and to have multiple partners over their children's life course (Cherlin, 2010; Chiappori, Iyigun, & Weiss, 2009). Family structure and number of children at home are associated with children's educational opportunities, and affect the availability of family resources that parents can draw upon to raise their children.

The family production hypothesis is especially notable in Becker's Human Capital theory, which emphasized that "the production of family capital is in the form of investing in children's human capital" (page 64). Schultz (2007) and Becker and Tomes (1976) also found that parents may choose to have fewer children in order to increase the quality of family reproduction and through increasing family investments. From this perspective, families with fewer children are more likely to make greater investments in their children.

In addition to human capital theory, the number of siblings also has theoretical significance in the resources dilution model and stratification literature. Previous research has suggested that the number of sibling s is associated with children's achievement and post-secondary education (Powell & Steelman, 1989; Steelman & Powell, 1989, 1991). For example, Powell and Steelman (1993) found that children living in families with more siblings perform worse in school and have lower GPAs. Conley and Glauber (2006) also found that increasing number of siblings reduces the children's attendance at a private high school and four-year college enrollment. Along with the demographic changes of the decline in the number of children per family, I expect the children's four-year college opportunities may change in response to smaller families. Smaller families refer to families with one or two children in this study and this tendency in terms of demographic changes may boost daughters' educational opportunities compared to sons' opportunities. I propose the following hypotheses:

(H1) The female advantage in college enrollment is increasing over time.

(H2) The female advantage in four-year college enrollment is larger than in two-year college enrollment.

However, the gap in this line of research is less concerned with the rise of women's position in the household. When mothers contribute to family income, they may have more control over the allocation of family resources among children. This bargaining position puts more weight on mothers' decision-making and preference in how to distribute family resources towards daughters' or sons' college education (England 2010). This gender-specific perspective emphasizes that the family culture and investment have increased simultaneous with increases in mothers' college education, labor force participation, and the declining number of children at home (Behrman & Rosenzweig, 2002; Mare & Maralani, 2006; Suitor, Plikuhn, Gilligan, & Powers, 2008). This perspective also suggests that the growth of mothers' resources may have a greater effect on daughters than on sons, and considers this as evidence of a gender-specific cultural socialization processes. This leads to the third and fourth hypotheses:

(H3) The female advantage in 4-year college enrollment is widening over time.

(H4) The female advantage in college enrollment is widening over time between children from small families and those from large families, and this gender difference is larger in the later cohort.

Changes in Family Investment and Family Resources

Structural advantages of family resources have become more important in shaping gender parity, especially in respect to those resources that parents are more likely to invest in daughters, rather than sons. For example, parents' investment strategies differentiate resource allocation by children's achievement and sex (Conley & Glauber, 2006; Lee, 2008). Some scholars have emphasized that parents' perception about their children's school performance determines their resource allocation and willingness to provide financial support for college tuition (p.192) (Crosnoe, 2001; Eccles& Harold, 1993). As a result, parents tend to favor investment in daughters because they are more likely to have a higher GPA in high school compared to sons. In addition to school achievement, changes in gender-role attitudes have also shifted parents' values about the importance of college education. Thus, daughters with higher school achievement are more likely to receive more family resources and parental investment in college education than sons.

American societal norms have arrived at a consensus that parents allocate their resources equally among children. However, the growth of non-traditional families and multiple partner fertility may shift this consensus in response to family composition and the availability of family resources at home. Family resources refer to monetary and non-monetary investments, use of time, parent-child interactions and social-psychological supports. According to this definition, family resources can be categorized into four types: 1) social-psychological, 2) financial, 3) cultural, and 4) social resources. Socio-psychological resources refer to parents' encouragement and expectations of their children to obtain a college education. The effects of parents' encouragement and expectations have been examined in the Status Attainment and Wisconsin models (Andrew & Hause, 2011; Scritchfield & Picou, 1982; Sewell & Hauser, 1980). Parents' decisions regarding resource allocation may reflect their relationship and emotional distance with their children. Crosnoe (2004) identified that parent-children communications serve as an important social-psychological process that may facilitate resource allocation towards children's higher education. Financial resources refer to the educational items that a family provides for targeted children. Previous research has shown a positive relationship between educational items and children's school achievement, particularly for books, computers and school-related materials

(Degraaf 1986). Cultural resources represent how well parents prepare their children for school, which serve as indications of parents' values about the importance of schooling (Lareau, 1999; Lareau & Weininger, 2003). Social resources refer to the family-school connection in regards to how parents participate, communicate, and interact with school teachers, activities, and organizations (Kim & Schneider, 2005; Schneider & Coleman, 1993). For example, parents' involvement in school related activities can enable them to access more information about school learning opportunities, which may help their children's development and achievement (Perna, 2006). This line of research leads to the fifth hypothesis:

(H5) The role of family resources in explaining the proportion of female advantage in college enrollment is increasing over cohorts and this tendency is more pronounced for four-year college enrollment than two-year college enrollment.

Data and Methods

Data

In order to answer these questions, I utilize data that includes the number of siblings at home, family resources, parents' investment strategies and measures of children's non-cognitive skills and cognitive achievements so that I can demonstrate the effect of inter- and intra-family gender-specific resources on the decision to enroll in college. In addition, covariates that measure children's school performance and college preparation in early adolescence are used contemporaneously, rather than retrospectively. I use follow up data to track how early school performance and parents' educational investment affect later college enrollment. My data offers reasonable comparability in these measures across birth cohorts. I am able to meet these data requirements by using survey data on three cohorts of 10th grade students: High School and

Beyond 1980, the National Education Longitudinal Study 1988, and the Education Longitudinal Study of 2002. These data sets allow me to compare three cohorts of 14-to-20 year old youth interviewed in 1980, 1988, and 2002 and who had at least three follow-up waves of data. These survey cohorts are consistent with the birth cohort after 1965-66, which has been identified as a period of children who grew during a time when women began to outpace men in college enrollment and graduation rates. I describe each of these surveys in more detail below.

The first cohort comes from the sophomore class survey of High School and Beyond (HS&B), a nationally representative sample of high school sophomores first surveyed in 1980. The sample includes information on family background, standardized test scores, non-cognitive traits, college enrollment and achievement for 27,683 sophomores from 988 schools across the US. A total of 14,670 students were included in the sample across all 5 waves.

The second cohort comes from the National Education Longitudinal Study of 1988 (NELS88). NELS88 started with a survey of a nationally representative sample of 8th graders (aged 14), who also participated in the first follow-up study two years later in 1990, when respondents were in 10th grade. In this study, I focus on 10th graders who participated in the first follow-up survey. The follow-up data offers the same variables as the base-year survey (1988), including standardized test scores, non-cognitive skills, and family characteristics. The later waves describe college enrollment and achievement. The first follow-up study covers 16,589 high school sophomores originally interviewed in 1990.

The third cohort comes from the Education Longitudinal Study of 2000 (ELS 2002), a nationally representative sample of 10th graders in 2002. The study provides information on cognitive, as well as non-cognitive skills. The sample includes about 12,441 students from 750 schools across the US.

Measures of Independent and Dependent Variables

Dependent Variables

My outcomes of interest include whether a student is enrolled in college, and whether the student is enrolled in two-year or four-year college. College enrollment is defined by enrollment in a first postsecondary institution for at least 6 months, which distinguishes between (a) students who enrolled in any postsecondary college, and (b) students who enrolled in a 4-year college. My college enrollment outcome measures whether 10th graders enrolled in college two years after high school graduation.

School GPA measures the overall average high school grades in HS&B in the third wave of follow-up data and average school GPA in NELS base year survey data. In the ELS second wave follow-up data, GPA was measured for all courses taken in the 9th through 12th grades. To make comparisons between datasets, I use the quartile coding of GPA composite, ranging from 1 to 4 across the three data sets.

I also measure student high school achievement by generating Naïve Percentile-Ranking with 10th graders' composite standardized test score (including reading and math). I recognize that there is a huge difference between different standardized procedures and test composite scores across datasets. To accomplish this analysis, I applied a simple linear equating procedure to generate a percentile-ranking based on the standardized test composite score (Friedkin & Thomas, 1997). This percentile-rank represents the relative position of test-score compared to other students in each survey cohort. This procedure makes a cohort comparison possible. Although transcript data is another option to link student performance across three data sets, it produces many missing cases when students drop out of high school. I also include the overall GPA in the final model and the main findings are still consistent across models.

Independent Variables

(1) Number of siblings. All three data sets asked (in various ways) "the number of siblings that 10th grader had" in the HS&B data. In the NELS data, respondents were asked about the number of siblings in both the student and parent surveys. In the ELS data, 10th grade respondents were asked about "the number of siblings living with the 10th grade respondent."

(2) Family Structure (Arrangement). The measure of family structure in this study can only distinguish between four types of family arrangements with 10th graders living at home: (1) intact family: represents children living with both biological parents, (2) step-family: represents children living with mother and male guardian; father and female guardian, (3) single family: represents children living with mother only or father only, (4) other guardians/relatives: represents children living with relatives or guardians. I do recognize the limitation of this measure, but the HS&B survey did not provide clear and exclusive information about parents' marital status or the duration of marriage (Astone & Mclanahan, 1991). To make a reliable comparison across three datasets, I use this variable to represent the family structure.

(3) Family Resources. There are five types of family resources measured in this study that are available to compare across cohorts. The first type of family resource indicates parents' human resources, which were measured by fathers', and mothers' highest educational achievement. To make a comparison across three data sets, I follow the same scale (6 categories, See Appendix B, Table 1) to recode fathers' and mothers' highest level of education. In HS&B, I used information reported from students to construct the education composite and substituted parent self-reported information. In NELS:88 and ELS:2002, parent self-reported information was used to construct the education composite; student-reported parent education was substituted when parent

information was missing. I also include the level of education for both mother and father in the analysis if the survey provided information.

The second type of family resource indicates (educational) material resources at home. I measure how many educational items are available at home, which included four harmonizing items in three datasets: (a) family has a daily newspaper, (b) family has a computer, (3) family has more than 50 books, and (4) child has his/her own room. I generated this measure by taking the sum of all four items at home. One hypothesis is that families with sons are more likely to have more educational materials than those with daughters (Conley & Glauber, 2006; Steelman & Powell, 1991). This trend may shift rapidly in the later cohort and is more likely to support daughters' educational opportunities, as well as sons' opportunities.

The third type of family resources indicates family socio-psychological resources in terms of parents' educational expectations in pursuit of higher education. There is an abundance of literature to support the effect of parents' educational expectation (Morgan, 1998, 2006), and expectation from significant others (Cheng & Starks, 2002; Scritchfield & Picou, 1982). For this study, I recode the original educational expectation into seven categories across three data sets. Both the NELS and ELS data also included a "don't know" option on the questionnaire. In this study, I aim to use students' perceived parents' educational expectation as a social-psychological factor. I assume that the higher the parental expectations students are exposed to, the higher academic pressure that students perceive from parents. In this setting, if students report that they don't know about their parents' expectations, this implies less perceived pressure from parents.

The forth type of family resource indicates family and cultural resources in relation to school value. I measure the school preparation for 10th graders at home, which includes three identical items among three data sets: (1) how often the student goes to class without pencil/paper; (2) how often the student goes to class without books; (3) how often student goes to class without homework done. I recoded the original scale with 1 indicating “frequently” and 4 as “never”. This measure also takes the sum of all three items, ranging from 0-12.

The fifth type of family resources indicates social resources for parents participating in school related organization, activities, and meetings. I measure how many school related activities that parents ever participated in at their 10th graders’ school, which includes four identical items among three datasets. This measure takes the sum of four types of activities: (1) how often parents attend school meetings; (2) how often parents phoned teacher/ counselor; (3) how often parents attended school event; and (4) how often parents acted as a volunteer at their 10th graders’ school.

(4) Other Covariates. Family SES: I also included the family SES composite score as a covariate in the model. The family SES composite score is determined by education and occupation of the head of the family and total family income. School-level characteristics include region, school type (Public, Private, or Catholic) also included in the model. For region, I generated three dummy variables and north-east serves as the reference group. For type of high school, public school serves as a reference group. I recoded all variables with a similar scale across all three data sets and use those with similar scale to take the sum of each resource variable. I account for missing cases for all independent variables by generating missing flags and include this in the final model. For the weighting procedures, I report current results based on the weight of panel data, which accounted for the potential attrition rate of panel data is in the post-secondary outcomes.

Analytic Methods

Table 2 shows descriptive statistics of college enrollment, number of siblings and family resources by gender and cohort. I start with simple logistic regression where college enrollment is regressed on cohorts and gender difference by five dummy variables, explanatory variables and other covariates. Model-1 provides a baseline estimate of cohort and gender differences in college enrollment controlling for school percentile ranking, mothers' education, family structure, family SES, students' expectation, high school types, region, race and ethnicity. I then add the key explanatory variables, such as number of siblings and each of the family resources in a nested model fashion to identify the degree to which number of siblings and family resources explains gender and cohort gaps in college enrollment.

A t-test was applied to examine the gender and cohort effects of the linear combinations. The results of the t-test are reported in the bottom panel among tables. "Yes/ No" indicates whether there is a significant difference in the logged odds of enrolling in college between cohorts among females and males. "Female/ Male" indicated whether there is a significant gender difference in the logged odds of enrolling college within cohorts. I also account for clustering in high schools by obtaining robust standard errors in all regression analyses.

The next step is to apply a t-test to examine whether the effects of two explanatory variables are changing for men and women across cohorts. The college enrollment rate for females in the 1980s serves as the reference group in all models. I adopt the approach of the cohort perspective to understand the relationship between family resources and female advantage in college enrollment patterns (Flashman, 2013). To visualize the opportunity differences between gender and cohort, I plot the predicted probability of college enrollment based on Model 3 at Table 3 in Figure 2.

The last step is to examine whether two-year and four-year college enrollment patterns vary by gender and cohorts, conditional on changes in the number of siblings and family resources. By applying multi-nominal logistic regression model, I examine the likelihood of attending two-year and four-year colleges, compared to those not enrolled in any post-secondary education two years after high school graduation.

In this analysis, I focus on the three way-interactions between gender, cohort, number of siblings and family resources variables. In the table, I assess whether the main effects of college enrollment varied significantly across cohorts and whether these effects differ between females and males. In the bottom of the table, I also apply a t-test to examine whether the effects are significantly different in a cohort-by-gender manner, such as whether the effect of four-year college enrollment for daughters in 1980 is statistically different from the effect of four-year college enrollment for daughters in 2002. I present multi-nominal logistic regression coefficients in Table 4 and plot the predicted probability in Figure 3 and Figure 4.

Results

Trends in Number of Siblings, Family Resources and College Enrollment

The proportion in Table 2 showed increasing rates of college enrollment within and across cohort-gender subgroups. The results showed significant growth in college enrollment, especially for women. Among the 1980 cohort, 63% of women attended college and this trend continued to increase to 71% in the 1988 cohort, and 79% in the 2002 cohort. By contrast, 56% of men attended college in the 1980 cohort, and this trend continued to increase to 66% in the 1988 cohort, and 71% in the 2002 cohort. The gender gap in college enrollment was about 7% in 1980, and slightly decreased in 1988, but increased to 8% in the later cohort of 2002. The gender gap in college enrollment was observed across all pathways.

Two major explanatory variables in terms of number of siblings and family resources were considered in the analytical model, along with a cohort-by-gender linear combination of a series of dummy variables. This study expected that the declining number of siblings and increases in certain types of family resources may explain the growing gender gaps in college attendance and the patterns of two-year college enrollment and four-year college enrollment.

The average number of siblings decreased from 1980 to the 2002. This implies that the growth trend of living in a smaller family was consistent for both families of daughters and families of sons. The proportion of step-families and single-families also increased over time. Eleven percent of daughters lived in a step-family in 1980, and this increased to 15% in 2002. In contrast, only 8% of sons lived in a step-family in 1980, and this increased to 15% in 2002. Moreover, 17% of daughters lived in a single family in 1980, and this increased to 21% in 2002. This tendency was also observed for sons.

Family resources in terms of materials, socio-psychological, cultural, and social also increased over cohorts, except for social resources in the ELS cohort. Family material resources and socio-psychological resources also showed significant gender differences among cohorts. The proportion of college educated mothers increased over cohorts. Following this trend, the proportion of mothers with some college increased more rapidly than mothers who graduated from college.

Table 3 shows the results for the logistic regression. The top of the table reports the logged odds of college enrollment estimates compared to those who are not attending college. Beginning with the main effect of cohort-gender difference, I found that the female advantage in college enrollment held across cohorts in Model-1, controlling for number of siblings, relative percentile ranking, and other demographic characteristics. The cohort difference among females' college enrollment was significant compared to the 1980 cohort and increased over cohorts compared with the 1980 cohort. A daughter from the 1988 cohort with the same percentile ranking class rank, family SES, and other covariates as a daughter in the 1980 cohort had an odds 1.43 times that of a daughter in the 1980 cohort of attending college ($e^{.361} = 1.43$). That same daughter would have odds more than 1.61 times those of the 1980 daughter if she were a member of the 2002 cohort. This finding confirms the first hypothesis: the female advantage in college enrollment increases over time. On the other hand, the cohort difference among males' college enrollment was also significant compared to the 1980 cohort. However, the gender difference among cohorts in the bottom panel of table 3 showed a significant advantage of college enrollment in favor daughters over sons.

What role does number of siblings play in this gender gap? Model 2 describes the cohort-gender difference in college enrollment controlling for differences in number of siblings, percentile ranking of school achievement, and other covariates. The results show that the cohort-gender difference decreased after number of sibling was controlled for in the model. As the results suggest, with the inclusion of number of siblings, the female advantage coefficient decreased approximately 5% in the 1988 cohort, and 7.5% in the 2002 cohort. The cohort difference among females and among males was still observed. Moreover, number of siblings was negatively associated with college enrollment. This confirms the second hypothesis: the presence of an additional sibling at home decreases the opportunities for college enrollment. Figure 2 shows that the predicted probabilities of college enrollment for each cohort-gender subgroup at different number of siblings. In the HS&B cohort, the female advantage in college enrollment dropped immediately with an additional sibling at home, compared to females in single-child families. In the NELS cohort, the female advantage in college enrollment remained at a similar level, with up to three additional siblings. This trend points to the possible harmful effect for those children living in larger families in the NELS cohort. In the ELS cohort, the pattern was similar to the NELS cohort, but the decreasing tendency was slower than the NELS cohort in the larger families.

Two patterns were observed in Figure 1 and Figure 2. In general, in the HS&B cohort, daughters and sons decreased their college enrollment rate with an additional sibling at home. In the NELS and ELS cohort, daughters consistently held the highest college enrollment rate, particularly for those living in families with one or two children. Although sons received similar advantages in smaller families, their college enrollment decreased when the number of siblings was larger than one. In addition, a family with four siblings presented the worst environment for children's college enrollment, and this effect held for both daughters and sons. To examine the divergent gender gap hypothesis, for example, the predicted probability of college enrollment for sons with four siblings in the 1980 cohort, was 8% lower than that for the 1980 daughters (58.42% versus. 66.21%), holding other covariates as the average. In contrast, the predicted probability of college enrollment for sons with four siblings in the 2002 cohort was 1 % lower than for daughters (77.84% versus 89.02%) in 2002. This divergent tendency confirms the fourth hypothesis of increasing gender inequality between smaller and larger families.

What role do family resources play in this trend? Model-3 describes the cohort-gender difference in college enrollment by adding in the family resources variable. The female advantage in college enrollment remained significant across cohorts. This implies that the role of family resources in explaining the gender gap in college enrollment is limited. For example, with the inclusion of family resources measures, the female advantage in college enrollment decreased approximately 24% in the NELS cohort and 48% in the ELS cohort. In short, these findings indicate that family resources play significant roles in explaining the female advantage in college enrollment, particularly in the recent cohort. This result also supports the fifth hypothesis.

Trend in Two-Year and Four-Year College Enrollment with Family Resources

Table 4 shows the results of the multi-nominal logistic regression for the pattern of two-year and four-year college enrollment. Beginning with model 1, nets of school percentile ranking, family SES, family structure and other covariates, the female advantage was present in the 1988 cohort for both two-year and four-year college enrollment. Females in the 1988 cohort were 1.32 times ($e^{.279} = 1.32$) more likely to enroll in a two year college over no college compared to females in the 1980 cohort, and almost 1.64 times ($e^{.495} = 1.64$) more likely to enroll in a four-year college over no college compared to females in the 1980 cohort. In other words, a daughter from the 1988 cohort with the same percentile ranking class rank, family SES and other covariates as a daughter in the 1980 cohort had odds 1.32 times those of the daughter in the 1980 cohort of attending a two-year college, and 1.64 times those of the daughter in the 1980 cohort of attending a four-year college. Nevertheless, the female advantage was not observed in the 2002 cohort compared to the 1980 cohort, which partially supports the third hypothesis.

Results also showed that males in the 1980 cohort and the 2002 cohort reduced the likelihood of enrolling in a two-year and four-year college compared to females in the 1980 cohort. Moreover, step-families and single families were negatively associated with two-year and four-year college enrollment. As expected, immigrant status, family SES, and students' educational expectations were positively associated with two-year college enrollment, except for the effect of mothers' education. On the contrary, mothers who graduated from college, family SES and students' educational expectation were positively associated with four-year college enrollment.

The bottom of the table reports the t-test results examining whether there was a statistically significant difference in two-year and four-year college enrollment across cohorts and whether there were statistically significant gender differences among cohorts. Importantly, results showed that female-favorable pattern of two-year and four-year college enrollment was present in the 1988 and 2002 cohort.

Model 2 added number of siblings and showed a reduction in the female advantage in both two-year and four-year college enrollment. Number of siblings was negatively associated with two-year and four-year college enrollment. The cohort-gender difference decreased after number of siblings was controlled for in the model. As the results suggest, with the inclusion of number of siblings, the female advantage coefficient decreased approximately 6% for the two-year college advantage, and 4% in the four-year college advantage in the 2002 cohort. With respect to the sibling dilution effect in model 2, number of siblings was negatively associated with both four-year and two-year college enrollment across cohorts. Students' four-year college enrollment was .92 times ($e^{-0.082}$=.92) and two-year college is .93 times ($e^{-0.07}$=.93) lower when an additional sibling was present in a family. In the bottom panel of table 4, the cohort difference among female members was observed in the 1988 cohort and the cohort difference among male members was observed in the 1980 cohort and the 2002 cohort compared to the 1988 cohort. Males' cohort differences in the decline in two-year and four-year college enrollment remained strong even after controlling for the effect of number of siblings. The female-favorable pattern of two-year and four-year college enrollment remained.

In Model 3, variables measuring students' family resources were introduced. The female advantage in two-year and four-year college enrollment remained significant in the 1988 cohort. The Hausman test on the female advantage in two-year versus four-year college enrollment ($p < .05$) was statistically significant, which confirms the second hypothesis.

With the inclusion of family resources variables, the female advantage in college enrollment decreased approximately 20% for two-year college enrollment, and 26% for four-year college enrollment in the 1988 cohort. In contrast, the male disadvantage decreased approximately 4% for two-year college enrollment and 11% for four-year college enrollment in the 1980 cohort, holding constant the family resources variables. In short, these findings indicate that family resources explained the reduction in the female advantage for both two-year and four-year college enrollment in the 1988 cohort, and that this reduction tendency was more pronounced for four-year college enrollment than two-year college enrollment. This finding supports the fifth hypothesis. I also found that most family resources were positively associated with four-year college enrollment, except for parental involvement in school activities on two-year college enrollment.

Figure 3 shows the predictive margins of two-year college enrollment in model 3 separated by cohort and gender and conditional on the number of siblings. In general, the female advantage in two-year college enrollment was significant between the 1980 and the 1988 cohort. But the gender gap became smaller when the number of sibling was larger than three. For female members, the probability difference on two-year college enrollment was larger across cohorts, particularly for smaller numbers of siblings. In contrast, males' probability of two-year college enrollment was more condense and smaller over time.

Figure 4 shows the predictive margins of four-year college enrollment for cohort-gender subgroups at different number of siblings. Notably, female advantage was larger when number of siblings grew from one to three, but the gender gap became smaller in larger families in the 1988 cohort. However, the divergent tendency between smaller and larger families still held, especially for the 2002 cohort. Generally, for men, the probability difference on four-year college enrollment between cohorts was larger across number of siblings. For women, the difference between cohorts was the highest at families with one and two children, and this tendency converged when the number of siblings increased. While this study tends to account for potential family resources as much as possible, I also recognize that there are unexplained variations in the female advantage of two-year and four –year college enrollment in the 1988 cohort.

Discussion and Conclusion

The goal of this study was to understand the effect of family resources on children's college enrollment, specifically within the context of a declining number of siblings in families that has occurred over the past three decades. Utilizing three large nationally representative datasets of 10th graders in 1980, 1990 and 2002, this study aimed to examine the role of number of siblings and family resources in explaining the female advantage in college enrollment.

The first hypothesis concerned whether the female advantage in college enrollment still held after accounting for number of siblings and a series of family resources. I found strong evidence to support that the female advantage in college enrollment increased over time after controlling for other potential confounders. Students with better family resources had a higher likelihood of enrolling in college compared to those without the same level of family resources. Results also confirmed that the number of siblings had a detrimental effect on college enrollment. Female and male cohort differences were observed, except for the cohort difference between 1988 and 2002. The gender difference in college enrollment among cohort favored daughters over sons.

The second and third hypotheses concerned whether the female advantage in four-year college still held and whether the gender gap widened for four-year college compared to two-year college enrollment, after accounting for number of siblings and a series of family resources presented in table 3. Results confirmed that the female advantage in four-year college enrollment still held after controlling for other potential confounders. Through a Hauseman test, I also found that the female advantage in four-year college enrollment was significantly larger than in two-year college enrollment in the 1988 cohort. Surprisingly, the male disadvantage in four-year college enrollment was also significantly larger than in two-year college enrollment in the 2002 cohort.

The fourth hypothesis examined whether the gender difference diverged with the number of siblings over cohorts. Predicted probability states that an increasing trend of gender inequality between smaller and large families compared the 1980 cohort and the 2002 cohort using the model 3 in table 2. That being said, gender differences in college enrollment were significant when comparing cohorts, conditional on the number of siblings.

The fifth hypothesis posits that family resources explain the variation in the patterns of college enrollment across cohort and gender. The evidence for this hypothesis on four-year college enrollment was fairly strong, particularly for material, socio-psychological, cultural, and social resources. The positive association between family resources and four-year college enrollment was strong, despite the fact that parents' participation in school related activities seemed to have no effect in predicting two-year college enrollment.

I also found that the role of number of siblings and family resources stratified college opportunities for daughters and sons in different ways. The results confirmed gender differences between smaller (one sibling) and large families (four siblings). Females living in a family with siblings less than two still showed a significant advantage in college enrollment compared to males with the same number of siblings in the same cohort. This gender gap continued to increase when the number of siblings increased. However, men almost showed a linear decrease when adding in any additional siblings at home. This pattern was even more salient for the four-year college enrollment pattern. This gendered pattern of college enrollment suggests that women are more resistant to the resource dilution of siblings and may receive more family supports, including monetary and non-monetary, in sustaining their college enrollment decision.

This study has several limitations. First, this study did not account for the selection bias of parents' fertility decision, which may affect parents' ability to raise children and preferences to invest in daughters over sons. Understanding this potential selection bias requires detailed information about parents' attitudes towards obtaining a college degree and family investments in each of their children (e.g., omitted variables, intra-families variation). Second, due to data limitations, I did not include some family resource indicators. For example, the measure of family wealth and parents' time with their children (Aguiar& Hurst, 2007) may also represent different dimensions of family investment in children's college education. I am aware that different measures of family resources may affect children's college enrollment differently. Similarly, the same family resources may have different impacts on daughters' and sons' college enrollment (Eccles& Harold 1993). That is, using different family resource measures or gender-specific resource measures may alter the findings and conclusions of this study. Third, I operationalize a number of sibling and family resources as individual characteristics. This strategy is commonly used in the resource dilution model (Steelman & Powell, 1989, 1993) without accounting for the intra-family configuration, which may yield different findings (Conley & Glauber 2006) and a limitation shared by most national representative data without whole family members' data. Finally, this study focused on the family-based structural and resource allocation; controlling for school clustering effects and the effects of specific school contexts is beyond the current scope of this study.

Despite the limitations above, this study contributes to the existent literature in three ways. First, substantively, this study confirmed that number of siblings and family resources contribute to the female advantage in college enrollment. Specifically, I found evidence for the role of number of siblings and family resources in terms of materials, socio-psychological, cultural, and social resources to explain the changes in the female advantage in college enrollment from 1980 to 2002 while controlling for school achievement, mothers' education, students' expectations, and other covariates. Female advantage in college enrollment was observed across cohorts. Second, this study identifies the females' cohort advantage and males' cohort disadvantage through two-year and four-year college enrollment. As the results suggest, gender differences in four-year college enrollment were present in each cohort. In contrast, gender differences in two-year college enrollment were present only in the 1988 and 2002 cohort. Among those gender differences, females continued to outpace males in two-year and four-year college enrollment, holding constant family resources, school achievement, number of siblings, and other covariates. Third, the female advantage in four-year college enrollment was significantly widened compared to two-year college enrollment. Importantly, the inclusion of family resources explained more variation in the female advantage in four-year college than in two-year college enrollment. These results were consistent with Diprete and Buchmann's (2013) findings that a gender reversal trend has shifted in favor daughters toward higher education. This study provided more information about the gender reversal trend of college enrollment, even after controlling for number of siblings, mothers' education, and family SES. Lastly, these results lead to several important questions that researchers and social demographers need to consider. It is important to better understand why the transition from high school to college for daughters is smoother than for sons, and the possible gender bias that may exist through teacher evaluations, low parental expectations, and school achievement that may reduce sons' opportunities and motivation to attend college.

APPENDICES

APPENDIX A

FIGURES FOR CHAPTER ONE

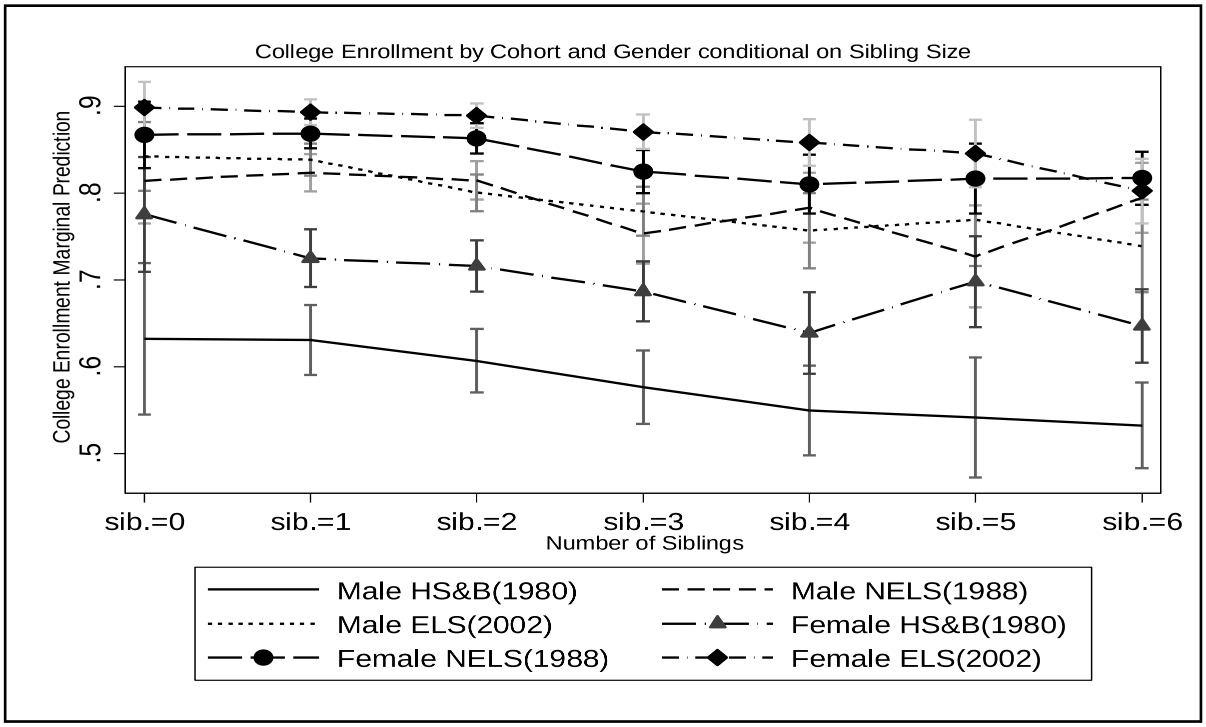

Figure 1: Marginal Prediction of College Enrollment by Gender and Cohort within the Number of Siblings
Source: HSB, NELS, ELS

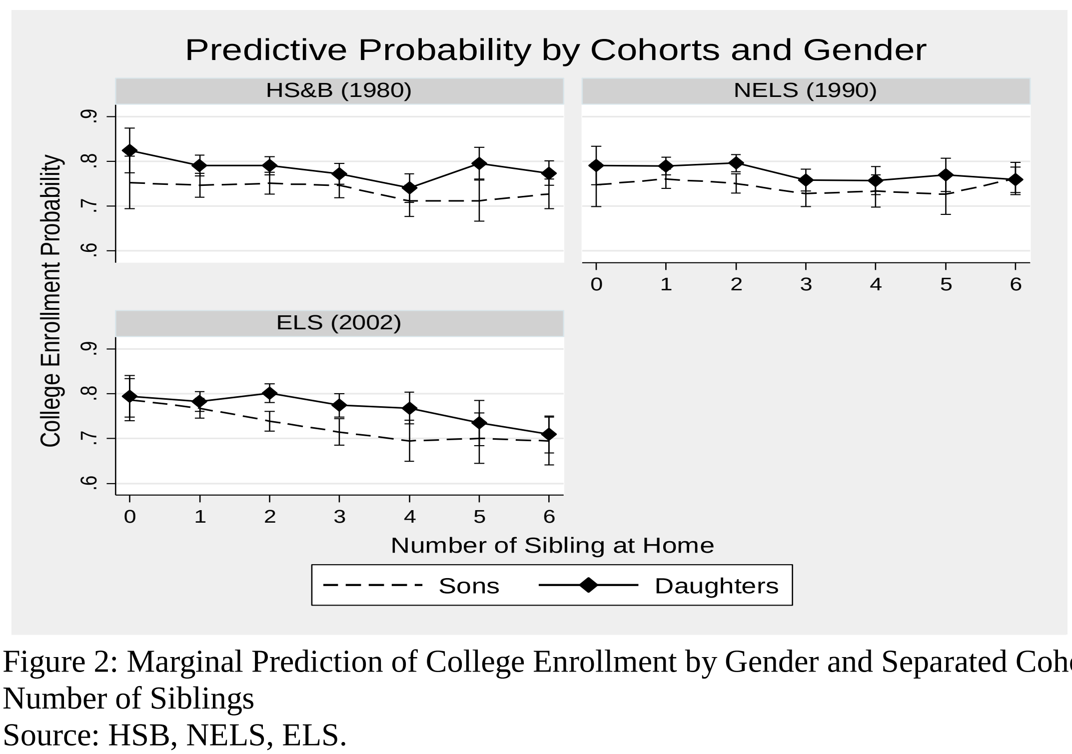

Figure 2: Marginal Prediction of College Enrollment by Gender and Separated Cohort within the Number of Siblings
Source: HSB, NELS, ELS.

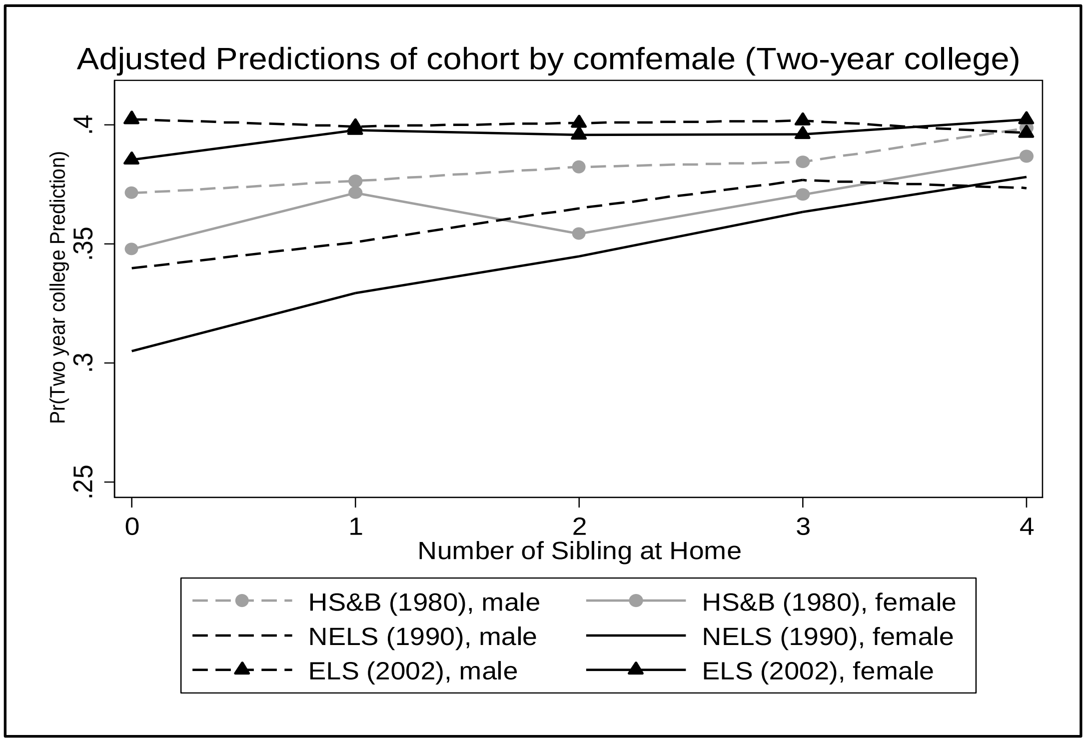

Figure 3: College Enrollment Probability in Two-Year College by Gender and Cohort Conditional on Number of Siblings

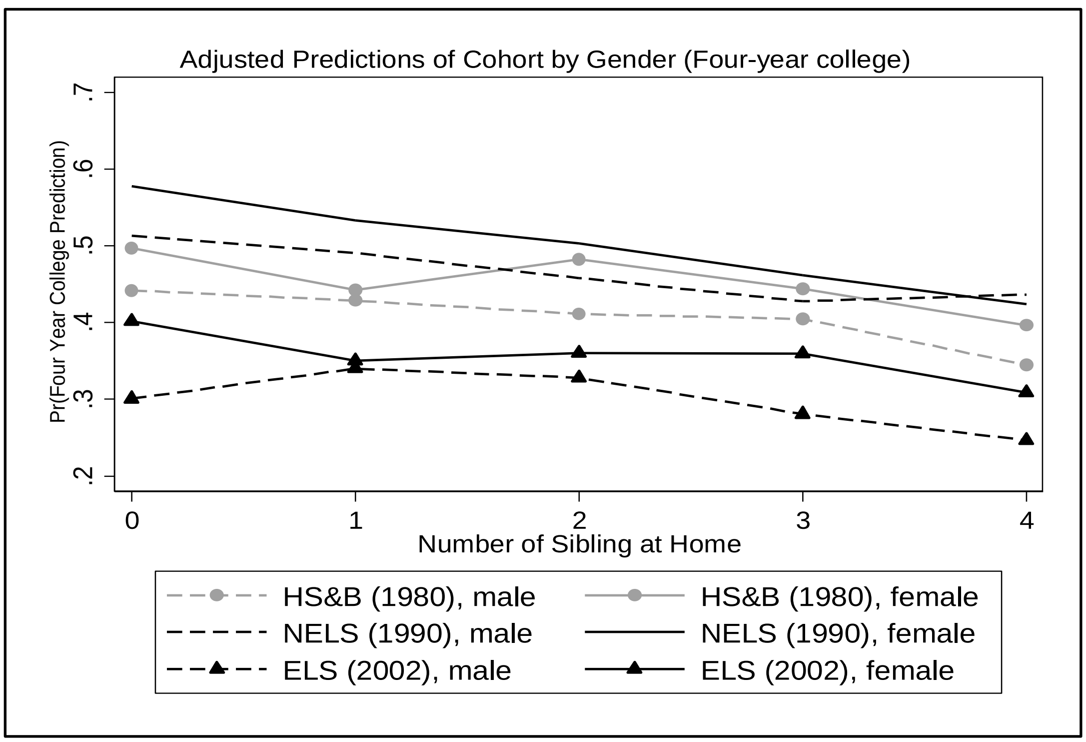

Figure 4: College Enrollment Probability in Four-Year College by Gender and Cohort Conditional on Number of Siblings

APPENDIX B

TABLES FOR CHAPTER ONE

Table 1: Variable Description, Mean and Standard Deviation

Variables	**Description**	**N**	**Mean**	**SD**
College enrollment	Whether enrolled in college in 1984 (HS&B); in 1994 (NELS); in 2006 (ELS)	39715	0.68	(.47)
Enrolled 2 year college	Whether enrolled in 2-year college in 1984 (HS&B); in 1994 (NELS); in 2006 (ELS)	41314	0.20	(.40)
Enrolled 4 year college	Whether enrolled in 4-year college in 1984 (HS&B); in 1994 (NELS); in 2006 (ELS)	41314	0.43	(.49)
HS cohort GPA	High school overall GPA composite in 1984 (HS&B); in 1994 (NELS); in 2006 (ELS)	40784	2.70	(.87)
10th grader Naïve Percentile-Ranking	Linear Equity original composite 10th grader percentile-ranking	39858	51.21	(20.45)
Student sex		42339	0.51	(.50)
Student White		41968	0.63	(.48)
Student Black		41968	0.12	(.33)
Student Hispanic		41968	0.17	(.37)
Student Asian		41968	0.07	(.25)
Student Native		41968	0.01	(.12)
Family Structure				
Number of Siblings	Number of Siblings	36893	2.59	(1.69)
Intact family	Living with mother and father	43166	0.59	(.49)
Step-family	Living with Mother and male guardian; Father and female guardian	43166	0.11	(.32)
Single family	Living with Mother only ; Father only	43166	0.16	(.37)
Other Relative/Guardian-family	Living with female guardian; male guardian; or both	43166	0.03	(.17)

Table 1 (cont'd)

Family Resources				
Material/Financial Resources				
Educational Items	Sum of 4 items: (1) Family has a daily newspaper, (2) Family has a computer, (3) Family has more than 50 books, (4) Has own room	36619	2.89	(.94)
Socio-psychological Resources				
Parent educational expectation	How far in school parent want you to go (HS&B) and (NELS); How far in school parent wants 10th grader to go (ELS). Scale 1-7.	39874	4.70	(1.65)
Student educational expectation	How far in school mother want you to go (HS&B) and (NELS); How far in school mother wants 10th grader to go (ELS). Scale 1-7.	38445	4.63	(1.64)
Cultural resources				
School preparation at home	(1) How often goes to class without pencil/paper; (2)How often goes to class without books;(3) How often goes to class without homework done	37118	9.56	(2.08)
Social resources				
Parent participate in school-related organization, activities	(1) how often parents attend school meetings; (2) how often parent phoned teacher, counselor; (3) how often parents attended school event ; (4) parents acted as volunteer at r^s school	33920	1.48	(1.32)

Table 1 (cont'd)

Mother education			
Mother less than high school	38445	0.20	(.40)
Mother high school degree	38445	0.32	(.47)
Mother some college	38445	0.26	(.44)
Mother college graduated and beyond	38445	0.22	(.42)
Control variables			
Region			
North east	42828	0.20	(.40)
Midwest	42828	0.26	(.44)
South	42828	0.34	(.47)
West	42828	0.20	(.40)
High school type			
Public high school	42760	0.83	(.38)
Catholic high school	42760	0.11	(.31)
Private high school	42760	0.06	(.24)

Table 2: Gender Difference in College Enrollment and Family Resources across Three Decades [a]

	HS&B	NELS(1988	ELS(2002	HS&B	NELS(1988	ELS(2002
		Female			Male	
College enrollment	.63*	.71*	.79*	.56	.66	.71
Enrolled 2 year college	.27*	.28*	.30*	.22	.25	.26
Enrolled 4 year college	.35*	.42*	.37*	.33	.39	.32
School Achievement						
10th grader Relative	52.72	51.02	49.69	54.90	50.20	49.32
	(20.96	(23.48)	(15.95	(21.63	(24.66)	(17.17
High School GPA	2.39	2.68	3.32	2.16	2.57	3.06
	(.73)	(.80)	(.74)	(.72)	(.81)	(.79)
Family Structure						
Number of Siblings	2.98	2.57	2.33	2.98	2.40	2.24
	(1.78)	(1.72)	(1.56)	(1.76)	(1.64)	(1.49)
Intact family	.62	.57	.59	.64	.58	.60
Step-family	.11	.09	.15	.08	.08	.15
Single family	.17	.12	.21	.15	.10	.21
Other	.03	.02	.04	.04	.02	.04
Mother education						
Mother less than high	.25	.28	.13	.20	.24	.12
Mother high school	.37	.32	.27	.41	.34	.26
Mother some college	.24	.20	.33	.22	.18	.34
Mother college	.14	.21	.27	.17	.25	.28
Family Resources						
Material/Financial						
Educational Items (0-4)	2.49	2.78	3.25	2.55	2.89	3.26
	(0.79)	(0.96)	(0.85)	(0.81)	(0.98)	(0.87)
Socio-psychological						
Parent educational	4.17	4.39	5.48	4.09	4.35	5.29
	(1.89)	(1.43)	(1.23)	(1.95)	(1.41)	(1.32)
Student educational	4.13	4.72	5.42	3.98	4.50	4.96
	(1.71)	(1.57)	(1.33)	(1.73)	(1.54)	(1.49)
Cultural resources						
Parent school	9.99	9.98	9.65	9.28	9.50	9.06
Social resources	(1.63)	(1.64)	(2.34)	(1.94)	(1.83)	(2.53)
Parent participate in	1.40	1.79	1.24	1.47	1.90	1.22
	(1.24)	(1.27)	(1.34)	(1.25)	(1.31)	(1.34)
Student White	.60	.68	.62	.58	.70	.62
Student Black	.14	.10	.13	.14	.09	.13
Student Hispanic	.21	.14	.15	.23	.13	.15
Student Asian	.03	.07	.09	.03	.07	.10
Student Native	.02	.01	.01	.02	.01	.01
High school types						
Public	0.77	0.88	0.83	0.80	0.86	0.83
Catholic	0.20	0.06	0.08	0.16	0.07	0.08
Private	0.02	0.06	0.09	0.04	0.07	0.09

Note. Standard deviation (in parentheses)

Table 3: Logistic Regression Predicting College Enrollment across Gender and Cohort [a]

	Model-1	Model-2	Model-3
Female			
Cohort-1980 Female	[Reference]	[Reference]	[Reference]
Cohort-1988 Female	0.361***	0.341***	0.260**
	(0.085)	(0.086)	(0.087)
Cohort-2002 Female	0.480***	0.444***	0.229*
	(0.092)	(0.092)	(0.099)
Male			
Cohort-1980 Male	-0.393***	-0.389***	-0.352***
	(0.078)	(0.079)	(0.081)
Cohort-1988 Male	0.009	-0.018	-0.110
	(0.107)	(0.109)	(0.114)
Cohort-2002 Male	0.087	0.038	-0.129
	(0.086)	(0.087)	(0.093)
Resources dilution			
Number of Siblings		-0.079***	-0.073***
		(0.016)	(0.016)
School Achievement			
Student Relative-percentile rank	0.030***	0.030***	0.028***
	(0.002)	(0.002)	(0.002)
Family Resources			
Parent educational expectation			0.221***
			(0.019)
Educational Items			0.123**
			(0.038)
Parent school preparation at home			0.060***
			(0.013)
Parent participate in school-related			0.094***
			(0.023)
Family Composition (Ref.= Intact family)			
Step-family	-0.377***	-0.319***	-0.303***
	(0.081)	(0.082)	(0.081)
Single-family	-0.058	-0.049	-0.026
	(0.079)	(0.080)	(0.081)
Other Guardians	-0.450**	-0.444**	-0.444**
	(0.165)	(0.166)	(0.165)

Table 3 (cont'd)

Mother education (Ref.=Less than High school)			
High school mother	-0.045	-0.063	-0.097
	(0.077)	(0.078)	(0.079)
Some college mother	0.011	-0.012	-0.064
	(0.093)	(0.094)	(0.095)
College graduated mother	0.278*	0.263*	0.217+
	(0.120)	(0.121)	(0.120)
Immigrant status	0.350*	0.344*	0.340*
	(0.155)	(0.156)	(0.156)
Family Socioeconomic status (Composite score)	0.704***	0.685***	0.574***
	(0.057)	(0.058)	(0.062)
Students' educational expectation	0.474***	0.470***	0.365***
	(0.021)	(0.021)	(0.023)
Group T-test	Model-1	Model-2	Model-3
Significant female cohort differences			
1980 vs. 1988	Yes	Yes	Yes
1980 vs. 2002	Yes	Yes	Yes
1988 vs. 2002	No	No	No
Significant male cohort differences			
1980 vs. 1988	Yes	Yes	Yes
1980 vs. 2002	Yes	Yes	Yes
1988 vs. 2002	No	No	No
Significant gender differences			
1980 cohort	Female	Female	Female
1988 cohort	Female	Female	Female
2002 cohort	Female	Female	Female

+ p< .1; * p<.0,5; ** p<.01; *** p<.001 ; Standard errors in parentheses.

Note: Reported original logistic regression coefficient.

[a] All models adjusted for race group variables, region, high school type. Final analytic sample= 21,553

Table 4: Multi-nominal Logistic Regression Model Predicted Two-Year and Four-Year College Enrollment

Women (Ref. Cohort-1980 Female)	Model-1	Model-2	Model-3	Model-1	Model-2	Model-3
Cohort-1988 Female	[Ref.]	[Ref.]	[Ref.]	[Ref.]	[Ref.]	[Ref.]
Cohort-1988 Female	0.279**	0.261**	0.209*	0.495**	0.473**	0.348**
	(0.093)	(0.094)	(0.095)	(0.096)	(0.096)	(0.097)
Cohort-2002 Female	0.102	0.068	-0.124	-0.057	-0.094	-0.132
	(0.091)	(0.091)	(0.097)	(0.099)	(0.100)	(0.107)
Cohort-1980 Male	-0.407**	-0.404**	-0.386**	-0.376**	-0.372**	-0.330**
	(0.086)	(0.086)	(0.087)	(0.092)	(0.092)	(0.094)
Cohort-1988 Male	-0.047	-0.071	-0.133	0.115	0.086	-0.049
	(0.113)	(0.115)	(0.119)	(0.118)	(0.120)	(0.125)
Cohort-2002 Male	-0.381**	-0.426**	-0.593**	-0.565**	-0.613**	-0.852**
	(0.088)	(0.089)	(0.095)	(0.096)	(0.097)	(0.105)
Differential Fertility						
Number of Siblings		-0.070**	-0.065**		-0.082**	-0.073**
		(0.017)	(0.017)		(0.017)	(0.018)
School Achievement						
Student Relative-percentile rank	0.015**	0.015**	0.014***	0.051**	0.051**	0.049**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Family Resources						
Parent educational expectation			0.158***			0.306**
			(0.019)			(0.023)
Educational Items			0.095*			0.145**
			(0.036)			(0.043)
Parent school preparation at home			0.030*			0.071**
			(0.013)			(0.015)
Parent participate in school-related			0.033			0.160**
			(0.022)			(0.023)

Table 4 (cont'd)

Family Composition (Ref.=Other Guardians)						
Intact family	-0.263**	-0.210*	-0.207*	-0.506**	-0.441**	-0.396**
	(0.081)	(0.082)	(0.082)	(0.086)	(0.088)	(0.087)
Step-family	-0.052	-0.045	-0.039	-0.093	-0.084	-0.039
	(0.079)	(0.079)	(0.080)	(0.084)	(0.084)	(0.085)
Single family	-0.354*	-0.345*	-0.349*	-0.679**	-0.662**	-0.645**
	(0.168)	(0.169)	(0.167)	(0.183)	(0.180)	(0.180)
Mother education (Ref.=Less than High						
High school mother	-0.032	-0.048	-0.069	0.062	0.043	-0.007
	(0.081)	(0.082)	(0.081)	(0.087)	(0.087)	(0.088)
Some college mother	0.025	0.006	-0.025	0.100	0.077	-0.007
	(0.094)	(0.095)	(0.095)	(0.100)	(0.101)	(0.102)
College graduated mother	0.111	0.098	0.076	0.375**	0.358**	0.286*
	(0.121)	(0.121)	(0.120)	(0.125)	(0.125)	(0.126)
Immigrant status	0.434**	0.429**	0.414**	0.094	0.087	0.096
	(0.138)	(0.138)	(0.138)	(0.157)	(0.158)	(0.157)
Family Socioeconomic status	0.521***	0.504**	0.428**	0.853***	0.834***	0.692***
	(0.056)	(0.056)	(0.060)	(0.061)	(0.062)	(0.066)
Students' educational expectation	0.330***	0.328**	0.257**	0.609***	0.605***	0.473***
	(0.022)	(0.022)	(0.023)	(0.023)	(0.023)	(0.025)
Group T-test						
Significant female cohort differences						
1980 vs. 1988	yes	yes	yes	yes	yes	yes
1980 vs. 2002	no	no	no	no	no	yes
1988 vs. 2002	yes	yes	yes	yes	yes	yes
Significant male cohort differences						
1980 vs. 1988	yes	yes	yes	yes	yes	yes
1980 vs. 2002	no	no	yes	no	yes	yes
1988 vs. 2002	yes	yes	yes	yes	yes	yes
Group T-test						
Significant gender differences						
1980 cohort	no	no	no	no	no	Female
1988 cohort	Female	Female	Female	Female	Female	Female
2002 cohort	Female	Female	Female	Female	Female	Female

+ p< .1; * p<.05; ** p<.01; *** p<.001;
Standard errors in parentheses. Note: Reported original logistic regression coefficient.

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CHAPTER TWO

SIBLING SIZE, GENDER COMPOSITION, AND PARENT INVESTMENT IN COLLEGE ENROLLMENT

Introduction

Research indicates that the female advantage in postsecondary enrollment and completion has increased substantially from the 1980s through today (DiPrete & Buchmann, 2013; Buchmann, DiPrete,& McDaniel, 2008). This change has been in part attributed to decreasing family size and increases in women's labor force participation which has resulted in directing more educational resources to children's schooling (Torche, 2011; Dufur, Parcel, Hoffmann, &Braudt,2016). What has received less attention is the potential importance of structural changes in sibling configuration and its impact on family supports for college. For example, in the 1980 cohort of the U.S. national longitudinal High School and Beyond study, 23.1 % of boys and 23.3 % of girls lived in single-child and two-children families. In comparison, 36.9 % of boys and 35.6 % of girls lived in single-child and two-child families in the 2002 recent cohort of the national Educational Longitudinal Study (Chen, Schneider, & Frank, 2015). The probability of youth 18 years old and younger living with only one sibling increased approximately by 12 % from 1980 to 2002.

Estimates of the gender disparity in college enrollment between small and large families but overlook sibship composition, that is, whether the family has a son and a daughter or two daughters are likely to miss important differences in the educational expectations and resources parents are willing to allocate to their daughters compared to their sons (Bissell-Havran, Loken, & McHale, 2012). This structural heterogeneity among families coincides with decreases in family size over the last thirty years (Eggebeen, 1992; Mare & Maralani, 2006). By separating out the effect of sibling size from sibship gender–position we can gain a deeper understanding of what factors are directly shaping the female advantage in college enrollment and how they have been changing over time. This study examines the differential effects of sibling size, sibship-gender composition, and family educational resources allocations on female college enrollment using the National Educational Longitudinal Study 1988-1994 (NELS 88)and the National Longitudinal Study of Adolescent Health, 1994-2008 (Add Health).

Background

Resources Dilution Model: Gender-Specific Dilution

The resource dilution model—that is diminished family resources allocation to their children depending on number of siblings (named sibling size)—introduced by sociologists and demographers (Anastasi 1956; Blake, 1989, 1981; Downey, 1995, 2001) offers the most widely accepted explanation for the relationship between sibling size, family resources, and children's educational opportunities. While having an additional child at home has a negative effect on family resource allocation and children's educational opportunities, the evidence for sibling gender composition on children's educational outcomes is mixed and related to gender asymmetry within the family (Chu, Xie, & Yu 2007; Conley &Glauber, 2006; Lee, 2008). For example, parents' perceptions of educational returns or their personal experiences with the expected gendered roles of boys versus girls may guide resource allocations to favor one child over another. Previous research by Steelman and Powell (1989) found that the presence of an additional brother reduced parents' financial contribution to their daughters' schooling. Most studies on sibling size and family resources through the 1990s also showed that gender-specific resource dilution depended on the presence of larger families and sibling composition (Yamaguchi & Ferguson, 1995).

Research also has shown that parents are inclined to have an additional child to achieve a balanced gender boy/girl composition. Conley and colleagues (2006) used 1990 census data to examine the causal effect of increasing sibling size on educational outcomes while accounting for parents' boy/girl composition preferences. They concluded that sibling size has a more consistent dilution effect on sons in families with more than two children (where the eldest two children are of the same gender). Similar effects were found by Kalmijn and van de Werfhouse (2016). Given that family size continues to decrease (Census 2010; Hobbs &Stoops, 2002), we expect to find greater resource dilution and gender asymmetric effects in earlier family cohorts than today. We propose the following hypotheses:

Hypothesis1: The cohort trend of smaller families results in the decline gender-specific dilution on college enrollment (The narrowing dilution hypothesis).

Sibship composition and Gender Socialization

The concept of sibling gender composition originates from a child's gender position relative to other siblings in the home. Previous research on sibling gender composition has focused on the influence of the number and balance of sisters and brothers within the family on a sibling's educational outcomes (Kuo & Hauser, 1995; Butcher & Case, 1994).Recent studies have shown differential parent expectations, household chores, and resource allocations for similar and differential gendered sibling dyads (Marks, Lam, & McHale, 2009; McHale & Crouter, 2003a; Brody & Steelman, 1985) in the household. For example, McHale and Crouter (2003b) found that in older-brother-younger-sister dyads, younger girls did more housework than their older brothers. Likewise, in older-sister-younger-brother dyads, older sisters performed more housework than their younger brothers. These patterns do not appear to be consistent when there are the same female sibling configurations. Recently, Mark and colleagues (2009) found that girl-girl sibling dyads rather than boy-boy or mixed gender sibling dyads are more likely to be characterized as having more egalitarian gender role attitudes. We suspect that educational expectations and resource allocations are likely to depend on the gender composition of the family, such as girl-girl dyads and gender position, older girl and younger brother.

To capture this concept, we constructed three gendered sibship composition patterns (e.g., majority, minority and balanced, see Appendix A). Each position in the household sibship constellation corresponds to a child's gender, siblings' gender, and sibling size. Based on this constellation, we measure the relationship of the proportion of same-sex siblings at home with parent attitudes and resource allocations. Given that family size has decreased we expect that daughters may gain more in the same-gender majority position in a home-based environment, which in turn affect their educational opportunities.

> *Hypothesis 2*: The trend toward smaller familieshas increased the importance of sibshipgender- majority position on family expectations, resource allocations and four year college enrollment (Sibship-gender majority hypothesis).

Differential Parental Resource and Cultural Supports

In addition to sibling composition, we also recognize that there are likely to be other competing factors in the household, such as their own gendered experiences which are likely to affect parent attitudes toward their children and their resource allocations. Parent attention and educational college expectations have been found to be different between sons and daughters in the same household. Bissell-Havran (2012) found that sisters reported their mothers have higher educational expectations for them compared to their brothers in the same household. Carter and Wojtkiewicz (2000) also found higher parental involvement, educational plans, and school discussions with their daughters in contrast to their sons'. On the other hand, in two children and mixed-sex sibling families, brothers reported higher father involvement compared to their sisters in the same household. With respect to education and career choices, Bleeker and Jacobs (2004) found that daughters' pursuits of science career in engineering and other hard sciences were positively related to their mothers' beliefs and perceptions of their math and science achievement and career opportunities. This effect was not found for sons. However, parental involvement in the boy-boy families reveals the largest gender stereotype expectations compared to boy-girl and girl-girl sibling family compositions (Marks, Lam, & McHale, 2009).

In addition to differences in educational expectations, role models, and involvement in school activities, research has also shown that parents differentially allocate resources, such as parental granting autonomy, lessons for art and music, summer camps, computers and other electronic equipment between their sons and daughters. These differential investments are related in part to parent perceptions of their children's academic and athletic abilities. The increasing competitive college landscape is in part pressuring parents to make major investments in their children's education experiences both in and out of the home. It is not that parents did not make some of these choices in the past, we suspect that what has changed is that there may be differences in resource allocations between families of sons and families of daughters. Parents may be willing to allocate even more to their daughters to ease their path to a four-year college.

Hypothesis 3: Parents' today are likely to be more responsive to allocating resources to their daughters' education compared to their sons, taking into account the academic ability of their daughters and sons(Cultural resources hypothesis).

Data and Methods

Data

Data for this study were derived from two national longitudinal surveys, the National Educational Longitudinal Study (NELS: 88) conducted from 1988-1994 and the National Longitudinal Study of Adolescent Health (ADD Health) conducted from 1995-2008. NELS88 began with 8th graders (aged 14) and included subsequent follow-up surveys with students, their parents, and schools. Among the original sample, 9,202 students had valid postsecondary outcomes from the last follow-up. Applying listwise deletion for key covariates, such as sibling size, family living arrangement, mother education, school performance, types of high school and family resources; the final analytic sample included 6,364 adolescents. Analyses were conducted to ensure that the final analytic sample was not biased and representative of the third follow-up cohort.

ADD Health surveyed high school students who were in 7th through 12th grade from 1994 –1995. Four waves of data were collected in 1995, 1996, 2002, and 2008. We used these four waves of data and generated a variable to represent whether a student enrolled in a two-year or four-year college by age 20. We used the high school transcript data to represent students' level of mathematics achievement. Listwise deletion for key variables was also conducted, which reduced the final analytic sample to 5,615 adolescents. The NELS cohort included an oversample of Hispanic and Asian families, and the ADD Health cohort also included an oversample of Cuban, Puerto Rican, Chinese, and high SES Black families

Measures of Dependent Variables

College Enrollment. The outcome for both surveys was college enrollment two years after high school graduation. Students are classified into three groups those who were: (a) not enrolled in postsecondary school (b) enrolled in a two-year college, and (c) enrolled in a four -year college.

Measures of Independent Variables

Sibship-gender Composition. In the NELS data, respondents were asked about the number of older and younger sisters and brothers at home. We also compared the same question in the parent survey to with the student one to ensure the accuracy of sibling configuration and their gender position. In the ADD Health data, respondents were asked to provide information on each member who regularly resided in the home with their relationship, gender, and age to the sampled student. We used the first wave of the surveys to construct the sibling size and gender composition variables.

To examine the effect of a sibship-gender majority position on female advantage in college enrollment, we first configured the sibling-sex composition with both size and gender information into twenty-eight possible patterns. Second, we classified sibship-gender position into three categories: (1) the sibship-gender minority; (2) the sibship-gender balanced, and, (3) the sibship-gender majority (See the Table 10 for details). In the analysis, we used sibship-gender minority as the reference group.

Family Resources. Family resources refer to parent expectations, investments and involvement in their children's education. We focus on six of these including: (1) extracurricular activities organized by parents and by schools; (2) social capital—knowing the parents of the students' friends (Coleman 1990); (3) parent-child discussion and parent-child relationship; (4) independence—allowing students with autonomy for some decisions; (5) involvement in monitoring and supervision of student activities such as homework; and (6) education and career expectations parents had for their students. Variable definitions and sample statistics for all these resource variables in the two datasets are listed in the Table 11.

Other Covariates. We measured 10th grade school performance using standardized test scores in mathematics and reading from the NELS data. For the ADD Health data, we recoded the Picture Vocabulary Test score into a relative percentile rank to represent students' vocabulary performance at wave 3. For mathematics performance in the ADD Health data, we used the highest mathematics credit that students received in wave 3. We constructed this math level variable as follow 0= *No Math*; 1= *Remedial Math*; 2 = *General Math*; 3 = *Pre-Algebra*; 4 = *Algebra I*; 5 = *Geometry*; 6 = *Algebra II*; 7 = *Advanced Math including Algebra III, Statistics and Probability, and Discrete Math*; 8 = *Pre-Calculus*; 9 = *Calculus*).We also examined school GPA as an indicator of school performance, which increased the analytic sample size and the final results remain the same as math performance. Thus, we reported the estimation of the modeling results based on school performance in vocabulary and the highest math performance at wave 3.

Family living arrangement distinguished between four types of family arrangements in both the NELS and ADD health data: (1) intact family: living with both biological parents, (2) step-family: living with biological mother and male guardian or biological father and female guardian, (3) single family: living in mother only or father only families, (4) other guardians/relatives: living with relatives or other non-biological guardians. Family income in NELS was scaled from 0-13 in the first follow-up; in ADD Health, the total household income was scaled from 0-4 in wave one. Race and ethnicity categorized students' backgrounds into five groups, not Hispanic white, black, Hispanic, Asian/pacific-islander, and others. The Hispanic category included all students of Hispanic origin regardless of whether they reported being multi-racial or white. Mother's education was categorized into five groups using the parent survey, ranging from 1 = less than high school to 5 = college graduated and beyond. If this variable was missing or the mother was not surveyed, we substituted using adolescents' reports of the education level of residential mother. High school type was operationalized as two dummy variables as private or Catholic, with public school as the referent group. Region was operationalized as three dummy variables, with South as the referent group.

Analytic Methods

To answer if females were more likely than males given their sibling size, sibship composition, and family resources were more likely to attend a four-year postsecondary school, we employed a multi-nominal logistic model (MNL) where the dependent variable was one of three destinations after high school graduation. Our inferences about the possible effect of sibship size on two-year and four-year college enrollment were based on an observational survey, where the assignment of children living in a small (one or two children families) versus a large family was not a random event. Our first step was to conduct a set of descriptive analysis to determine the distribution of sibling size, sibship gender composition and family resources across cohorts. We then used the Heckman selection approach to adjust for nonrandom event of small families in each cohort (Heckman, 1979; Winship and Mare 1992). The two-step approach began with a probit model predicting the probability of an adolescent living in a small family. Variables used to predict living in a small family included immigrant status, mothers' age, religion, parent education, parent marital status, household income, race, and region. All measures were based on the first follow-up data in NELS and first wave data in ADD Health.

Following this correction, estimates for two-year and four-year college enrollment were interpreted as an adjustment to the sample selection of small families. The second stage included the predicated probabilities from the first stage to estimate the likelihood of two-year and four-year college attendance in the multi-nominal logistic model. The second stage equation was as follows:

$$Pr\ (y_i=1|\ x_i) = P_{i1} = \frac{1}{1+exp\ (x_i\beta_2)+exp\ (x_i\beta_3)}$$

$$Pr\ (y_i=2|\ x_i) = P_{i2} = \frac{exp\ (x_i\beta_2)}{1+exp\ (x_i\beta_2)+exp\ (x_i\beta_3)}$$

$$Pr\ (y_i=3|\ x_i) = P_{i3} = \frac{exp\ (x_i\beta_3)}{1+exp\ (x_i\beta_2)+exp\ (x_i\beta_3)}$$

β_2 and β_3 represent the effects of two-year and four-year college enrollment with no postsecondary school enrollment as the referent group. The equation forP_{i1} was derived from the constraint that the three probabilities sum to 1 (Powers and Xie, 2000). We then implemented a model where family resource variables were not included for the purpose of establishing the auxiliary relationship between number of sibling and female advantage in college enrollment. The second model further accounted for all family resources to investigate whether the effect of female advantage in college enrollment could be mediated. We also estimated the model with and without the inclusion of the Heckman sample control and found that the latter fit the data better based on the Bayesian information criterion (BIC), and Likelihood ratio test (coefficients without selection control are available upon request). To further account for the heterogeneity issue, we also ran additional analyses using generalized ordered logitmodel(Williams, 2009) to check whether the sibling characteristics were heterogeneous across gender groups (e.g., the number of sibling on college enrollment may be greater for sons over daughters). In so doing, we confirmed our main findings still hold and present more informative findings using multi-nominal logistic model format.

Results

Descriptive Results

Table 5 shows the distribution and the means of the focal variables, by survey and gender. Within each of the two survey cohorts, the trend of female advantage in college enrollment is fairly consistent. Daughters are more likely to enroll in college compared to sons. There is a significant decline in number of siblings ($p < .05$) in all types of families. Sons have a greater chance of living in sibship gender-majority families whereas daughters have a higher likelihood of living in sibship gender-minority families. This tendency is consistent across cohorts. Adolescents in the recent cohort have a greater chance of living in the sibling gender-majority ($p < .05$) and gender-balance families ($p < .05$) in the ADD Health cohort. Cohort changes also showed a positive increase in step families, private high school attendance, mothers with high school, and college degree.

The mean family resources by sibship gender composition are presented in Table 6. In the NELS cohort, there is a notable gender difference in parental supervision and parents' organized extracurricular activities across the three categories of sibship composition, with families of daughters reporting higher activities and parental supervision than families of sons. As expected, parents had higher educational expectation for their daughters than sons in the sibship-gender majority position. Within each sample of girls and boys, mean differences across positions are fairly consistent with respect to a better resource allocation in the sibship gender-balanced position. There are other allocation differences across positions.

One key difference is the gender resources gap between majority position and minority position. For example, daughters obtain a significantly higher degree of cultural related resources ($p < .001$), parent-child discussion ($p < .01$) and educational expectation ($p < .01$) in the majority position, but we find that the absence of a similar tendency for sons in the same position. The resource gap between gender-balanced and gender-minority position shows a similar pattern as better resource allocation is noted for gender-balanced positions.

In the ADD Health cohort, there is a notable gender difference in cultural-related extracurricular activities in school and parent respect child's autonomy across the three categories of sibship composition. Interestingly, sons receive more autonomy from parents than daughters. In the sibship-gender majority position, daughters have greater cultural activities ($p<.01$), parental closure network ($p<.01$) and supervision ($p<.01$) compared to sons. However, daughters in the sibship minority position have significantly lower parental expectations ($p<.05$) compared to sons. Within each subsample of girls and boys, the ADD Health cohort shows the same consistent pattern as the NELS cohort, with resource allocations in the sibship gender-balanced position being relatively better than other positions regardless of a student's gender.

Multi-nominal Regression Results

Our multivariate analysis consists of two steps. The first analysis investigates the effects of sibling size and family resources in explaining the female advantage in college enrollment by cohorts. The second investigates the effect of sibship gender position and whether these effects vary between females and males by cohort. Beginning with Model 1 in the NELS cohort, shown in Table 7, panel A results indicate a significant female advantage in college enrollment, net of number of siblings, family SES, and demographic characteristics. Females were 1.39 times ($e^{0.33}$=1.39) more likely to enroll in a four year college over no college compared to males and almost 1.36 times ($e^{0.31}$=1.36) more likely to enroll in a two-year college over no college. Comparing the NELS results with the ADD Health shown in Table 7 panel B the pattern of the female advantage in a four-year college is similar, yet no female advantage was observed in two-year college enrollment.

With respect to the sibling dilution effect, number of siblings was negatively associated with both four-year and two-year college enrollment across cohorts. The NELS students' four-year college reduced 1.1% predicted probability with an additional sibling presence at home and the NELS students' two-year college also reduced 0.8% predicted probability with an additional sibling presence in the family. Likewise, with one sibling presence at home, the ADD Health students' four-year college enrollment was associated with 1.2% reduction of predicted probability and 0.9% reduction of predicted probability in a two-year college enrollment. For example, males with one sibling had a predicted probability of 50% for attending a four-year college; a predicted probability of 46% for attending a four-year college if he had three siblings at home (these models also included the full set of covariates).

Model 2 added the family resource variables and showed that a decline in the gender significance of 31% in the four-year college and 20% in two-year college enrollment. Five measures of the family resources variables are significant predictors of four-year college enrollment, which included cultural-related extracurricular activities, parent-child discussing school things, parents' social capital resources, monitoring and supervision, and educational expectations. Importantly, our results showed that a great reduction of female's likelihood of four in four-year college enrollment than for two-year college, suggesting which suggested that the female advantage in four-year college was mostly derived from the family resources in the NELS cohort. Correspondingly, in Model 2 in the ADD Health cohort, our results shown a similar declining pattern of the female advantage in the four-year college enrollment by 22 %, however, females still retained advantage over males four-year college enrollment. Four measures of family resources variables are significant predicted four-year college enrollment, which included parent-child relationships, parents' social resources, parental expectations and parent respect children's autonomy.

The second step of the analysis investigated the effect of sibling size and sibship gender position on college enrollment shown in the NELS cohort in Table 8. As see in model 1, net of family characteristics and family resources, we found no direct effect of sibship gender-majority advantage in college enrollment. The next two columns estimated the gender-specific family context within respect to the number of siblings and sibship gender composition. The male -specific sibling dilution effect was present in both two-year and four-year college enrollment in Model 2, suggesting. It suggested that the effect of sibling dilution on college enrollment depended to some extent on a student's child's gender. To cite an example, the results indicated that sibling dilution effect was more severe for males than for females. We calculated the probability of four-year college enrollment for males who is average of the other covariates, varying only the number of siblings. Males with one sibling had a predicted probability of 50% for attending a four-year college; and males had a predicted probability of 46% for attending a four-year college if he had having three siblings at home (these models also included the full set of covariates). Results suggested that males' college opportunities reduced when having more siblings presented at home.

In contrast, our results showed that females' four-year college enrollment was 1.52 times higher than males when in the sibship-gender majority position. This beneficial effect however, was observed only for four-year college enrollment. We also calculated the probability of four-year college enrollment for females who is average of the other covariates, varying only the sibling gender position. Females with a gender majority position had a predicted probability of 60% for attending a four-year college compared to 51% for females and 54% for males in other sibship positions; suggesting that . Our results imply that the gender-specific sibship context tended to favor daughters in the sibship gender majority positions tend to favor daughters.

Up to this point, we found that both resource dilution and gender majority benefits were present in four-year college enrollments. That being said, males' four year college opportunities are particularly sensitive to the number of siblings at home whereas and females' four-year college opportunities are responsive to their sibling gender composition. Perhaps those daughters who were singular children and those daughters who single child have more sisters and having sisters more than brothers at home tend to have greater opportunities to attend a four-year college. In the NELS cohort, we observed that gender-specific family contexts in terms of sibling dilution and gender majority socialization were working in determining children's college enrollment.

This patter also occurs with the ADD Health cohort however the effect is less. As shown in When come to the ADD Health cohort in Table 9, we found a slightly gender-majority advantage in four-year college enrollment (p<.1). Model 1 suggests, which suggested that students in sibship majority positions gained a greater opportunity to attend college compared to other sibship positions.

The next two columns estimated the gender-specific family context. In Model 2, we found that sibling dilution effect depended less on gender but diluted affected the students' likelihood of attending a two-year college. The pattern of male-specific sibling dilution in a four-year college was declining from the NELS cohort to ADD health cohort. We found the evidence of the decline gender specific dilution in males' four-year college enrollment and no cohort difference on the declining gender-specific dilution has been suggested for two-year college enrollment. This finding supports the narrowing dilution hypothesis for four- year college enrollment. This may reflect the increased importance of smaller families rather than gender for increasing four year college enrollment for both males and females to attend four-year college in the ADD Health cohort.

In Model 3, we only found a gender-specific beneficial context for the toward sibship gender majority position and this only occurs for two year college enrollment. However, this effect operated only in two-year college enrollment, net of family resources allocation and the other covariates in the model. When calculated the probability of two-year college enrollment for females who is average of the other covariates, varying only the sibling gender position, females in a with gender majority position had a predicted probability of 42% for attending a two-year college compared to 38% for of females in with other positions to attend two-year college.

Results also indicated the increased importance of being in a gender majority position for attending a four-year college for the ADD health cohort. Students in the sibship gender majority position are almost 1.2 times more likely to attend a four-year college than their peers who had greater numbers of opposite-sex siblings at home. However, we observed a significant declining pattern of the daughter-specific majority effect across cohorts in choosing a four-year college but this pattern was not present for two-year college enrollment. The daughter-specific majority position did not operate in a consistent manner but this effect overtook the evidence of sibship gender majority benefit in the ADD Health cohort with other controls in the model.

To better understand how female advantage in college enrollment depends on family sibship gender composition and family resource allocations, we ran the full model separated by the three gender composition contexts. The female advantage in college enrollment was present only in the sibship gender majority composition controlling for number of siblings. Students' four-year college enrollment in the NLES cohort was more responsive to parent-child discussion, parents' social capital, monitoring, and educational expectations. We also found a sibship-gender majority advantage in the ADD Health cohort particularly for four-year college enrollment. Students' four year college enrollment in the ADD Health was also responsive to parents' social resources, child autonomy, and educational expectations.

Interestingly, students living in the sibship gender balance families, with greater family resources, had no female advantage on their college enrollment. Parents' interactions with their children may outweigh other factors in mixed gendered families which resulted in a more egalitarian attitude and resource allocations for daughters and sons to attend four year college.

Conclusion and Discussion

Our analysis of two national longitudinal studies yields three findings. First, we confirmed resources dilution hypothesis across cohorts and observed the present and decline of the male-specific resources dilution from the NELS cohort to the ADD Health cohort. This male "disadvantage" home-based environment is derived from the number of siblings and its negative association with resource allocations. This result, especially for sons in the NELS cohort, is consistent with results using twin data and sibling fixed effect model in Sweden (Amin, Petter, & Dan-Olof, 2011) and Norway (Black, Devereux, & Salvanes, 2005; Ermisch & Paronzato 2009).

Second, female advantage in college enrollment still holds across cohorts except for two-year college enrollment in the ADD Health cohort. We speculated that structural changes of sibship configuration might contribute to a daughters' advantage in college enrollment when she has few siblings and situating in the gender majority position, particularly for later cohorts. Our results support this proposition but only for daughters with sibship gender majority position for college enrollment. This "friendly" home-based environment enhances daughters' four-year college enrollment in the NELS cohort and two-year college enrollment in the ADD Health cohort.

We also find evidence of a decline in the importance of gender–specific dilution and socialization processes, particularly for four-year college enrollment. The gendered sibship majority socialization persists only in two-year college enrollment in the ADD Health cohort. Such changes point to a distinctive family advantage for students in the ADD Health cohort — either being a sibship gender majority position or greater female-friendly family with shared gender egalitarian socialization. More research should be undertaken to identify the influence of adolescents' experiences and development that may contribute to college-going mindset and pre-college preparation as well as the influence of their parents' education and labor market experiences. It may be that with the increasing financial opportunities to attend two-year colleges that the gendered majority position for two-year college enrollment may be seen as an economical and efficient pathway especially for females as they are more likely to study hard, complete their degrees, and transfer to four-year institutions if they desire.

Third, descriptive results confirm that family resource allocations varied by gender and sibship gender composition. This emerging influence of sibling gendered environment and differential resources allocation were largely confirmed in the multi-nominal models. Our analyses supported descriptive evidence of daughters-favorable resources allocation in cultural-related, socio-psychological and parents' supervision. The empirical evidence further suggested that greater resources promote two-year and four-year college enrollment and this tendency was consistent across cohorts. Surprisingly, our results suggested that better resource allocations toward the daughters and families with gender mixed siblings. However, our results and multi-nominal models further confirmed that better resources allocation is not necessary to have a female advantage in college enrollment. Result show that the female advantage in college is observed only with the daughters who have more sisters at home. Results seem to indicate the female sibship-gender majority socialization does not necessarily combine with the greatest family resource allocation. Daughters are particularly sensitive to family socialization with moderate family resources, which subsequently influences their college enrollment. Daughters' female-friendly family environments may provide supports for parents or daughters to develop more gender egalitarian attitude toward their higher education decisions.

Current results also point to potential disadvantage of daughters who are in the minority gender positions and of sons who are in larger families or are exposed to lower level of cultural and socio-psychological resources at home. Overall, family resource allocation appears to be particularly important for high school students in the transition into college. The inclusion of family resources explains 31% of the female advantage in four-year college enrollment in the NELS cohort and 22% of the female advantage in four-year college enrollment in the ADD Health cohort. It is worth noting that the inclusion of family resources nearly explains the total female advantage in four-year college enrollment in the NELS cohort ($p<.1$) controlling for family resources), but similar resources did not explain the female advantage in the ADD Health cohort suggesting a need for further examination of unobserved variables in the later cohort. In the NELS cohort, family resources explain a greater proportion of the female advantage in four-year college than two-year college (31% vs. 20%), which is consistent with the previous research that four-year college is largely dependent on family socio-economic status and resource availability (Bailey, Jaggars, & Jenkins, 2015; Ma & Baum, 2016). These results highlight the need to examine the differential resource allocation patterns (Dumais, 2002; Fasang, Mangino, & Bruckner, 2014; Kim & Schneider, 2005; McHale, Crouter, & Whiteman, 2003a) that contribute to home advantage toward daughters versus sons in high school achievement, college preparation, and college identity especially given the trend of smaller families.

Our findings point to a departure for future research. It bridges conventional educational inequality studies that have failed to examine sibship composition and family resources in explaining the female advantage in college enrollment. With smaller families and less emphasis on gendered balanced families, females are gaining a new resource opportunity. Mothers, especially those who have entered the labor force may be particularly sensitive to ensuring their daughters' future education and career successes and underscoring the importance of four year college enrollment.

Yet there are some limitations to this work. Although we identified the significance of family gender-specific context across cohorts, our multivariate analysis were restricted to comparable variables with similar questions on the two surveys and we may have missed some key measures in our models. Second, some family transitions, such as divorce or remarriage, may have occurred during the intervals within each of the surveys. We did however generate a dummy variable to capture the impact of these family transitions, our main findings still held across the cohorts. Third, this study focused on the effect of smaller number of siblings and gender composition on college enrollment, we do not discuss how the covariates in terms of family structure, income, and racial variation may change over time or any potential interactions among the covariates.

But even with these limitations one of the important values of this study is replicating the basic models with two different datasets, one of which that was started slightly earlier than the other. With two datasets it is possible to gain a deeper understanding of the general patterns on the female advantage in college enrollment based on up to date information about sibling gender composition by cohort comparative approach. Both datasets point to of the decline of the dilution model along with reductions in family size and casts a new perspective on accounting for sibship composition and multiple measures of family resource allocations. The female college advantage is complex and family not just schooling dependent. Being a good student is not quite enough without a family that expects college attendance and allocates education resources beyond family income to make that a reality.

APPENDICES

APPENDIX A

FIGURES FOR CHAPTER TWO

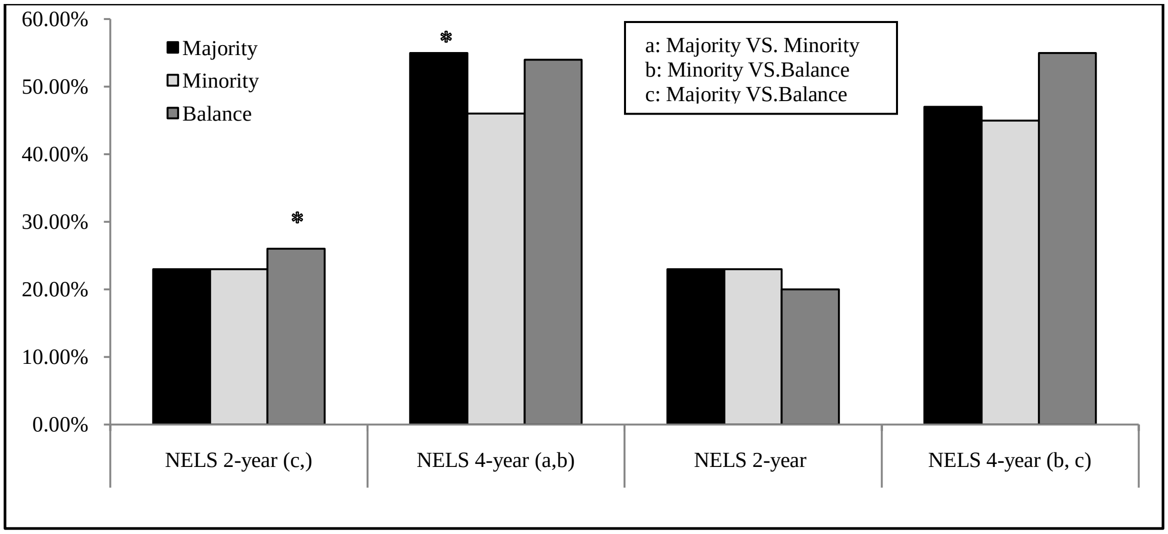

Figure 5: College Enrollment by Three Context of sibship Gender Composition in NELS cohort
Note. “a” indicates significant mean difference between majority and minority position; “b” indicates significant mean difference between minority and balance position; “c” indicates significant mean difference between majority and balance position. Statistical significance sets at level of 0.5.

Source: the National Educational Longitudinal Study 1988-1994 (NELS 88)

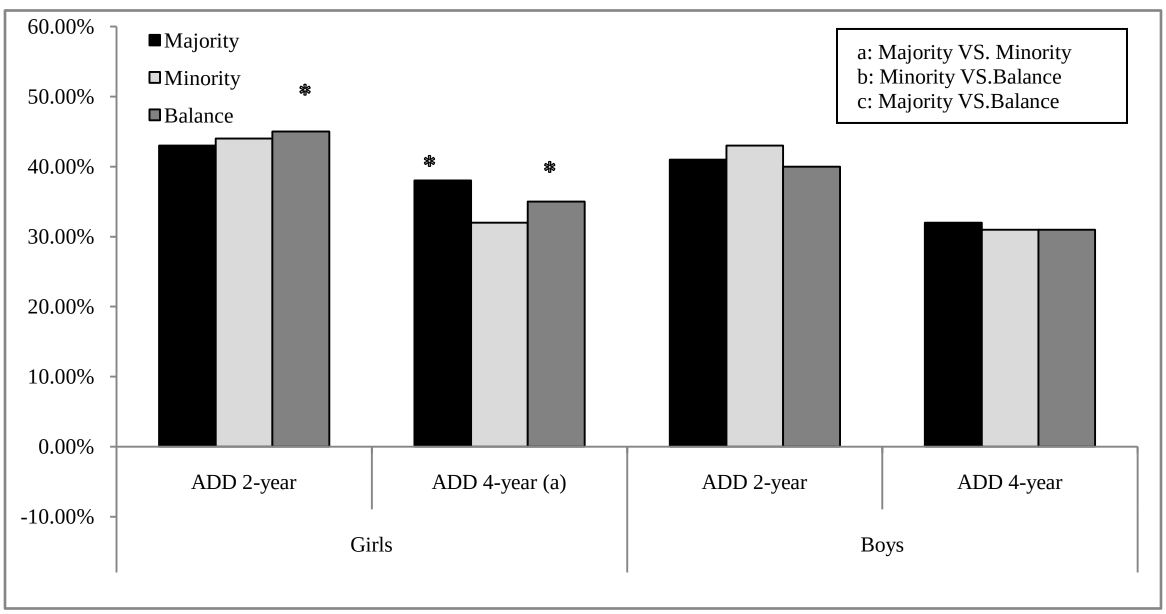

Figure 6: College Enrollment by Three Context of sibship Gender Composition in ADD Health cohort
Note. “a” indicates significant mean difference between majority and minority position; “b” indicates significant mean difference between minority and balance position; “c” indicates significant mean difference between majority and balance position. Statistical significance sets at level of 0.5.
Source: the National Longitudinal Study of Adolescent Health, 1994-2008 (Add Health)

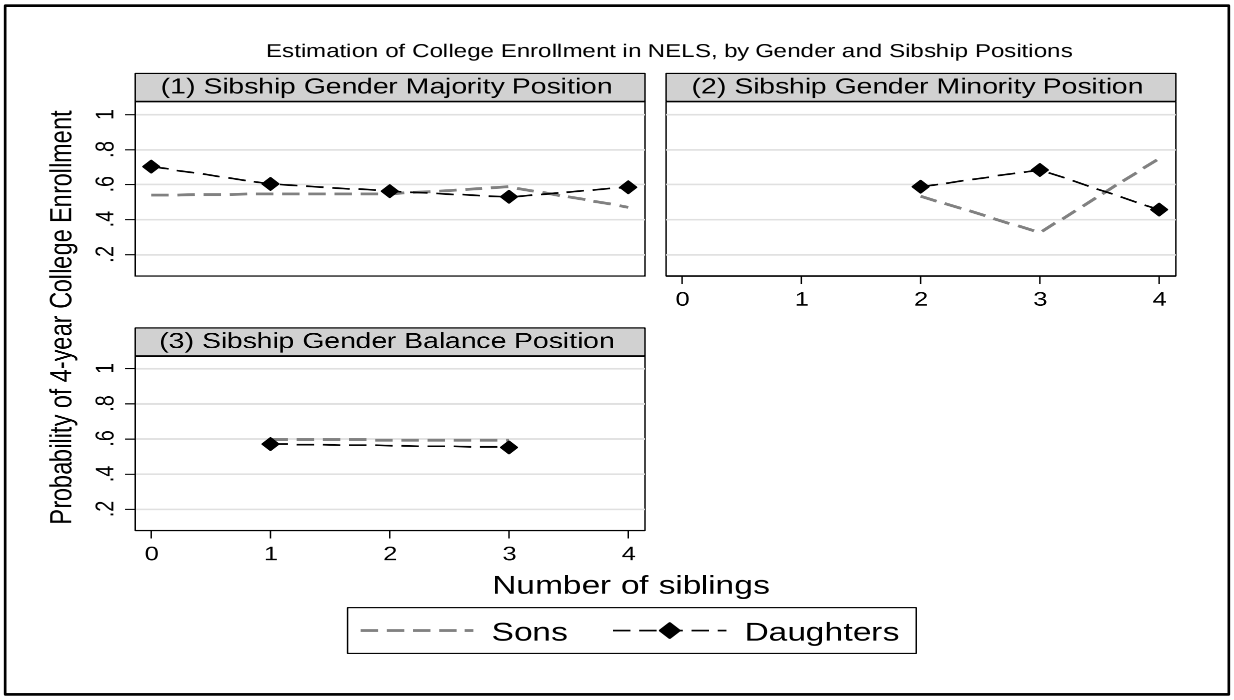

Figure 7: Four-Year College Enrollment Probability by Sibship Gender Composition in the NELS Cohort

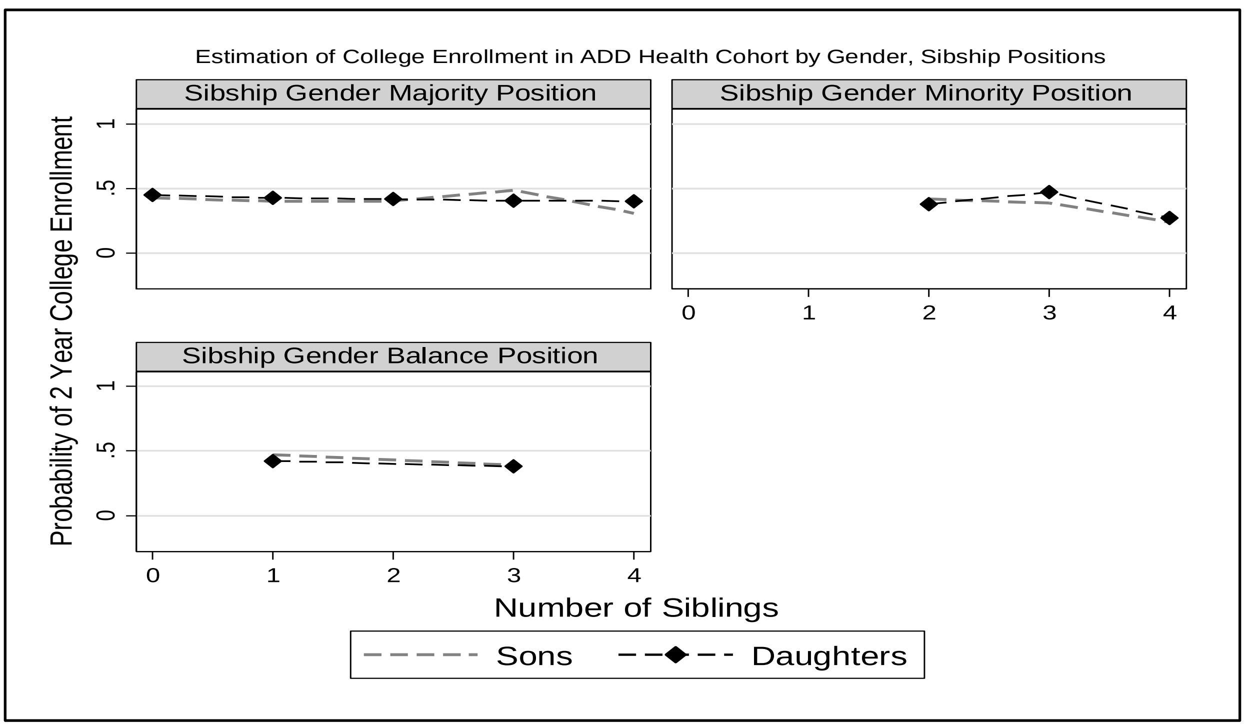

Figure 8: Two-Year College Enrollment Probability by Sibship Gender Composition in the ADD Health Cohort

APPENDIX B

TABLES FOR CHAPTER TWO

Table 5: Sample Means by Cohort and Sex for Variables Uses in Analysis

	NELS (1990-1994)			ADD Health (1994-2001)		
	Overall	Girls	Boys t-test[b]	Overall	Girls	Boys t-test[b]
Two-year college enrollment**(%)**	23	23	22	42[c]	44[c]	41 *
Four-year college enrollment**(%)**	51	53	48 *	34[c]	37[c]	32 *
Sibling gender composition						
living in sibshipgender-majority	60	57	65 *	64[c]	62[c]	68[c] *
living in sibshipgender-minority	16	18	13 *	8[c]	9[c]	7[c]
living in sibshipgender-balance family	24	25	23	28[c]	28[c]	24 *
Sibling Size						
Number of sibling	2.25	2.26	2.24	1.44[c]	1.45[c]	1.42[c]
School performance						
Math standardized score\Highest math	52.81	52.38	53.27 *	6.02	6.16	5.86 *
Reading standardized score\	52.69	53.25	52.09 *	66.86	66.12	67.62 *
Family Resources						
Cultural-related classes\extracurricular	0.73	0.91	0.54 *	0.42	0.49	0.35 *
Parent-child discusses school things\	9.46	9.46	9.46	16.15	16.13	16.16
Parent social resources (parent	3.15	3.16	3.13	2.71	2.73	2.69 *
Parent monitor\parent supervision[a]	6.14	6.56	5.67 *	12.35	12.39	12.31
Parents' support children's autonomy				2.69	2.64	2.74 *
Parents'expectation\ college	3.86	3.89	3.84 *	2.27	2.28	2.26
Race and Ethnicity (%)						
White	81	80	81	69[c]	69[c]	69[c]
Black	9	9	9	13[c]	14[c]	13[c]
Hispanic	6	7	6	10[c]	10[c]	10[c]
Asian	3	3	3	4	4	4
Others	0.1	0.1	0.1	3[c]	3[c]	3[c]
Family Living arrangement (%)						
Intact family	74	73	75	67[c]	65[c]	69[c] *
Step family	11	12	11	24[c]	25[c]	21[c] *
Single family	13	14	13	6[c]	6[c]	6[c]
Other guardians	2	2	1 *	4[c]	4[c]	3[c] *
Mother education (%)						
Mather less than HS	19	20	17 *	20	21	19[c] *
Mather HS	33	34	33	37[c]	38[c]	36[c]
Mather some college	22	22	21	15[c]	16[c]	14[c]
Mather college graduated	16	14	18 *	21[c]	19[c]	24[c] *
Mather beyond college	10	10	11	7[c]	7[c]	7[c] *

Table 5 (cont'd)

High school type (%)						
Public High school	89	90	89	82[c]	83[c]	81[c] *
Catholic High school	7	6	7	5[c]	4[c]	6[c] *
Private High school	4	4	4	13[c]	13[c]	13[c]
Student characteristics						
Student educational	3.98	4.05	3.90 *	4.19	4.30	4.07 *
Household income index [a]	9.57	9.47	9.68 *	2.55	2.53	2.57

Note: Analytic sample means and percentage are weighted.

[a.] The scale of the measurements between two cohorts is not consistent.

[b.] Statistical significance indicates a gender difference within each cohort.

[c.] Significant differences in the z test (t test for continuous variable) between this percentage and the corresponding percetage for the same demographic characteristics in the NELS sample.

* p<.05

Table 6: Mean Difference on Family Resources, by Child's Gender and Sibship Position in NELS and ADD Health cohort

NELS cohort	Girls			Boys		Girls position	Boys position
Majority	Mean	SD.		Mean	SD.	**Majority**	**versus Minority**
(1) Extracurricular activities	0.93	(1.06)	***	0.51	(.77)	***	
(2) Parent-child discussion/ relationship	9.47	(2.46)		9.43	(2.24)	**	
(3) Parent know about kid's friends' parent	3.13	(1.41)		3.12	(1.45)		
(5) Parent supervision /monitor	6.59	(2.29)	***	5.58	(2.50)		
(6) Parent educational expectation	3.90	(.87)	**	3.83	(.85)	**	
Minority						**Minority versus Balance**	
(1) Extracurricular activities	0.74	(.89)	**	0.57	(.89)	***	
(2) Parent-child discussion/ relationship	9.22	(2.61)		9.23	(2.31)	**	**
(3) Parent know about kid's friends' parent	3.10	(1.53)		3.20	(1.48)	**	
(5) Parent supervision /monitor	6.43	(2.52)	***	5.81	(2.41)		
(6) Parent educational expectation	3.81	(.82)		3.80	(.89)	**	
Balance						**Majority versus Balance**	
(1) Extracurricular activities	0.98	(1.02)	***	0.60	(.90)		**
(2) Parent-child discussion/ relationship	9.59	(2.38)		9.65	(2.16)		**
(3) Parent know about kid's friends' parent	3.28	(1.39)	**	3.12	(1.36)	**	
(5) Parent supervision /monitor	6.58	(2.33)	***	5.85	(2.42)		**
(6) Parent educational expectation	3.91	(.89)		3.88	(.87)		
ADD Health cohort							
Majority						**Majority**	**versus Minority**
(1) Extracurricular activities	0.48	(.70)	***	0.35	(.73)		
(2) Parent-child discussion/ relationship	16.06	(2.38)		16.16	(2.34)		
(3) Parent know about kid's friends' parent	2.73	(.67)	**	2.68	(.72)		
(4) Parents respect children's autonomy	2.64	(.99)	**	2.72	(1.05)		
(5) Parent supervision /monitor	12.40	(2.45)	**	12.26	(2.42)	**	
(6) Parent educational expectation	2.28	(.70)		2.25	(.72)		**
Minority						**Minority versus Balance**	
(1) Extracurricular activities	0.46	(.68)	***	0.29	(.58)		***
(2) Parent-child discussion/ relationship	16.11	(2.39)		16.12	(2.20)		

Table 6 (cont’d)

(3) Parent know about kid's friends’ parent	2.68	(.75)	2.71	(.65)	
(4) Parents respect children’s autonomy	2.56	(1.01) ***	2.80	(.98)	
(5) Parent supervision /monitor	12.70	(2.58) **	12.28	(2.39) **	
(6) Parent educational expectation	2.27	(.68) *	2.36	(.74)	
Balance					**Majority versus Balance**
(1) Extracurricular activities	0.52	(.79) **	0.41	(.83)	*
(2) Parent-child discussion/ relationship	16.28	(2.28)	16.19	(2.26) **	
(3) Parent know about kid's friends’ parent	2.75	(.64)	2.71	(.71)	
(4) Parents respect children’s autonomy	2.66	(.99) **	2.77	(1.00)	
(5) Parent supervision /monitor	12.27	(2.46)	12.44	(2.47)	
(6) Parent educational expectation	2.29	(.70)	2.27	(.72)	

Table 7: Multinominal Logistic Regression Predicting College Enrollment Pattern Using NELS (1990-1994) and ADD Health (1995-2008)

Panel-A: NELS 1990-1994	2-year versus non		4-year versus none	
	Model-1	Model-2	Model-1	Model-2
Female	0.310**	0.246*	0.334**	0.229+
	(0.113)	(0.123)	(0.119)	(0.128)
Sibling size	-0.087*	-0.076*	-0.119**	-0.099*
	(0.036)	(0.036)	(0.039)	(0.039)
School Performance				
Grade 10 math standardized	0.008	0.010	0.077***	0.081***
	(0.009)	(0.009)	(0.009)	(0.009)
Grade 10 reading	0.023**	0.021*	0.030***	0.027**
	(0.009)	(0.009)	(0.009)	(0.008)
Family Resources				
(1) Extracurricular activities		0.129+		0.197**
		(0.074)		(0.072)
(2) Parent-child discusses school		0.070**		0.143***
		(0.025)		(0.025)
(3) Parent social resources		0.117**		0.207***
		(0.038)		(0.041)
(5) Parent supervision		0.048*		0.055*
		(0.021)		(0.022)
(6) Parent educational	0.236**	0.172*	0.369***	0.298***
	(0.082)	(0.081)	(0.088)	(0.087)
Student educational	0.747***	0.704***	1.479***	1.415***
	(0.086)	(0.089)	(0.100)	(0.103)
Family income 1992	0.113**	0.124**	0.082+	0.090*
	(0.039)	(0.040)	(0.045)	(0.045)

Panel-B: ADD Health	2-year versus none		4-year versus none	
	Model-1	Model-2	Model-1	Model-2
Female	0.112[a]	0.110	0.288**	0.226*
	(0.075)	(0.074)	(0.102)	(0.099)
Sibling size	-0.086**	-0.085**	-0.128**	-0.102*
	(0.029)	(0.029)	(0.044)	(0.043)
School Performance				
The highest level of math	0.010*	0.010*	0.027***	0.025***
	(0.005)	(0.005)	(0.006)	(0.006)
Vocabulary score	0.345***	0.337***	0.645***	0.644***
	(0.025)	(0.026)	(0.033)	(0.034)
Family Resources				
(1) Extracurricular		0.133**		0.015
		(0.051)		(0.064)
(2) Parent-child		0.043**		0.067***
		(0.016)		(0.019)
(3) Parent social resources		0.100*		0.149*
		(0.046)		(0.063)
(4) Parents' support children's		-0.015		0.318***
		(0.036)		(0.052)
(5) Parent supervision		0.001		0.015
		(0.015)		(0.017)
(6) Parent college	0.095+	0.088	0.334***	0.327***
	(0.056)	(0.056)	(0.067)	(0.065)
Student college	0.280***	0.256***	0.677***	0.634***
	(0.034)	(0.035)	(0.054)	(0.055)
Household income quarter	0.208***	0.211***	0.295***	0.305***
	(0.037)	(0.039)	(0.049)	(0.051)

+ p< .1; * p<.05; ** p<.01; *** p<.001;*Note*. NELS analytic sample, N=6364. ADD Health sample, N=5615.Reported multi-nominal logistic regression coefficient and standard errors in parentheses. Model control for Heckman selection probability, family living arrangement, race, mother education, high school type, region. [a] Significant different from NELS cohort * p<.05 (Hausman test applied).

Table 8: Multinominal Logistic Model on College Enrollment by Sibship Gender Composition in NELS

	2 year			4-year		
	Model-1	Model-2[a]	Model-3	Model-1	Model-2[a]	Model-3
Female	0.260*	0.247*	0.142	0.222*	-0.001	-0.038
	(0.123)	(0.122)	(0.164)	(0.110)	(0.185)	(0.172)
Sibling size	-0.164***		-0.080*	-0.097*		-0.091*
	(0.045)		(0.039)	(0.041)		(0.039)
Sibship majority position	-0.031		-0.146	-0.086		-0.271
	(0.155)		(0.158)	(0.174)		(0.170)
Sibship balance position	0.054			-0.052		
	(0.179)			(0.197)		
Gender-specific family context						
Number of Siblings*Female		-0.039			-0.048	
		(0.043)			(0.048)	
Number of Siblings*Male		-0.130*			-0.140*	
		(0.057)			(0.058)	
Sibship Majority			0.170			0.421*
			(0.210)			(0.201)

Note. NELS analytic sample, N=6364. Reported multi-nominal logistic regression coefficient and standard errors in parentheses. [a] The interaction between female and sibling size is significant in Model 2. But, to specifiy gender-specific effect, we exmaine interaction separated by gender. The refernece group is the single-child families.+ p<.1* p<.05** p<.0*** p<.001

Table 9: Multinominal Logistic Model on College Enrollment by Sibship Gender Composition in ADD Health

	2 year			4-year		
	Model-1	Model-2[a]	Model-3	Model-1	Model-2[a]	Model-3
Female	0.115	0.217	-0.062		0.375***	0.444**
	(0.078)	(0.122)	(0.117)		(0.101)	(0.151)
Sibling size	-0.056[b]		-0.065*		-0.015[b]	
	(0.035)		(0.030)		(0.052)	
Sibship majority position	0.131		-0.162		0.186+[b]	
	(0.173)		(0.118)		(0.112)	
Sibship balance position	0.167				0.162	
	(0.175)				(0.201)	
Gender-specific family context						
Number of Siblings*Female		-0.091*			-0.070	
		(0.043)			(0.053)	
Number of Siblings*Male		-0.107*			-0.009[b]	
		(0.042)			(0.064)	
Sibship Majority position)*Female			0.266*			0.093[a]
			(0.121)			(0.198)

Note. ADD Health sample, N=5615.Reported multi-nominal logistic regression coefficient and standard errors in parentheses. [a] The interaction between female and sibling size is significant in Model 2. But, to specifiy gender-specific effect, we exmaine interaction separated by gender. The refernece group is the single-child families.[b]Significant different from NELS cohort, applying only for female, sibling size and gender composition variable across cohorts.* p<.05 (Hausman test applied)

APPENDIX C

SUPPLEMENTAL TABLES

Table 10: The Classification of Sibhip-sex Majority, Balance and Minority Context at Home

Type			Boy	Girl
1	Sibsize=0	**no sibling**	**Majority**	**Majority**
2	Sibsize=1	**1 girl sibling**	Balance	**Majority**
3	Sibsize=1	**1 boy sibling**	**Majority**	Balance
4	Sibsize=2	**2 girls sibling**	Minority	**Majority**
5	Sibsize=2	**1 girl and 1 boy sibling**	**Majority**	**Majority**
6	Sibsize=2	**2 boys sibling**	**Majority**	Minority
7	Sibsize=3	**3 girls sibling**	Minority	**Majority**
8	Sibsize=3	**2 girl and 1 boy sibling**	Balance	**Majority**
9	Sibsize=3	**1 girl and 2 boys sibling**	**Majority**	Balance
10	Sibsize=3	**3 boys sibling**	**Majority**	Minority
11	Sibsize=4	**4 girls sibling**	Minority	**Majority**
12	Sibsize=4	**3 girls and 1 boy sibling**	Minority	**Majority**
13	Sibsize=4	**2 girls and 2 boys**	**Majority**	**Majority**
14	Sibsize=4	**1 girl and 3 boys sibling**	**Majority**	Minority
15	Sibsize=4	**4 boys sibling**	**Majority**	Minority

Table 11: Family Resources Variables

Variable in NELS data	Variable description	Variable Range
(1) extracurricular activities organized by parents and by schools	Parents' report of whether the focal student attended cultural-related classes after school which included studying (a) art, (b) music, (c) dance, (d) language and (e) the computer.	This measure took the sum of all five items, ranging from 0-5.
(2) parent-child discussion and parent-child relationship	Parent reported how frequently a parent discussed the following with their teenage child (a) selecting courses, (b) school activities, (c) school studying, (d) grades, (e) ACT/SAT exam, and (f) applying to colleges.	This measure scaled from 0 (never) to 2 (often). We took the sum of all six items, ranging from 0-12.
(3) social capital—knowing the parents of the students' friends	Parents reported "whether he/she knows parents of teen's 1st-5th friend" which represents the number of a student's five closest friends' that parents knew in the NELS data.	This measure took the sum of all 5 friends, ranging from 0-5.
(5) involvement in monitoring and supervision of student activities such as homework	Students reported that how often their parent monitors: (1) where teen is after school, (2) where teen goes at night, and (3) what teen does with free time.	The scale of each item ranged from 1-5 and higher scores represented stronger control from parents.
(6) education and career expectations parents had for their students	Students reported educational expectations and parent expectation on "	The scale of item ranged from 1-7 and higher scores represented higher expectations.

Table 11 (cont'd)

Variable in ADD Health data	Variable description	Variable Range
(1) extracurricular activities organized by parents and by schools	Student self-report as to whether the student attended cultural-related extracurricular activities in school, such as attending a club focused on learning a second language, music club, or computer club.	This measure also took the sum of all nine items, ranging from 0-9.
(2) parent-child discussion and parent-child relationship	Parented reported (a) how well gets along with the adolescent, (b) makes decisions about the adolescent's life with the adolescent, (3) trust the adolescent, and (4) satisfaction with his or her relationship with the adolescent.	Answers were recoded into five categories and we took the sum of all four items, ranging from 0-20.
(3) social capital—knowing the parents of the students' friends	Parents reported in wave one about "how many parents of [focal child's] friends have you talked to in the last 4 weeks?"	Answers were re-coded into six categories from 0 to 5 (represents five or more friends) to align with the same variable in the NELS data.
(4) independence—allowing students with autonomy for some decisions	Students reported whether parents allow you making your own decisions about (1) the time at home on weekend nights, (2) people you hang around with, (3) how much television you watch, and (4) which television programs you watch.	This measure took the sum of all 4 items, ranging from 0-4.
(5) involvement in monitoring and supervision of student activities such as homework	Student reported how often each resident mother and father was home: (1) before they go to school, (2) after they return from school and (3) when they go to bed.	The scale of each item ranged from 1-5. We combine mother and father information as a parental supervision variable.
(6) education and career expectations parents had for their students	Students reported how likely is it that you will go to college?" where higher scores represented higher expectations. And, parent reported their college expectations for children as "how disappointed would you be if your kid did not graduate from college?"	The scale of student expectation was a five-point scale. The scale of parent college expectation was a three-point scale.

Note. [a]. All resource measures in NELS came from the second follow-up data.
[b]. All resource measures in ADD Health came from Wave 1 data.

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CHAPTER THREE

THE EFFECT OF MARRIED MOTHERS' EMPLOYMENT ON CHILDREN'S HIGH SCHOOL ACHIEVEMENT, MATHEMATICS SELF-EFFICACY AND STEM MAJORS

Introduction

Enhancing women's participation in the STEM fields of computer science and engineering remains a national priority. Females lag behind their male counterparts in certain STEM fields, among STEM degree recipients, and in the labor market (Anderson & Kim, 2006; Wang, 2013). The best method of bringing more women into STEM careers remains unclear; current explanations for the low number in STEM fields tend to emphasize educational factors, gender stereotypes and gendered perceptions of STEM careers (Ceci & Williams, 2011; Eccles & Roeser, 2011; Tyson, Lee, Borman, & Hanson, 2007). Some evidence, however, indicates that mothers' employment status and family social and psychological resources have a greater influence on women's entry into STEM fields (Fomby, 2013; Xie, Fang, &Shauman, 2015). Despite substantial demographic change in delayed parenthood and mothers' increased participation in the labor force, the extent to which mothers' labor force participation is associated with their children's likelihood of majoring in a STEM field remains underexplored.

There are several explanations why fewer females than males major in STEM fields, including biological differences in spatial versus verbal skills (Ceci, Williams, & Barnett, 2009); parents' expectations and investment in their children's schooling (Baker & Milligan, 2016; Morgan, 2005; Morgan &Weeden, 2013); social and cultural influences (Guiso, Monte, Sapienza, &Zingales, 2008); non-cognitive skills and peer influence (DiPrete& Jennings, 2012 ; Kulis, Sicotte, & Collins, 2002); gender-specific social contexts and discrimination (Wang, Eccles, & Kenny, 2013; Ceci& Williams, 2011) and teacher bias. Despite the debate over the shortage of female role models and supportive communities in the workforce, there is a paucity of research on when and the extent to which mothers' employment status encourages their adolescent daughters to major in a STEM field.

Mothers' employment status shapes their children's educational opportunities and aspirations through parental investment and involvement in children's schooling and career preparation. Adolescents with career mothers tend to have better economic and socio-cultural resources than adolescents with stay-at-home mothers. Career mothers are able to spend more of their income, time and knowledge investing in educational resources and services for their children, such as having their children take the SAT, receive tutoring, and attend summer camps and extracurricular activities.

This study examines the role of mothers' employment conditions on children's STEM major. Specifically, I examine two aspects of mothers' employment -- working hours and occupational prestige -- in four cohorts of surveys between 1980 and 2013 to discern whether having a career mother affects children's decision to major in a STEM field and how this may change over time. Career mothers refer to mothers that were part of the labor market during their children's life stage at 10th grade to four years after. This study assumes that the role of motherhood has changed as more mothers increase their economic independence and as female equity rises. Mothers' employment status and economic resources may promote their children's STEM career through three transmitting processes: 1) children's mathematics self-efficacy, 2) cognitive development, and 3) family support.

Background

Career Mothers and Impacts on Children

Current studies of the relationship between mothers' employment and children's educational outcomes present three arguments over whether paid jobs have a positive, negative or neutral effect on their children's educational outcomes (Goldberg, Prause, Lucas-Thompson, &Himsel, 2008). For example, Parcel, Nickoll & Dufur (1996) found that mothers with full-time jobs had a negative effect on children's reading and math scores for nine-to-twelve-year-olds compared to mothers employed part-time. Ruhm (2004) also found a small deleterious effect of full-time employed mothers on verbal ability and a larger negative impact on school achievement of five-to-six-year-olds.

In contrast, Haveman, Wolfe & Spaulding (1991) identified that the effect of mothers' employment on four-to-fifteen-year-old children had a positive association with their children's probability of graduating from high school. Johnson and colleagues (2012) found that mothers with higher job stability and jobs with high cognitive-skill demands tended to reduce children's behavioral problems. Jobs requiring high cognitive skills were also expected to increase mothers' wages, which allowed mothers to contribute to family income and investment in children.

A third group of studies found no clear association between mothers' employment and their children's educational outcomes. For example, Aughinbaugh & Gittleman (2004) examined the impact of maternal employment on children's adolescents' risky behaviors and found no strong evidence between mother's employment and children's behavioral problems using data from the NLSY79. Baum (2004) found that mothers' employment during childhood did not affect school GPA when their adolescent was in high school. However, Baum found a marginal negative effect on high school grades when mothers were employed during high school students' adolescent years;

this effect was stronger for sons than daughters. Despite considerable research, little is known about whether mothers' employment status is associated with children's STEM decision, and even less has been explored about the mechanisms through which mothers' employment conditions affect their children's educational outcomes.

What are the key messages conveyed by the aforementioned research? First, a longitudinal study is desirable to identify family processes that transmit causal impacts from mothers' employment to children's outcomes in adolescence. Second, by taking advantage of longitudinal data, researchers should investigate the mechanisms that may account for the detrimental and beneficial effect of mothers' employment on children across children's life course, such as early childhood or adolescence. Finally, definitions of mothers' employment should be expanded to other factors in terms of earnings, work hours and occupational prestige, rather than limited to a dichotomous variable and a nationally representative analysis is needed. The goal of this study is to address these issues by proposing a research framework that is based on the suggestions by Dufur, Parcel & Troutman (2013) and testing it with four nationally representative surveys.

Previous research has suggested that schooling and parenting are two major mechanisms to transmit mothers' influence into children's development. I argue that it is a contingent effect of maternal employment on children's educational outcomes. Whether this effect is positive or negative may depend on the family processes between mother and children, such as children's development on cognitive ability and interests in a STEM career. In this study, I focus on two processes. The first process is to link mothers' employment to children's schooling and school achievement. The second process is to link mothers' employment to children's development in math self-efficacy.

Theoretical Perspectives: the Causal Effect of Career Mother on Children's Cognitive Development and Interest in a STEM Career

I proposed three theoretical hypotheses to link maternal employment and children's STEM participation. First, the gender asymmetric hypothesis emphasizes the involvement of mothers' time and care has a strong influence on their children's educational outcomes and interest in a STEM career. Therefore, a reduction of mothers' involvement as a result of their participation in the labor market has a more detrimental effect on their children's school achievement. Following this line of research, and given that more mothers have entered the labor force, has led to the hypothesis that the potentially negative effects of maternal employment for children may increase over time.

The economic independence hypothesis describes that changes from "traditional motherhood" to "modern motherhood," have led to more economic autonomy allowing for mothers to be involved in and invest in children's schooling. For instance, children may need more resources and family support to indulge in STEM major interests. Career mothers with more moderate gender role attitudes, more prestigious jobs, and greater participation in the labor market, are more likely to allocate economic, social, and cultural resources to ease their children's transition into demanding math/science careers. Augustine, Cavanagh &Crosnoe (2009) found that maternal cognitive and psychological skills contribute to the effect of maternal employment on children's outcomes. Married career mothers also gained more economic and social resources by participating in the labor market. College-educated career mothers are associated with more effective parenting and caring styles than less educated mothers (Kalmijn 1994). For example, career mothers tend to know how to stimulate their children's cognitive development, and manage, monitor, and encourage their children's academic activities and decisions (Archer et al., 2012).

Career mothers could also serve as role models to their children in transmitting career values and experiences (Kalmijn 1994). Archer and colleagues (2012) found that mothers encouraged daughters to engage in self-supervision and self-confidence in mastering any subjects in school that include actual participation in the STEM major courses. Based on this line of reasoning, I argue that the children of career mothers are more likely to be interested in math/science areas among high school seniors and a narrowing gender gap in STEM fields.

According to the mothers' cognitive ability and occupational prestige hypothesis, jobs with high occupational prestige are more likely to include complex jobs requiring mothers' high cognitive skills and development, resulting in better stimulation and mothering on children's cognitive development (Cooksey, Menaghan, &Jekielek, 1997; Parcel &Dufur, 2001; Parcel &Menaghan, 1990). In addition, career mothers with prestigious jobs are more likely to earn more, and have stable income and professional affiliations with colleagues. As such, these mothers tend to promote the internalization of behavioral norms, encourage self-efficacy, and facilitate cooperation in their children, as their occupation tends to value self-supervision and self-worth. This line of research has suggested that parents in more complex occupations provide more warmth and cognitive stimulation for their children than do parents in routinized occupations (Parcel &Menaghan, 1994) and full-time shift position with lower cognitive demands. Mothers' job stability and job complexity, therefore, have a positive effect on children's educational outcomes, cognitive development and interest in mastering STEM fields (Johnson, Kalil, &Dunifon, 2012). I therefore argue that children of mothers in high prestige careers are associated with growing school achievement, which in turn, affects children's interest and opportunities in STEM career among high school seniors.

Career Mother and Family Supports

Parents' school involvement and support are indicators of family social capital, which refers to "relations among persons that facilitate action" (Coleman 1988: p.100). In this study, action indicates that family members built relations within and outside their immediate family that facilitate attending college and majoring in STEM. Family social capital represents a connection between parent and teacher, and between family and school (Chin & Phillips, 2004; Kim & Schneider, 2005; Offer & Schneider, 2007; Crosnoe, 2004, 2009). For example, college educated mothers are better able to recognize the value of a college education for children, particularly for daughters (Buchmann & DiPrete, 2013; Raley & Bianchi, 2006), and are more likely to be equipped with math-specific or science-specific capital to build up a local community of the "STEM family" (Archer et al., 2012).

In addition, family social capital and support for education varies by children's gender, school achievement and mother's employment. Eccles (2015) found that parents of daughters are more likely to have cohesive parent-child communication, relationships, and social capital than parents of sons. In addition, new family social capital may form in the raising of a mother's position in the labor market. Although mothers with full-time professional jobs may participate less often in regular school activities (e.g., PTO meeting, school board), some evidence has indicated that career mothers are more flexible in arranging and organizing school (Fox, Han, Ruhm, & Waldfogel, 2013) and leisure activities (e.g., STEM-related programs, science camp, summer travel) for their children. To date, we know less about whether and how the family support changes in the dynamics of mothers' labor force participation. Few researchers have investigated the connections between the changes in mothers' employment and how it affects children's participation in STEM fields. While previous research has been clear on the positive effect of family social capital on students' schooling, few pieces of research have investigated whether family support has increased or declined over time, and what types of new family supports may take shape.

The theoretical framework in this study integrates the family social capital theory, gender-specific resources perspective and prior literature on factors closely related to mothers' employment and students' selection of math/science college majors. Within this framework, students' participation in STEM field is a function of school achievement in the 12th-grade, exposure to effective family support and, belief in mathematics self-efficacy.

Research Questions

This study will examine the effects of two maternal employment conditions -- work hours and occupational prestige – on children's interest and participation in math/science activities and college major. Three questions about potential changes in mothers' labor force participation, and children's math/science interesting and participation guide this research: 1) As mothers' labor force participation increases, what is the relationship between maternal employment and children's majoring in a STEM field? 2) To what degree does maternal employment affect children's math/science major through math-efficacy and school achievement? 3) Does mothers' employment affect boys' and girls' math/science participation in different ways?

Hypothesis 1a: The negative influence of mother's employment on children's participation in STEM fields increases over time.

Hypothesis 1b: The negative influence of mother's employment on children's participation in STEM fields decreases over time.

Hypothesis 2: The growing number of high-prestige and full-time career mothers strengthens their influence on children's education through cognitive stimulation and self-confidence in math.

Hypothesis 3: The influence of full-time career and mothers with prestigious jobs affects daughters more than sons, but this tendency is present only in the recent cohort.

Data and Methods

Data

My sample consists of high school seniors living with their married biological parents. I exclude single-parent, divorced and legal guardian families to simplify the model and reduce confounding. In doing so, this study is able to focus on changes and patterns in mothers' employment on the unit of two-biological family in respect to children's educational outcomes. I also exclude families in which the adolescent respondents did not report or whose responses were missing in the postsecondary outcomes from the last follow-up. Limiting the sample in these ways may produce some selection bias in the final analytic sample. For example, it slightly changes the sample toward families who reported higher father's educational attainment of 2.44 and mother's education attainment of 2.33 in the High School and Beyond 1980 in the descriptive statistics presented in Table 12, compared to an average father's educational attainment of 2.42 and an average mother's education attainment of 2.30 in Table 27.

To track changes in mothers' employment, I consult four longitudinal studies conducted by the National Center for Educational Statistics (NCES): High School and Beyond 1980 (HS&B), the National Education Longitudinal Study 1988 (NELS 88), the Education Longitudinal Study of 2002 (ELS02) and High School Longitudinal Study (HSLS09). HS&B includes 14,670 sophomore students in 988 schools who reported in the third follow-up survey in 1986. The NELS includes 12,144 10th grade students in the first to fourth follow-up. The ELS includes 16,197 students in 750 schools who reported in the third follow-up survey. The HSLS data surveys 17,800 9th grade students in 944 schools who reported in both the first and the second follow-up surveys in 2013.

I use data from student and parent surveys to compare four cohorts of 15-16 year-olds interviewed in 1980, 1990, 2002 and 2009. (See the appendix for description of background and control variables.) I discuss key variables of interest below.

Measures of Dependent Variables

My primary outcome of interest is whether students have enrolled in a math/science intensified college major two years after high school graduation. This outcome is based on the requirement of math/science ability to categorize into four nominal choices (George-Jackson, 2014; Lara Perez-Felkner et al., 2015): (a) participated in physics, engineering, mathematics, and computer science major (PEMC); (b) participated in agricultural, architectural and natural resources sciences (AAN); (c) participated in biological sciences, psychology, clinical and health science (BPCH); and (d) enrolled in humanities, education, general curriculum, social and behavior science (HESB).

Measures of Independent Variables

This study examines three paths by which mothers' employment conditions (e.g., working hours and occupational prestige) affect children's college majors. Mother's employment was measured by two dummy variables to capture whether a mother works part-time, full-time, or not at all. I also recode the occupation category of mother and father in the survey into occupational prestige scores ((Blau& Duncan, 1967; also See Table 28). The occupational prestige scores come from Nakao & Treas (1990, 1994) for each of the 503 Census occupations and updated code for the more recent survey data from Hout and colleagues (2010).

Students' Mathematics Efficacy. Table 17 lists the indicators of students' mathematics efficacy, their factor loadings, and the factors' measure of reliability. The table also contains the indicators and their factor loadings, with the measures of reliability across cohorts used in the analysis. Table 26 gives further details on the variables. Career mothers may have more egalitarian gender role attitudes, and affective beliefs about their children's schooling and achievement goal (Eccles, 2015), which may increase children's interest in STEM fields. As Bleeker& Jacobs (2004) suggested, daughters' pursuit of careers in engineering and other math/science fields was positively related to their mothers' belief in and perception of their math and science achievement and their confidence in succeeding in a STEM career. As such, career mothers are more likely to have a better knowledge of their children, which may increase likelihood of their children enrolling in STEM fields.

School Achievement. The measure of students' achievement uses students' grade point average in 12th grade among the HS&B, NELS and ELS data. For the HSLS data, the measure of students' achievement uses students' grade point average in the 11th grade. Although transcript data is another variable to represent students' school performance, it produces a larger proportion of missing cases. Thus, I use students' grade point average to represent students' school achievement. I also measure students' high school achievement by generating Naïve Percentile-Ranking with 10th graders composite standardized test score (combined bother reading and math). I recognize that there is a huge difference between different standardized procedures and test composite scores across datasets. To perform this analysis, I apply a simple linear equating procedure to generate a percentile-ranking based on standardized test composite score (Friedkin & Thomas, 1997). This percentile-rank represents the school ranking of students' standardized test-score compared to their peers in each survey cohort. I use this Naïve Percentile-Ranking variable to double check the distribution of GPA across cohorts. The results are similar when using either the GPA or Naïve Percentile-Ranking of composite standardized test score. Thus, in the final analytical model, I report school achievement using school average GPA.

Family Resources. The availability of family resources for children is derived from family structure, parents' employment status, and fertility decisions. In this study, four types of family resources are identified that may contribute to families with a career mother that has more resources: (1) family preparation for school, (2) parental involvement in schooling, (3) parents' educational expectations, (4) parents' savings for the focal child's education.

Family preparation for school: this measure is derived from each data set with three identical items: (1) how often the student goes to class without pencil/paper, (2) how often the student goes to class without books, (3) how often the student goes to class without having done the homework. I recode the original scale and generate the sum of all three items for each family.

Parental involvement in schooling: this measure is derived from each data set with four identical activities: (1) how often parents attend school meetings, (2) how often parents phoned a teacher or counselor, (3) how often parents attended school events, and (4) how often parents volunteered at their 10th graders' school. On a scale of 0-4, this measure represents how many school activities parents participated in at their 10th graders' school.

Parents' educational expectation: this measure is derived from each data set with one identical item. I recode students' and parents' educational expectations into seven categories. This question includes a "don't know" option on the questionnaire. In this study, I use students' perception of their parents' educational expectations as an indication of social-psychological encouragement. I assume that the higher the parental expectations, the higher the academic orientation students perceived from parents. Based on this notion, if students reported that they didn't know their parents' expectations, this implies that students perceive no academic orientation from their parents.

Parents' saving for the focal child's education: this measure is derived from each data set, in which parents report whether they have ever set aside money for a teen's education. I use a dummy variable to capture whether parents saved money for the targeted teen.

Measures of Control Variables. (1) Family SES. I include family SES as a composite score in the model. To make the comparison across three data sets, I generate new family SES composite scores using the information obtained from each survey, which includes father occupation, father education, mother occupation, mother education and household income. (2) Race and ethnicity. I separate this measure into four dichotomous variables, which represent students' racial and ethnic background: non-Hispanic white (reference category), Black, Hispanic and Asian/Pacific Islander. The Hispanic category includes all Hispanic-origin students regardless of whether he/she reported multi-racial or white. Students who identified as Native American or other race/ethnicity are excluded from the analyses due to small sample sizes. (4) Mother's education. Using the parent survey, I categorize mother's education into four groups: 1) less-than high school, 2) high school diploma, 3) some college, and 4) college and beyond. When this variable is missing for some respondents or when the mother was not surveyed, I use adolescents' reporting of the education level of residential mother. (5) Immigrant status. I generate a dichotomous variable to represent whether or not students were born in the United States. (6) Number of siblings. All four data sets asked (in various ways) "the number of siblings that 10^{th} grade had" in the HS&B data. In the NELS data, respondents were asked about the number of siblings in both the student and parent surveys. In the ELS data, 10^{th} grade respondents were asked about "the number of siblings living with the 10^{th} grade respondent." In the HSLS data, respondents were asked about "the number of siblings living at home." I use these variables in their original form to represent the number of siblings, which did not distinguish between full-sibling, half-sibling or adopted sibling.

Analytic Methods

This study uses a two-step modeling approach to access whether the gender gap of STEM major change over time. In the first step, the measurement part of the model is examined and I report the factor loading, as well as the factor's measure of reliability in Table 17. All measurement models across data sets are acceptable (Kline 2011). In the second step, I analyze the multi-group structural equation model using pooled data across the datasets, where the measurement and structural parts of the model were simultaneously estimated using Mplus 7.1 software package (Muthén&Muthén, 2012). Given the nature of the nominal outcome, multinomial logistic regression is used, in which the log odds of the outcomes are modeled as a linear combination of the predictor variables.

Multi-group analysis is also applied to simultaneously estimate the relationships among these concepts/factors and to examine hypotheses in the framework of Figure 9. Observations across four datasets are 23,187. The full information maximum likelihood estimation method is also adopted to account for missing cases in the independent variables and covariates. Listwise deletion is used to deal with the missing cases in the exogenous observed variables. Listwise deletion results in the removal of about 2651 cases from the sample, with a final analytic sample size of about 20,536 in the SEM model. M-plus package also accounts for survey weight, and indirect effects through two potential paths that I propose to examine in the research framework.

I then followed the two-stage approach (Anderson & Gerbing, 1988) to implement a model where the two pathways are not considered in the first model. The purpose of using a two-stage approach is to establish the auxiliary relationship between mothers' employment and children's STEM participation. The second model takes into account all covariates and the two proposed mechanisms to investigate if the effect of mothers' employment on children's STEM career decision is mediated. I summarize the standardized coefficients in tables, and calculated the indirect effect of mothers' employment on STEM career through two pathways (Hayes, 2013; Muthén&Muthén, 2012). With respect to model fit diagnostics, since this study uses the multinomial logistic regression and maximum likelihood estimation method, it is not as straightforward to do model fitting diagnostics with multinomial logistic regression models.

Descriptive statistics are reported by each survey data in Table 12-Table 15. First, I summarize the distribution of STEM participation across cohorts. As shown in the first line of each table, the proportion of students enrolled in STEM majors drop in the 1990s and slowly increases in the recent cohort after year 2000. In addition, the proportion of mothers' labor force participation is around 42% in the 1980s and increases over 55% in 2009. Students' school achievement also slightly increases over cohorts. Among family resources, parents' educational expectation and saving efforts for children also increase over time in married-two-biological families. For the distribution of STEM majors, Table 16 presents the proportion of male and female participants by gender and within each of the four categories of STEM major fields. A gender difference test is performed to show whether the difference reaches statistical significance. Results show that the gender difference is consistent across cohorts and concentrates on the PEMC majors, HESB major and AAN major in the earlier cohorts.

Next, I perform confirmatory factor analysis (CFA) to analyze the proposed measurement model. One latent factors and corresponding indicator items are shown in Table 17. Factor loading and Cronbach's Alpha are listed in the third and the fifth column in the table. Across four sets of latent constructs, NELS cohort has relative lower reliability compared to other data sets.

Following the CFA, structural equation modeling (SEM) and multiple-group SEM were performed using pooled data and cohort-specific data to examine the proposed conceptual model.

The path structure in this study is derived from three sets of simultaneously estimated regression equations. The first set of equations examines how family resources are each influenced by mothers' employment conditions. The second set of equations examines how 10th-12th-grade beliefs in math self-efficacy and 12th-grade average school achievement are each influenced by mothers' employment condition and family resources. The final set of equations investigates how students' participation in STEM fields is influenced by their self-efficacy beliefs, school achievement and family environment of support and encouragement.

Multiple-group analyses are employed to examine structural weight invariance across datasets. Specifically, I explore whether the hypothesized model is equivalent across cohort (HS&B, NELS, ELS and HSLS), within gender (females and males) and race (White, Asian, and Black and Hispanic). I focus on the structural patterns of the model; the invariance test centers on the equivalence of structural path parameters across different cohort of datasets. To describe the multiple-group approach used in this study, I start with gender-based multiple-group analysis. I first fit a baseline multiple-group model with factorial equality constraint across gender and the structural regression coefficients are estimated freely across groups. Following this procedure, I perform another multiple-group model with all structural regression coefficients across cohorts constrained to be equal. The result of the chi-square difference test is statistically significant, which suggests that one or more of the parameters are non-invariant across cohorts. Therefore, I perform parameters one by one to identify the parameters that should be estimated freely across cohorts. I list all possibilities in Table 18. In this study, I use the maximum likelihood estimation (ML) because the nature of the nominal variable, which means a structural invariance test needs to be obtained based on the corrected chi-square difference (See M-plus website: https://www.statmodel.com/chidiff.shtml). The baseline model is compared with the constrained-equal between cohorts. If the chi-square difference is significant, it shows that the given parameter is not equivalent across cohort groups. Therefore, this parameter will be set as a free estimate in the subsequent models. However, if the test indicates a non-invariance between groups as an insignificant chi-square difference, then regression coefficients can be constrained to be equal across cohort groups. By doing this constraint gradually, it helps to identify whether group differences could result from any other structural weights in the model.

This constraint procedure identifies several non-invariance paths, such as gender, mothers' employment; school average GPA, self-efficacy factor and two family supports. Therefore, the final model is set to be free for those estimates across all cohorts. Based on this test, I will need to account for the structural difference in cohorts and gender. To simplify the analysis, I first focus on the structural changes and weights across cohorts controlling for gender. After the first set of models, I report gender difference results in each cohort.

The effect of mothers' employment on school achievement and math efficacy beliefs is transmitted through two mediating pathways on children's STEM major participation. To obtain the indirect effect, I calculate and test for statistical significance using the M-plus MODEL CONSTRAINT OPTION

Results of Multiple-Group SEM Analyses

Based on previous analyses, the result indicates that a multiple-group based on cohorts, where the structural paths from mother employment to self-math efficacy, school achievement, and STEM majors need to set as free estimates. Table 19-Table 22 presents the final SEM model across four data sets.

In Table 19, mothers' full-time job and occupational prestige did not affect children's majoring in a STEM field from HS&B, NELS and ELS cohorts. Although there is a slightly negative effect in NELS cohort on the type of AAN field, the trend is consistent from the 1980s to 2002. Until the most recent cohort, mothers' occupational prestige ($p<.05$) is positively related to their children's participation in PEMC field, which means that a one-unit increase in mothers' occupational prestige score is associated with a .007 increase in the relative log odds of participating PEMC major over the relative log odds of those who are participating HESB field. Mothers' full-time employment ($p<.001$) is also positively associated with children's participation in a BPCH field. Only two direct effects are present in the HSLS cohort and show positive connections between mothers' employment and children's participation in PEMC and BPCH fields.

Results reflect that the effect of mothers' occupational prestige score and mothers' full0time employment tend to increase their children's participation in STEM major in the recent cohort, HSLS cohort. To facilitate discussion, I created Figure 11 wherein the estimated coefficients were shown by directed pathways for the sample across cohorts.

Daughters (women) are less likely to participate in the PEMC major and AAN fields except for the ELS cohort in the Table 21. Over time, the gender gap presents only in the PEMC field in the both ELS and HSLS cohort. Interestingly, BPCH fields attract more daughters than sons starting at the HS&B cohort, except in the NELS cohort in the Table 18. This tendency thereafter resumes with the following ELS and HSLS cohort. School achievement at the 12th grade and math self-efficacy are positively associated with PEMC major fields among all cohorts. The role of school achievement in the recent two cohorts, the ELS and the HSLS, becomes more profound and consistent in all three categories of STEM-related majors. Math self-efficacy is also positively associated with BPCH major in the NELS and HSLS cohortin the Table 20 and Table 21.

The effect of mothers' employment on children's educational outcome may also through indirect paths. In the same tables, I report the indirect effect that may transmit mothers' influence through two mediating paths: school achievement and mathematics self-efficacy. Results suggest that students' school achievement on PEMC major is more sensitive to mothers' employment at the HS&B cohort and spills over to AAN major participation in the NELS and ELS cohorts. The pattern is consistent: mothers with full-time jobs decrease children's STEM participation through school achievement; mothers with higher-prestige jobs increase the STEM participation through school achievement. Students' math efficacy does not have a strong indirect effect on the earlier cohorts, but does mediate students' participation in PEMC major in the ELS and HSLS cohorts, particularly for mothers with higher-prestige jobs. This finding supports theoretical hypothesis that the complexity of mothers' jobs affects their children's cognitive ability and self-confidence in mastering math and science. Coupled with the findings in the previous section, results also confirmed that school achievement and students' mathematics efficacy serve as mediation mechanisms in conveying the effect of mothers' employment condition on children's participation in STEM across cohorts (Figure 12-14).

It is important to note that mothers with full time jobs also have a negative influence on STEM participation, but this negative effect must go through students' school achievement. Full-time career mothers in the NELS and ELS cohort have a negative influence on children's participation in all STEM field through decreasing students' achievement. On the other hand, full-time career mothers in the ELS and HSLS cohort may also have a negative influence on children's participation in PEMC major through students' math efficacy. This finding implies that mothers' employment on children's STEM participation depends on the schooling and encouraging processes in relation to participating STEM fields.

Table 23-Table 24 reports the structural paths for both boys and girls in four cohorts. For the direct effect, the results show that only boys with full-time career mothers are more likely to increase PEMC major participation in the NELS cohort, and girls with full-time career mothers are more likely to increase participation in BPCH field in the HSLS cohort. The positive indirect effects are summarized in Table 25 for the comparison of the patterns. Table 25 presents the indirect paths by which mothers' employment positively relates to children's STEM participation. The result suggests that daughters are more responsive to mothers' employment in a full-time career by increasing STEM participation through school achievement. Mothers with high-prestige jobs are more encouraging of their daughters' interests in BPCH and PEMC major fields in both NELS and ELS cohorts. However, in the ELS cohort, this tendency applies only to sons. Sons in the NELS cohort benefit from a career mother by participating in a PEMC major field. Until the most recent cohort, daughters continue to gain with full-time career mothers through school achievement in pursuing their STEM participation. Sons whose mothers hold prestigious jobs may also benefit from better self-efficacy when entering a PEMC major field. Because of space constraints, table 5 does not compare boys and girls on each path.

Discussion and Conclusions

I use these findings to examine the research hypotheses of this study. The SEM model in Table 19-Table 22 show no strong relationship between mothers' employment and children's STEM participation except for the HSLS cohort. The results show a positive effect of full-time career and high-prestige mothers on children's participation in BPCH fields. As discussed previously, the literature suspects that mothers' employment has an immediate impact on their children's educational outcomes (in terms of the reduction of mothering, time spent with children) or affects children's behavior. This study shows that mothers' employment has no effect on children's STEM participation in the earlier cohort, which did not support the first hypothesis of the gender asymmetric perspective. But in the most recent cohort- HSLS (2009), a positive effect is present between mothers' full-time job and children's participation in a BPCH major, and mothers' high-prestige job and children's participation in PEMC majors. The results imply that the promotion effects of mothers' economic independence and job complexity emerge in the late cohort.

In the second hypothesis, I anticipate that students' math self-efficacy and high school achievement mediate the effects of mothers' employment on children's STEM participation. I find support for this hypothesis. The findings show that mothers' occupational prestige transmits positive impacts on STEM participation through children's school achievement in the recent cohort. In respect to the mediation process, I also find this beneficial effect of high-prestige mothers on STEM participation is present from the HS&B, NELS to ELS, which indicates a positive relation between mothers' job complexity, children's cognitive development, and STEM participation. Likewise, mothers with high-prestige jobs may also have a positive influence on their children's self-efficacy, but this effect only appears in later cohorts, such as ELS and HSLS. Overall, I find that mothers with high-prestige jobs transmit their influence through both school achievement and math-efficacy, which support both the economic independence hypothesis and job complexity hypothesis.

It is also worth noting that mothers' full-time job, however, has negative impacts on children's school achievement, resulting in the negative indirect association between full-time career mothers, school achievement and children's STEM participation. Such change points to distinctive family processes that are different between full-time career mothers and high-prestige career mothers— either higher levels of job complexity or greater economic resources may compensate for potential lack of mothering or involvement in children's education. This tendency also reveals a gender difference in how daughters and sons react to mothers' cognitive ability with a complex job and greater economic resources with a high-prestige job. More work should be performed to distinguish the influence of full-time career mothers from high-prestige career mothers on adolescents' experiences and development in family processes.

In the third hypothesis, I examine whether the transmission processes of the mothers' employment on children's STEM major varies by gender. I find that sons are more sensitive to mothers' employment since the HS&B cohort and experience more negative influences during the NELS cohort. Up until the ELS and HSLS cohort, mothers' full-time and prestige-jobs are facilitators that help sons' STEM entrance, particularly entrance in the PEMC majors. On the other hand, daughters became sensitive to mothers' employment at the NELS cohort. School achievement and mathematics-self-efficacy work to transmit mothers' influence on children's STEM field participation, particularly for the PEMC major field. However, there is no evidence present for the reinforcement of high prestige mothers on daughters' STEM in the HSLS cohort. Furthermore, the structural paths vary by gender and also vary by the fields, such daughters' preference to attend BPCH field more than sons, and sons' likelihood to attend PEMC fields is much higher than daughters'. Gender differences by cohorts on the two processes are concentrated on the HS&B and NELS cohort, which may imply that children suffer relatively severe gender bias during those two time periods because of mothers' employment. For example, sons are more sensitive to mothers' employment conditions. Mothers' full-time employment tends to reduce sons' school achievement more than it does daughters'.

While this study improves understanding of recent changes in mothers' employment on children's participation in a STEM field, it suffers from some limitations that require further discussion. Although I identify the significance of the difference between cohorts and gender groups, multi-group SEM analysis is restricted to comparable variables with similar questions between the four cohorts of the survey. Second, some other family structural factors, such as multi-generational families or the presence of other relatives at home, may have different structural constraints in response to mothers' employment and its consequences. Third, this study focuses on the effect of mothers' employment, children's school achievement and the development of self-efficacy in a STEM field; little attention was paid to a more comprehensive specification of variables and models in each cohort. In this study, I do not discuss how the covariates in terms of family structure, immigrant status, and racial variation may change over time or any potential interactions among the covariates. Although I control for race and ethnic variables in the model, a notable racial and immigrant variation occurred between cohorts with respect to their participation in college or STEM fields. Future research aiming to understand social change in terms of gender inequality in STEM fields would benefit from a consideration of race/ethnic and immigrant variation.

APPENDICES

APPENDIX A

FIGURES FOR CHAPTER THREE

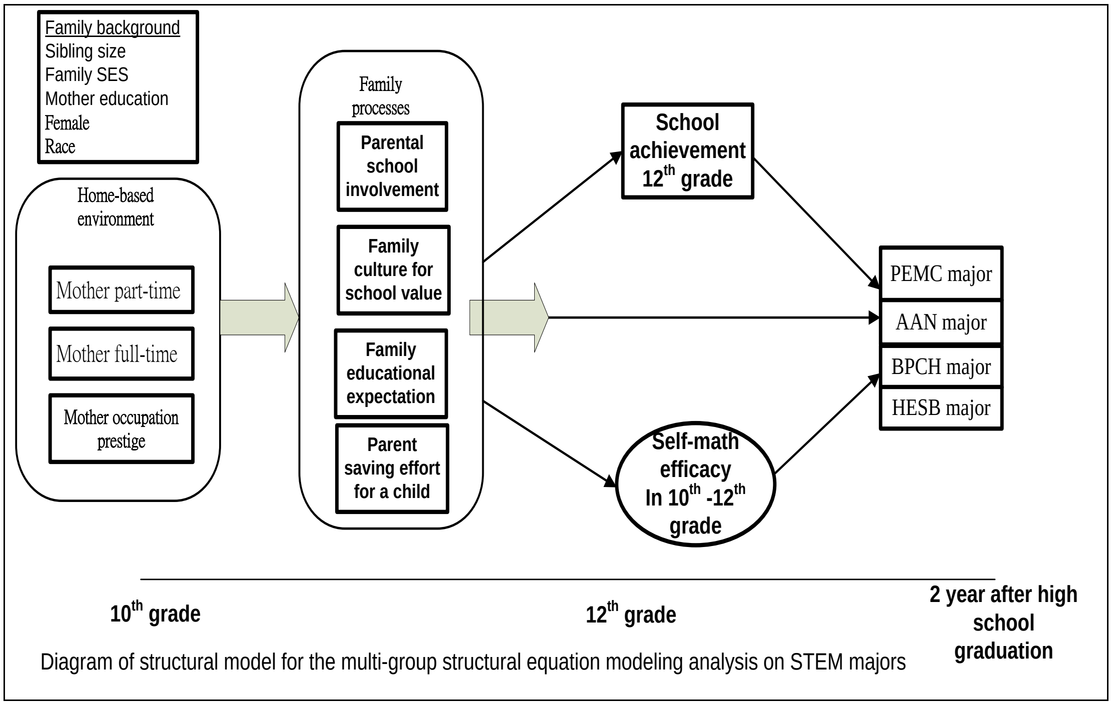

Figure 9:Theoretical Framework

Note: PEMC: physics, engineering, mathematics, and computer science.
AAN: agricultural, architectural and natural resources sciences.
BPCH: biological sciences, psychology, clinical and health science.
HESB: humanities, education, general curriculum, social and behavior science.

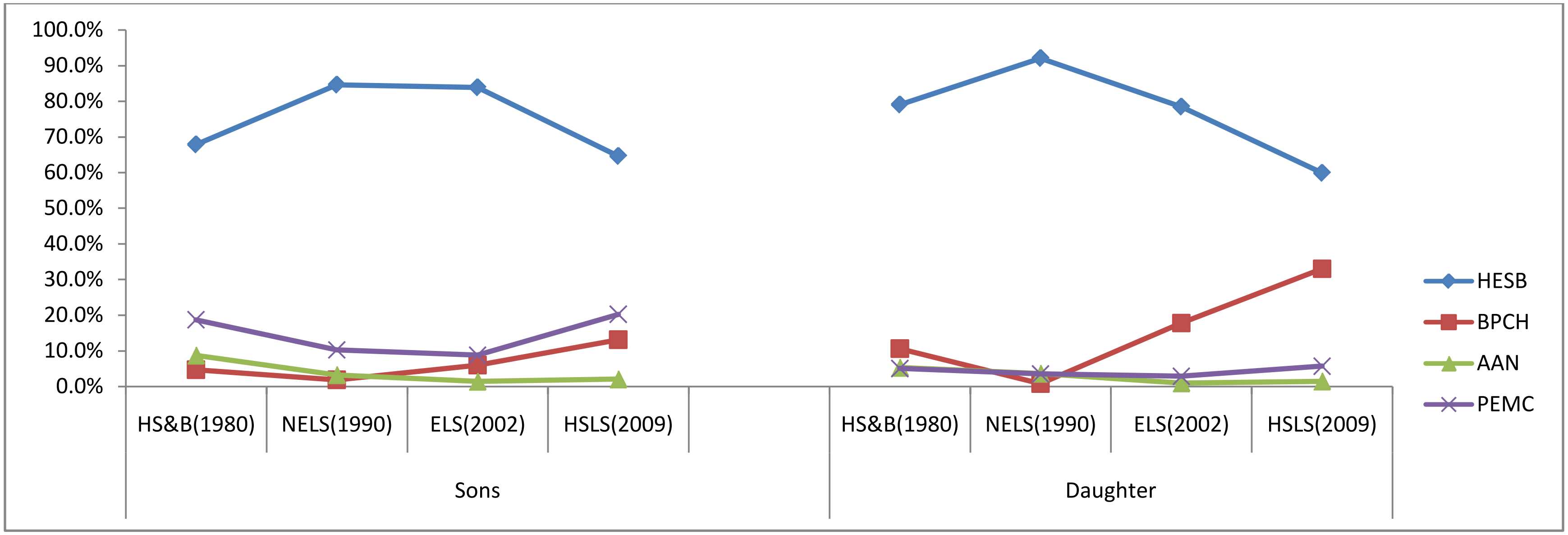

Figure 10: Main Direct Effect of Mother with Full-time Job and Mothers' Occupational Prestige across Cohorts

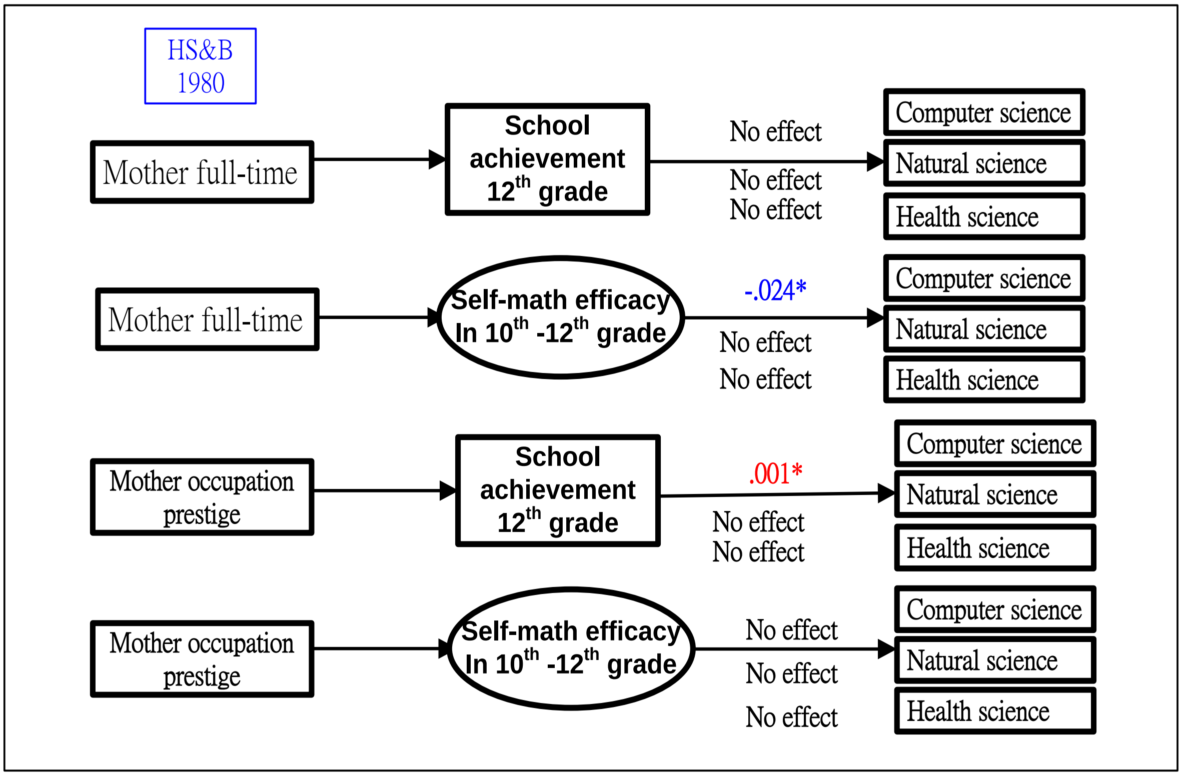

Figure 11: Indirect Effect of Mother with Full-time Job and Mothers' Occupational Prestige on Children's Participation in STEM Major in the HS&B Cohort

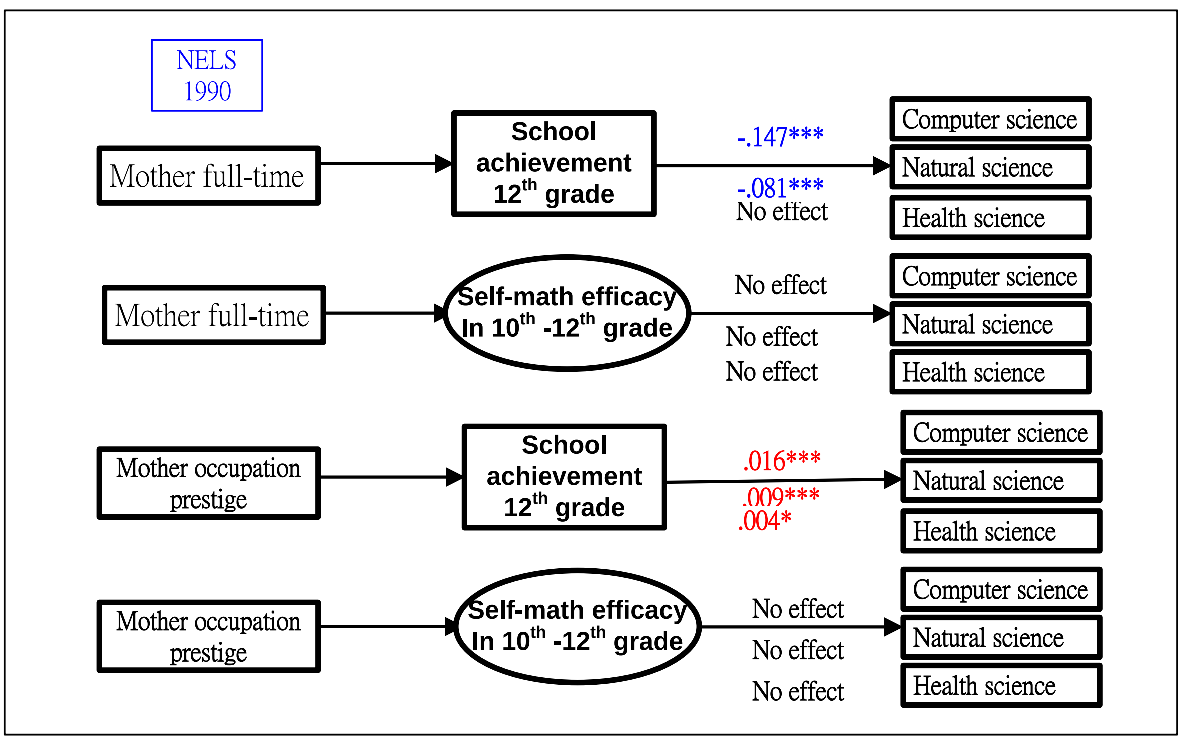

Figure 12: Indirect Effect of Mother with Full-time Job and Mothers' Occupational Prestige on Children's Participation in STEM Major in the NELS Cohort

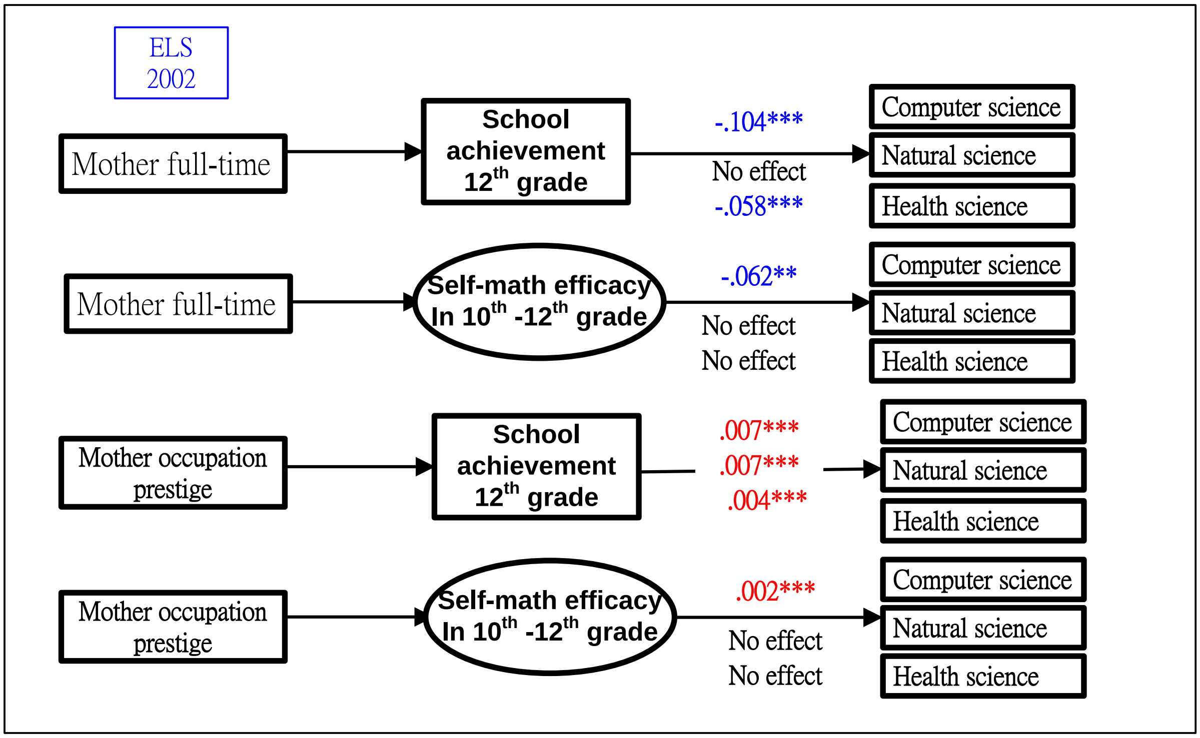

Figure 13: Indirect Effect of Mother with Full-time Job and Mothers' Occupational Prestige on Children's Participation in STEM Major in the ELS Cohort

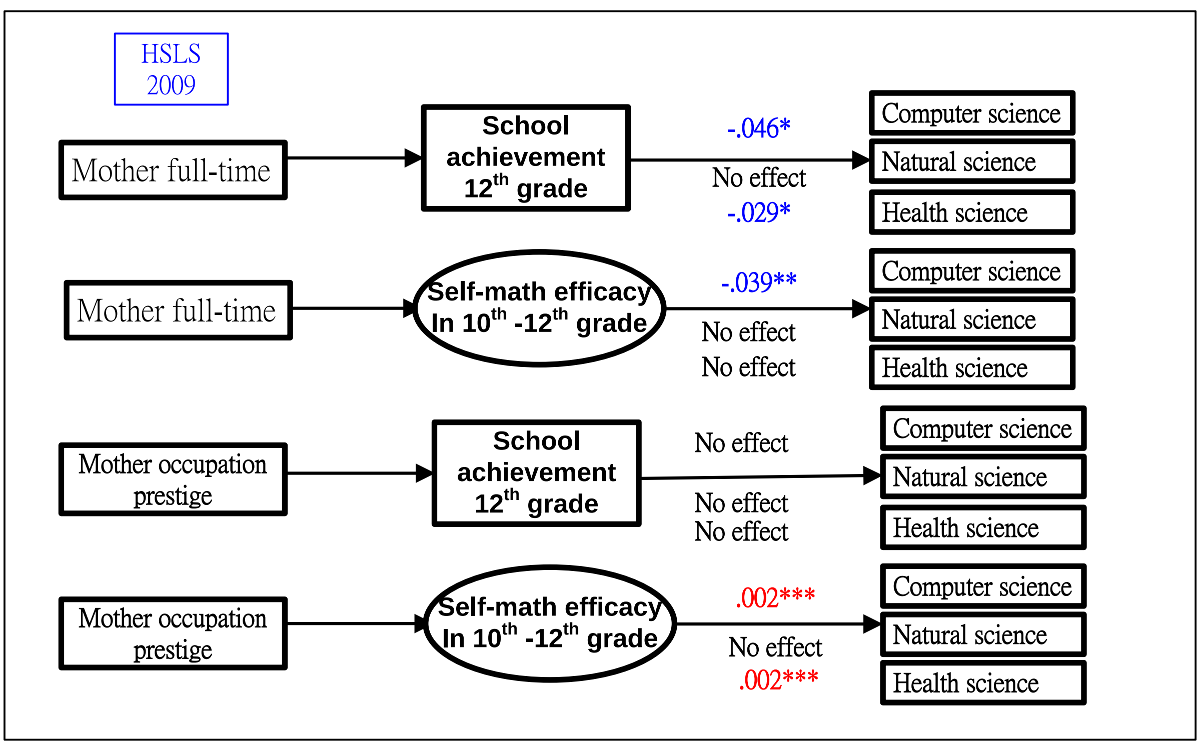

Figure 14: Indirect Effect of Mother with Full-time Job and Mothers' Occupational Prestige on Children's Participation in STEM Major in the HSLS Cohort

APPENDIX B

TABLES FOR CHAPTER THREE

Table 12: Descriptive Statistics for the HS&B Teens Living with Married-Two-Biological Parents families

	Mean (%)	Std. Dev.	Min	Max
Whether major in STEM	24.88%		0	1
Daughter (Ref. sons)	0.492	0.500	0	1
Number of siblings	2.898	1.725	0	6
SES composite score	0.031	0.738	-2.658	1.972
The average level of mother education	2.337	0.985	1	4
The average level of father education	2.444	1.100	1	4
Mother occupation prestige	39.881	16.737	0	73.51
Mother occupation prestige	43.670	10.767	0	73.51
% of mother with full-time job	42.05%		0	1
% of mother with part-time job	25.81%		0	1
Student education expectation	4.151	1.701	1	7
Parent education expectation	4.202	1.888	1	7
the average math efficacy	0.691	0.345	0	1
Naïve percentile ranking	55.825	21.133	5.065056	99.76766
Average GPA	2.334	0.736	1	4
Family preparation for school	9.650	1.797	1	12
parental school involvement	1.473	1.255	0	4
Parent saving efforts for children	27.44%			
White	65.63%		0	1
Asian	3.246%		0	1
Black	9.587%		0	1
Non-white Hispanic	21.538%		0	1
Whether as an immigrant	7.440%		0	1

Table 13: Descriptive Statistics for the NELS Teens Living with Married-Two-Biological Parents families

	Mean (%)	SD	Min	Max
Whether major in STEM	13.71%		0	1
Daughter (Ref. sons)	0.515	0.500	0	1
Number of siblings	2.349	1.602	0	6
SES composite score	0.029	0.802	-3.09	2.53
The average level of mother education	2.417	1.105	1	4
The average level of father education	2.505	1.166	1	4
Mother occupation prestige	39.194	14.274	0	73.51
Father occupation prestige	40.903	14.433	0	73.51
% of mother with full-time job	49.46%		0	1
% of mother with part-time job	19.83%		0	1
% of father with full-time job	88.45%		0	1
% of father with part-time job	2.58%		0	1
Student education expectation	4.689	1.538	1	7
Parent education expectation	4.436	1.393	1	7
the average math efficacy	2.974	0.547	1	4
Naïve percentile ranking	51.977	24.038	0	100
Average GPA	2.680	0.801	1	4
Family preparation for school	9.788	1.746	1	12
Parental school involvement	1.878	1.302	0	4
Parent saving efforts for children	37.01%			
White	71.34%		0	1
Asian	7.970%		0	1
Black	6.937%		0	1
Non-white Hispanic	13.757%		0	1
Whether as an immigrant	7.137%		0	1

Table 14: Descriptive Statistics for the ELS Teens Living with Married-Two-Biological Parents Families

	Mean (%)	SD	Min	Max
Whether major in STEM	10.33%		0	1
Daughter (Ref. sons)	0.499	0.500	0	1
Number of siblings	2.044	1.351	0	6
SES composite score	0.173	0.765	-2.11	1.98
The average level of mother education	2.843	0.998	1	4
The average level of father education	2.907	1.028	1	4
Mother occupation prestige	45.015	16.145	0	73.51
Father occupation prestige	45.493	12.167	0	73.51
% of mother with full-time job	54.55%		0	1
% of mother with part-time job	19.78%		0	1
% of father with full-time job	88.36%		0	1
% of father with part-time job	3.21%		0	1
Student education expectation	5.324	1.360	1	7
Parent education expectation	5.442	1.218	1	7
the average math efficacy	1.570	0.843	0	3
Naïve percentile ranking	52.221	16.096	0	100
Average GPA	3.304	0.758	1	4
Family preparation for school	9.503	2.404	1	12
Parental school involvement	1.390	1.390	0	4
Parent saving efforts for children	45.07%			
White	71.06%		0	1
Asian	10.199%		0	1
Black	6.538%		0	1
Non-white Hispanic	12.204%		0	1
Whether as an immigrant	10.712%		0	1

Table 15: Descriptive Statistics for the HSLS Teens Living with Married-Two-Biological Parents Families

	Mean (%)	SD	Min	Max
Whether major in STEM	36.35%		0	1
Daughter (Ref. sons)	0.491	0.500	0	1
Number of siblings	1.515	1.409	0	6
SES composite score	0.262	0.795	-1.93	2.88
The average level of mother education	2.875	1.016	1	4
The average level of father education	2.824	1.055	1	4
Mother occupation prestige	46.857	12.482	0	73.7
Father occupation prestige	42.198	16.727	0	73.7
% of mother with full-time job	55.82%		0	1
% of mother with part-time job	16.40%		0	1
% of father with full-time job	75.35%		0	1
% of father with part-time job	4.15%		0	1
Student education expectation	5.451	1.564	1	7
Parent education expectation	5.487	1.336	1	7
the average math efficacy	1.191	0.704	0	3
Naïve percentile ranking	49.622	16.210	0	100
Average GPA	2.794	0.819	0	4
Family preparation for school	12.842	2.375	1	12
Parental school involvement	2.038	1.263	0	4
Parent saving efforts for children	47.77%			
White	69.79%		0	1
Asian	8.776%		0	1
Black	6.323%		0	1
Non-white Hispanic	15.107%		0	1
Whether as an immigrant	6.987%		0	1

Table 16: The Distribution of STEM Participation across Cohort of Teens

		Humanities, Education, Social science & Behavior science (HESB)	**Biology, Psychology, Clinic & Health (BPCH)**	**Agriculture, Architecture & Natural Resources (AAN)**	**Physics, Engineering, Mathematics, and Computer science**	**Total N**
Sons	HS&B(1980)	58.15%	6.11%	11.39%	24.35%	2177
	NELS(1990)	75.49%	2.99%	5.18%	16.34%	2375
	ELS(2002)	76.12%	8.92%	2.03%	12.94%	3061
	HSLS(2009)	53.83%	17.37%	2.63%	26.17%	3305
Daughter	HS&B(1980)	70.74%*	14.86%*	7.39%*	7.00%*	2543
	NELS(1990)	89.62%*	1.07%	4.73%	4.58%*	2708
	ELS(2002)	72.27%*	22.87%*	1.19%	3.67%*	3516
	HSLS(2009)	52.70%	39.50%*	1.64%	6.15%*	3592

* $p<0.05$, Z-statistics to indicate the gender difference in each cohort
Total valid cases in STEM major outcome in each cohort: HS&B= 4630, NELS= 5083, ELS=6577, HSLS=6897
Overall observations= 23,187

Table 17: Math self-Efficacy Beliefs across HS&B, NELS, ELS and HSLS data

Cohort	Variables	Indicators	scale	Factor
HS&B	YB035E	At Ease in math class	0--1	0.782
	YB035F	Feel tense about math assignment	0--1	0.72
	YB035G	Math class doesn't scare me	0--1	0.746
	YB035H	Dread math class	0--1	0.707
		Cronbach's Alph =.723		
NELS	F1S63D	Mathematics is one of r's best subjects	1--6	0.779
	F1S27A	Often work hard in math class	1--6	0.751
	F1S28A	Often feel challenged in math class	1--6	0.487
		Cronbach's Alph =.516		
ELS	BYS89A	Can do excellent job on math tests	1--4	0.874
	BYS89B	Can understand difficult math texts	1--4	0.879
	BYS89L	Can understand difficult math class	1--4	0.899
	BYS89R	Can do excellent job on math assignments	1--4	0.896
	BYS89U	Can master math class skills	1--4	0.892
		Cronbach's Alph =.933		
HSLS	S2MTESTS	Confident can do an excellent job on (spring 2012) math tests	1--4	0.901
	S2MTEXTBOOK	Certain can understand (spring 2012) math textbook	1--4	0.822
	S2MSKILLS	Certain can master skills taught in (spring 2012) math course	1--4	0.886
	S2MASSEXCL	Confident can do excellent job on (spring 2012) math assignments	1--4	0.889
		Cronbach's Alph =.893		

Table 18: Cohort Structural Weight Invariance Tests

Model	Corrected $\Delta\chi^2(\Delta df)$	Number of Free	Log-likelihood value [a]
Baseline (Free structural paths and factoral constrained)		219	-43872.5
Constrained female	54.96 (9)*	210	-43927.5
Constrained asian	18.56(9)	210	-43891.1
Constrained balck	21.62(9)	210	-43894.1
Constrained hispanic	8.30(9)	210	-43880.8
GPA	57.75(9)*	210	-43930.2
Constrained Math self-efficacy	94.63(19)*	200	-43947.1
Constrained family supports	124.53(45)	174	-43997
Constrained family supports to GPA	60.51(15)*	204	-43933
Constrained family supports to efficacy	67.39(15)*	204	-43939.9
Gender groups			
Baseline (Free structural paths and factoral constrained)		109	-30906
Constrained GPA	77.94(9)*	100	-31116.3
Constrained Math self-efficacy	75.36(9)*	100	-31113.7
Family supports	77.91(9)*	100	-31114.8

* $p<0.05$

Note. A significant $\Delta\chi$value indicates that the estimate is non-invariant across groups.

Corrected chi-square test calculate based on the log-likelihood value and the adjusted formula on https://www.statmodel.com/chidiff.shtm

Table 19: Final SEM model by Cohort of the High School & Beyond

HS&B	PEMC major		AAN major		BBPCH major	
	ß	S.E.	ß	S.E.	ß	S.E.
Daughter (Ref. sons)	-1.792	(.096) ***	-1.268	(.092) ***	0.487	(.108) ***
Mother with full-time job	-0.022	(.114)	0.002	(.113)	0.17	(.125)
Mother occupation prestige	-0.004	(.003)	-0.002	(.003)	-0.001	(.003)
The latent of math efficacy (efficacy)	0.355	(.049) ***	0.094	(.043) *	0.059	(.046)
School achievement	0.171	(.068) *	0.073	(.070)	-0.044	(.075)
Parent education expectation	-0.05	(.035)	0.009	(.033)	0.038	(.042)
	0.085	(.093)	-0.075	(.099)	0.051	(.098)
Indirect effect						
STEM ← Achievement ← Mother occupation prestige	0.001	(.000) *	0.000	(.000)	0.000	(.000)
STEM ←Achievement ←Mother full-time	-0.024	(.010) *	-0.010	(.010)	0.006	(.011)
STEM ←Efficacy ← Mother occupation prestige	0.000	(.000)	0.000	(.000)	0.000	(.000)
STEM ←Efficacy ←Mother full-time	-0.021	(.010)	-0.006	(.004)	-0.006	(.004)
STEM ← parent expectation ← Mother occupation	0.000	(.001)	0.000	(.001)	0.000	(.001)
STEM ← parent school involvement ← Mother	0.000	(.000)	0.000	(.000)	0.000	(.000)
STEM ← home preparation for school ← Mother	0.000	(.000)	0.000	(.000)	0.000	(.000)
STEM ← parent saving efforts ← Mother occupation	0.000	(.000)	0.000	(.000)	0.000	(.000)

+ p< .1; * p<.05; ** p<.01; *** p<.001;
Note. Reported standardized coefficient.
[a] the measurement of latent factors is omitted from the table.
[b] the endogenous variables, 10th/12th-grade math self-efficacy beliefs, school achievement, and family supports, serve as both a dependent and an independent variable.

Table 20: Final SEM model by Cohort of the NELS (1988)

NELS(1988)	PEMC major		AAN major		BPCH major	
	ß	S.E.	ß	S.E.	ß	S.E.
Daughter (Ref. sons)	-1.37	(.118) ***	-0.337	(.146) *	-1.023	(.242) ***
Mother with full-time job	-0.11	(.133)	-0.311	(.177) †	-0.251	(.268)
Mother occupation prestige	0.001	(.004)	-0.003	(.005)	0.007	(.009)
The latent of math efficacy	0.426	(.041) ***	0.055	(.047)	0.21	(.072) *
School achievement	0.434	(.080) ***	0.697	(.117) ***	-0.059	(.160)
Parent education expectation	-0.117	(.075)	0.223	(.105) *	0.036	(.145)
Parent saving efforts	0.208	(.119) †	0.331	(.167) *	0.682	(.267) *
Indirect effect						
STEM ← Achievement ← Mother occupation prestige	0.016	(.002) ***	0.009	(.002) ***	0.004	(.002) *
STEM ←Achievement ←Mother full-time	-0.147	(.034) ***	-0.081	(.023) ***	-0.038	(.022)
STEM ←Efficacy ← Mother occupation prestige	0.000	(.000)	0.000	(.000)	0.000	(.000)
STEM ←Efficacy ←Mother full-time	0.000	(.000)	0.001	(.004)	0.002	(.009)
STEM ← parent expectation ← Mother occupation prestige	-0.002	(.001)	0.004	(.002) *	0.000	(.003)
STEM ← parent school involvement ← Mother occupation	0.000	(.001)	0.000	(.001)	0.000	(.001)
STEM ← home preparation for school ← Mother occupation	0.000	(.000)	0.000	(.000)	0.000	(.003)
STEM ← parent saving efforts ← Mother occupation	0.001	(.001) +	0.001	(.001)	0.003	(.001) *

+ p< .1; * p<.05; ** p<.01; *** p<.001;

Note. Reported standardized coefficient.

[a] the measurement of latent factors is omitted from the table.

[b] the endogenous variables, 10th/12th-grade math self-efficacy beliefs, school achievement, and family supports, serve as both a dependent and an independent variable.

Table 21: Final SEM model by Cohort of the ELS (2002)

ELS (2002)	PEMC major		AAN major		BPCH major	
	ß	S.E.	**ß**	S.E.	**ß**	S.E.
Daughter (Ref. sons)	-1.125	(.142) ***	-0.494	(.294)	0.849	(.105) ***
Mother with full-time job	-0.015	(.166)	0.509	(.416)	0.055	(.123)
Mother occupation prestige	0.002	(.005)	0.004	(.012)	0.001	(.004)
The latent of math efficacy	0.493	(.072) ***	-0.094	(.150)	0.049	(.049)
School achievement	1.297	(.156) ***	1.026	(.309) ***	0.653	(.098) ***
Parent education expectation	0.026	(.078)	-0.281	(.186)	0.05	(.057)
Parent saving efforts	0.171	(.142)	-0.273	(.305)	0.091	(.102)
Indirect effect						
STEM ← Achievement ← Mother occupation prestige	0.007	(.001) ***	0.007	(.002) ***	0.004	(.001) ***
STEM ←Achievement ←Mother full-time	-0.104	(.027) ***	-0.093	(.047)	-0.058	(.016) ***
STEM ←Efficacy ← Mother occupation prestige	0.002	(.000) ***	-0.001	(.001)	0.000	(.000)
STEM ←Efficacy ←Mother full-time	-0.062	(.019) **	0.021	(.020)	-0.006	(.006)
STEM ← parent expectation ← Mother occupation	0.000	(.001)	0.000	(.001)	0.000	(.001)
STEM ← parent school involvement ← Mother	-0.002	(.001) *	0.000	(.001)	0.000	(.001)
STEM ← home preparation for school ← Mother	0.000	(.000)	0.000	(.000)	0.000	(.000)
STEM ← parent saving efforts ← Mother occupation	0.001	(.001)	-0.001	(.001)	0.001	(.001)

+ p< .1; * p<.05; ** p<.01; *** p<.001;

Note. Reported standardized coefficient.

[a] the measurement of latent factors is omitted from the table.

[b] the endogenous variables, 10th/12th-grade math self-efficacy beliefs, school achievement, and family supports, serve as both a dependent and an independent variable.

Table 22: Final SEM Model by Cohort of the HSLS (2009)

HSLS(2009)	PEMC major		AAN major		BPCH major	
	ß	S.E.	**ß**	S.E.	**ß**	S.E.
Daughter (Ref. sons)	-1.386	(.099) ***	-0.366	(.196)	0.718	(.074) ***
Mother with full-time job	-0.044	(.105)	0.281	(.247)	0.311	(.087) ***
Mother occupation prestige	0.007	(.004) *	-0.003	(.008)	0.003	(.003)
The latent of math efficacy	0.492	(.050) ***	0.022	(.105)	0.087	(.036) *
School achievement	0.719	(.080) ***	0.691	(.185) ***	0.446	(.062) ***
Parent education expectation	0.09	(.048) *	0.156	(.108)	0.247	(.037) ***
Parent saving efforts	0.026	(.092)	0.11	(.213)	0.059	(.027) *
Indirect effect						
STEM ← Achievement ← Mother occupation prestige	0.005	(.001)	0.005	(.001)	0.003	(.001)
STEM ←Achievement ←Mother full-time	-0.046	(.018) *	-0.04	(.010)	-0.029	(.012) *
STEM ←Efficacy ← Mother occupation prestige	0.002	(.001) **	0	(.000)	0.002	(.000) *
STEM ←Efficacy ←Mother full-time	-0.039	(.016) *	0.001	(.008)	-0.006	(.004)
STEM ← parent expectation ← Mother occupation	0.002	(.000) *	0.001	(.001)	0.002	(.000) ***
STEM ← parent school involvement ← Mother	0.001	(.001)	0.001	(.001)	0.001	(.001)
STEM ← home preparation for school ← Mother	0.000	(.000)	0.000	(.000)	0.000	(.000)
STEM ← parent saving efforts ← Mother occupation	0.000	(.000)	0.000	(.000)	0.002	(.000) *

+ p< .1; * p<.05; ** p<.01; *** p<.001;

Note. Reported standardized coefficient.

[a] the measurement of latent factors is omitted from the table.

[b] the endogenous variables, 10th/12th-grade math self-efficacy beliefs, school achievement, and family supports, serve as both a dependent and an independent variable.

Table 23: Final SEM Model by Cohort and Gender (reported structural paths only) in the HS&B (1980) and NELS (1988)

	HS&B				NELS			
	Female		Male		Female		Male	
	ß	S.E.	**ß**	S.E.	**ß**	S.E.	**ß**	S.E.
Efficacy ←Mother full-time	-0.044	(.052)	-0.107	(.056)	0.019	(.034)	-0.035	(.036)
Efficacy ← Mother occupation	.001	(.001)	0.002	(.001)	0.002	(.001) *	0.001	(.001)
GPA← Mother occupation prestige	-0.246	(.035) ***	-0.143	(.037) ***	-3.461	(1.044) *	-3.565	(1.125) *
GPA← Mother full-time	0.004	(.001) ***	0.004	(.001) ***	0.402	(.032) ***	0.334	(.034) ***
PEMC major ←Mother full-time	0.107	(.206)	-0.075	(.142)	0.119	(.245)	0.001	(.005)
PEMC major ←Mother occupation	0.001	(.005)	-0.005	(.003)	-0.007	(.008)	0.04	(.004) ***
PEMC major ←GPA	0.066	(.124)	0.240	(.085) ***	0.049	(.006) ***	-0.076	(.086)
PEMC major ←Efficacy	0.448	(.087) ***	0.351	(.061) ***	0.19	(.135)	0.06	(.069)
AAN major ←Mother full-time	0.009	(.176)	0.039	(.155)	-0.49	(.233) *	0.013	(.272)
AAN major ←Mother occupation	-0.001	(.005)	-0.004	(.004)	0.003	(.008)	-0.01	(.008)
AAN major ←GPA	0.037	(.110)	0.120	(.094)	0.029	(.006) ***	0.018	(.006) **
AAN major ←Efficacy	0.044	(.065)	0.200	(.063) ***	0.551	(.112) ***	-0.219	(.141)
BPCH major ←Mother full-time	0.193	(.147)	0.149	(.239)	-0.088	(.465)	-0.251	(.330)
BPCH major ←Mother occupation	-0.003	(.004)	0.004	(.006)	-0.039	(.017) *	0.022	(.010)
BPCH major ←GPA	-0.106	(.090)	0.079	(.140)	0.027	(.012) *	0.006	(.007)
BPCH major ←Efficacy	0.048	(.053)	0.091	(.098)	-0.453	(.235)	-0.291	(.174)

+ p< .1; * p<.05; ** p<.01; *** p<.001;

Note. Reported standardized coefficient.

[a] the measurement of latent factors is omitted from the table.

[b] the endogenous variables, 10th/12th-grade math self-efficacy beliefs, school achievement, and family supports, serve as both a dependent and an independent variable.

Table 24: Final SEM Model by Cohort and Gender (reported structural paths only) in the ELS (2002) and HSLS (2009)

	ELS				HSLS			
	Female		Male		Female		Male	
	ß	S.E.	**ß**	S.E.	**ß**	S.E.	**ß**	S.E.
Efficacy ←Mother full-time	-0.139	(.050) *	-0.128	(.051) *	-0.038	(.045)	-0.112	(.045) *
Efficacy ← Mother occupation	0.003	(.001) *	0.004	(.001) **	0.002	(.001)	0.005	(.001) **
GPA← Mother occupation prestige	-0.093	(.031) *	-0.091	(.031) *	-0.074	(.033) *	-0.062	(.033)
GPA←Mother full-time	0.006	(.001) ***	0.007	(.001) ***	0.006	(.001) ***	0.008	(.001) ***
PEMC major ←Mother full-time	0.066	(.284)	0.045	(.163)	-0.018	(.199)	-0.098	(.120)
PEMC major ←Mother occupation	-0.009	(.008)	0.001	(.005)	0.009	(.007)	0.008	(.004)
PEMC major ←GPA	0.994	(.281) ***	1.202	(.135) ***	1.409	(.206) ***	0.64	(.086) ***
PEMC major ←Efficacy	0.601	(.124) ***	0.432	(.085) ***	-0.547	(.094) ***	0.469	(.058) ***
AAN major ←Mother full-time	-0.4	(.516)	0.787	(.427)	0.206	(.349)	0.135	(.319)
AAN major ←Mother occupation	-0.007	(.013)	-0.011	(.012)	0.009	(.012)	-0.006	(.010)
AAN major ←GPA	0.977	(.491) *	1.072	(.289) ***	0.915	(.313) **	0.501	(.223) *
AAN major ←Efficacy	-0.073	(.240)	-0.399	(.201)	-0.084	(.164)	-0.279	(.139) *
BPCH major ←Mother full-time	0.147	(.124)	0.074	(.193)	0.325	(.104) ***	0.163	(.143)
BPCH major ←Mother occupation	-0.003	(.004)	.0000	(.006)	0.001	(.003)	0.007	(.005)
BPCH major ←GPA	0.516	(.098) ***	0.86	(.148) ***	0.387	(.077) ***	0.594	(.100) *
BPCH major ←Efficacy	0.104	(.054) *	-0.094	(.093)	-0.064	(.042)	0.134	(.065) *

+ p< .1; * p<.05; ** p<.01; *** p<.001;

Note. Reported standardized coefficient.

[a] the measurement of latent factors is omitted from the table.

[b] the endogenous variables, 10th/12th-grade math self-efficacy beliefs, school achievement, and family supports, serve as both a dependent and an independent variable

Table 25: Summary of Positively Significant Indirect Effect between Mother Employment, Math-Efficacy and School Average GPA by Girls and Boys Group over Cohort

	FEMALE	MALE
HS&B		PEMC major ←GPA← Mother full-time (+)
		AAN major ←Efficacy ←Mother full-time (+)
NELS	AAN major ←Efficacy ← Mother occupation prestige(+)	AAN major ←GPA← Mother full-time(+)
	PEMC major ←GPA← Mother full-time(+)	
	AAN major← GPA← Mother full-time(+)	
	BPCH major ←GPA ←Mother full-time(+)	
ELS	PEMC major ←Efficacy ← Mother occupation prestige(+)	PEMC major ←Efficacy ← Mother occupation prestige(+)
	PEMC major ←GPA← Mother full-time(+)	PEMC major ←GPA← Mother full-time(+)
	AAN major← GPA← Mother full-time(+)	AAN major← GPA← Mother full-time(+)
	BPCH major ←GPA← Mother full-time(+)	BPCH major ←GPA← Mother full-time(+)
HSLS		PEMC major ←Efficacy ← Mother occupation prestige(+)
	PEMC major ←GPA← Mother full-time(+)	PEMC major ←GPA← Mother full-time(+)
	AAN major← GPA← Mother full-time(+)	AAN major← GPA← Mother full-time(+)
	BPCH major ←GPA← Mother full-time(+)	BPCH major ←GPA← Mother full-time(+)

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note. Reported standardized coefficient. Gender group difference test: $\Delta\chi$value of female versus male > 3.84.

APPENDIX C

SUPPLEMENTAL TABLES

Table 26: Four STEM Categories

Category	2 digits CIP codes	Family of fields
PEMC major	11	Computer and Information Sciences and Support Services
	14	Engineering
	27	Mathematics and Statistics
	40	Physical Sciences
AAN major	1	Agriculture, Agriculture Operations, and Related Services
	3	Natural Resources and Conservation
	4	Architecture and Related Services
BPCH major	26	Biological and Biomedical Sciences
	42	Psychology
	51	Health Professions and Related Clinical Sciences
HESB	9	Communication, Journalism, and Related Programs
	13	Education
	16	Foreign Languages, Literatures, and Linguistics
	19	Family and Consumer Sciences/Human Sciences
	23	English Language and Literature/Letters
	24	Liberal Arts and Sciences, General Studies and Humanities
	30	Multi/Interdisciplinary Studies
	31	Parks, Recreation, Leisure, and Fitness Studies
	38	Philosophy and Religious Studies
	45	Social Sciences
	49	Transportation and Materials Moving
	50	Visual and Performing Arts
	52	Business, Management, Marketing, and Related Support Services
	54	History (New): Study and Interpretation of Past Events, Institutions, Issues, and Cultures
	99	General Curriculum

Table 27: Average Demographic Characteristics in Each Survey
(Including all types of families)

	Mean	Std.
Whether major in STEM	0.24	(.429)
Daughter (Ref. sons)	0.50	(.500)
Number of sibling	2.98	(1.776)
SES composite score	-0.07	(.758)
The average level of mother education	2.30	(.991)
The average level of father education	2.42	(1.094)
Mother occupation prestige	40.19	(16.215)
Father occupation prestige	43.24	(10.676)
% of mother with full-time job	47%	
% of mother with part-time job	24%	
%White	70%	
%Asian	3%	
%Black	14%	
%Non-white Hispanic	22%	
NES Cohort		
Whether major in STEM	0.13	(.334)
Daughter (Ref. sons)	0.52	(.499)
Number of sibling	2.49	(1.684)
SES composite score	-0.05	(.812)
The average level of mother education	2.38	(1.097)
The average level of father education	2.42	(1.164)
Mother occupation prestige	38.87	(14.035)
Father occupation prestige	39.47	(15.488)
% of mother with full-time job	53%	
% of mother with part-time job	18%	
%White	70%	
%Asian	7%	
%Black	10%	
%Non-white Hispanic	13%	

Table 27 (cont'd)

ELS(2002)		
Whether major in STEM	0.09	(.280)
Daughter (Ref. sons)	0.50	(.500)
Number of sibling	2.30	(1.531)
SES composite score	0.04	(.753)
The average level of mother education	2.75	(.994)
The average level of father education	2.77	(1.041)
Mother occupation prestige	44.16	(15.522)
Father occupation prestige	44.23	(12.018)
% of mother with full-time job	58%	
% of mother with part-time job	17%	
%White	65%	
%Asian	9%	
%Black	12%	
%Non-white Hispanic	14%	
HSLS Cohort		
Whether major in STEM	0.29	(.456)
Daughter (Ref. sons)	0.49	(.500)
Number of sibling	1.63	(1.517)
SES composite score	0.05	(.780)
The average level of mother education	2.78	(1.018)
The average level of father education	2.78	(1.056)
Mother occupation prestige	43.79	(15.744)
Father occupation prestige	34.64	(21.868)
Whether major in STEM	0.29	(.456)
% of mother with full-time job	55%	
% of mother with part-time job	14%	
%White	65%	
%Asian	8%	
%Black	10%	
%Non-white Hispanic	16%	

Table 28: Mother Occupation and Occupational Prestige Score

HS&B/ NELS/ ELS/HSLS		
Mother/female guardian's current/most recent occupation: 2-digit ONET code[a, b]		
Occupation	Categories	Occupation prestige score
0	NO JOB	0
1	CLERICAL	38.15
2	CRAFTSMAN	38.51
3	FARMER, FARM MNGR	35.57
4	HOMEMAKER	33.93
5	LABORER	33.38
6	MANAGER, ADMNTR	53.52
7	MILITARY	33.09
8	OPERATIVE	35.94
9	PROFESSIONAL	62.24
10	PROFESSIONAL,DOCTOR	64.38
11	PROPRIETOR,OWNER	44.15
12	PROTECTIVE SERVICE	48.4
13	SALES	35.77
14	SCHOOL TEACHER	73.51
15	SERVICE	34.95
16	TECHNICAL	40.43

Note: [a.] Parents' occupation coding scheme see using 2-digit ONET code to align with HS&B code. In ELS and HSLS data also provide 6-digit ONET code for more category description.
[b.]The ONET Database is in compliance with the mandate that all federal agencies collecting occupational information use the Standard Occupational Classification System external site (SOC). The ONET Database uses the basic 6-digit numerical coding structure of the SOC as its framework, adding a 2-digit extension (sequentially numbered beginning with ".01") to differentiate unique ONET occupations within the SOC system.

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