

The Demographic Pathways of Intergenerational Transmission of Educational Attainment ----- The Role of Fertility and Assortative Mating in Status Reproduction

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A thesis submitted for the degree of
Doctor of Philosophy

2022

Word Count: 43,731

Content

Abstract

Acknowledgement

Co-authorship Declaration

Introduction **01**

Chapter One
Educational Dividend or Educational Disparity: The Consequences of Fertility Decline During the One-Child Policy era in China
..... **11**

Chapter Two
The More the Merrier? How Family Size Moderates Grandparents' Role in Educational Attainment
..... **47**

Chapter Three
The Role of Parents' Education in Marital Sorting over the Life Course
..... **77**

Chapter Four
Two Sides of the Coin: How Educational Homogamy Shapes the Intergenerational Educational Reproduction

..... **104**

Chapter Five
Conclusion **145**

Appendix **150**
Chapter One **150**
Chapter Three **159**
Chapter Four **162**

Reference **164**

Abstract

The intergenerational transmission of education examines to what extent has one generation's attainment determined the next generation's attainment. It is deemed an important indicator of social fluidity and inequality. This thesis explores the demographic pathways of intergenerational transmission, focusing on fertility and assortative mating. It includes four self-contained essays, two on fertility and two on assortative mating.

Chapter One brought the previous individual-level inquiries on the relationship between sibship size and educational attainment to the societal level. Using the case of China, findings show that fertility decline during its One Child Policy era brought modest improvement in the average educational attainment of the country. However, differential fertility rates by rural/urban residency have a marked impact on rural/urban educational inequality.

Chapter Two examined the role of fertility in three-generational transmission. It proposed a new moderator for the process: the fertility rates of the grandparents. Findings using data from the Panel Studies of Income Dynamics (PSID) show that having multiple children (i.e., multiple members in the parental generation) amplifies grandparents' influence on grandchildren's educational attainment.

Chapter Three examined the role of parents in adult children's marital sorting. It extends previous findings on first and new marriages from a life course perspective. Results using PSID data show divergent trends by gender. Parents' influence becomes less important for males but more vital for females over the life course.

Chapter Four examined the role of education homogamy in intergenerational reproduction. It brought the previous one-sided analysis, which focused on one parent only, to the couple level and proposed an approach that is the first to consider and distinguish two sources—resource combination and family milieu—that generate the difference between homogamy and heterogamy. Findings using PSID data demonstrate that these two sources affect couples' probability of having children and their children's educational attainment differently, and their influences change over cohorts.

(300 words)

Acknowledgement

I would like to thank my supervisor Prof.Richard Breen. I read my M.phil and D.phil degrees with his guidance and support. The past six years were wonderful. Chapter Four of this thesis is our co-authored work, and the declaration of co-authorship is attached.

I would like to thank the China Scholarship Council for the financial support of my D.phil study. The ideas expressed in this thesis are those of mine.

I would like to thank Prof.John Ermisch for his valuable comments on this thesis along the way.

I would like to thank Prof.Xi Song for providing me with her codes for navigating the PSID dataset I used to write three chapters of this thesis.

I would like to thank a person whose name I do not know. A related paper to Chapter Four, co-authored by Richard and me, was reviewed at *American Sociological Review* in 2020. One of the anonymous reviewers provided insightful comments. Those comments inspired me to develop Chapter Four into its current state.

I would like to thank Prof.Wei Zhao, who protected and supported me during my bachelor's study, which allowed all my pursuits afterwards possible.

I would like to thank my parents for their unconditional love. Wish us a joyful reunion soon.

I would like to thank Yao Wang and Wenjie Mei for their companions and friendships over the past ten years. Best wishes to their PhD endeavours.

Co-Authorship Declaration Form

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The idea for the underlying model is mine. The idea for this chapter was Hanzhi Hu's. She did all the empirical work including data analysis and wrote the chapter. I edited it but it is substantially her own work.

"I hereby declare that this chapter is predominantly original work by the student named above"

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Introduction

The intergenerational transmission of educational attainment has been a central concern of stratification research. To what extent has one generation's attainment determined the next generation's attainment is deemed an important indicator of social fluidity and inequality in opportunities. Previous studies on this topic usually follow two paradigms: the “retrospective” approach and the “prospective” approach.

The Two Paradigms: the “Retrospective” Approach and the “Prospective” Approach

The "retrospective approach" refers to the practice that uses a sample of the child generation and compares their educational attainment with their parents. Studies follow the "retrospective approach" primarily focus on, given there is a child generation, to what extent the parents' characteristics determine the educational attainment of the children. For decades, studies that adopted the retrospective approach have examined the intergenerational association in educational attainment (e.g., Breen & Johnsson, 2005) and how the strength of the association changed overtime (Shavit & Blossfeld, 1993; Hertz et al., 2007) and in different countries (Chevalier, Denny & McMahon, 2003; Pfeffer, 2008; Burger, 2016).

The “retrospective approach” has attracted criticism for two reasons. First, it samples on the child generation, which results in a non-representative parental generation (Duncan, 1966). The analyses are restricted to those with children and might oversample parents with multiple offspring while excluding those who never had children. It neglects the critical interplay between education and fertility of the parental generation, which decides whether there is a child generation in the first place. Second, it takes the parents' education as given, which neglects the family formation process. The education of a potential parent is associated with his/her timing (Raymo, 2003; Lefgren & Mclntyre, 2006; Wiik, 2009; Torr, 2011) and the

number of marriages (Smock, 1990; Bumpass, Sweet & Martin, 1990; Smith, Zick & Duncan, 1991), the educational attainment of his/her spouse (Mare, 1991; Qian, 1998; Shaferl & Qian, 2010; Shafer, 2013), fertility rates (Rindfuss, Morgan & Offutt, 1996; Kravdal & Rindfuss, 2008), relationship stability (Ono, 2009; Kaplan & Herbst, 2015) and other factors, which together make up the family context where the children grew up. While previous "retrospective" studies made much effort to discover the net effect of parental education on the attainment of the next generation, they cannot shed light on the underlying mechanisms that produced the results.

In contrast, the sampling strategy of the "prospective approach" is to follow a cohort of potential parents and observe whether and how they marry and have the next generation. It enables us to see a more complete picture of the intergenerational reproduction process. Though the importance of considering the dynamic reproduction process in intergenerational transmission has been recognized early (Duncan 1966), empirical studies started formally developing the "prospective approach" to account for it only recently (e.g., Mare & Maralani, 2006; Mare, 2011; Kye & Mare, 2012; Maralani, 2013; Lawrence & Breen, 2016; Breen & Ermisch, 2017). Studies follow the "prospective approach" seek to answer, for a generation of potential parents, how their traits determine their chance of having a child with a certain level of educational attainment. For example, Mare & Maralani (2006) first suggested that the overall effects of increasing women's educational attainment on the educational attainment of the next generation in Indonesia depend on two mechanisms. A woman's high educational attainment can enhance her children's chances of attaining a better education via assortative mating with someone with high education. However, the beneficial effect of mothers' high educational attainment is partially offset by the lower fertility rate of well-educated women. Likewise, Lawrence & Breen (2016) found that obtaining a college degree increases male

graduates' probability of having a child who also completes college. However, it did not affect a woman's probability of having a child who also graduated from college in the U.S., because female college graduates were less likely to marry and have children. Moreover, Maralani (2013) found that the differential strength of "parent-child" educational associations between white and black women is driven by their differential fertility and assortative mating patterns. By far, pioneering works employing the "prospective approach" have revealed a more complex picture of intergenerational transmission of educational attainment by considering the demographic pathways such as fertility and assortative mating.

Following the findings from "prospective" studies, this thesis will explore the demographic pathways of intergenerational transmission by investigating the role of fertility and assortative mating in educational reproduction. It includes four self-contained essays, two focusing on fertility and two on assortative mating.

Fertility and Intergenerational Transmission

The importance of fertility in intergenerational transmission has long been recognized in the literature. Parents' age at childbirth (D'Onofrio et al., 2014; Fomby, Krueger & Wagner, 2014), physical (Hardie & Landale, 2013) and psychological conditions (Torche, 2011, 2018) at child birth, the total number (Blake 1981; Heer, 1995; Steelman et al., 2002) and spacing of childbirth (Dewey & Cohen, 2007; Conde-Agudelo et al.,2012) are influential in the development of their children in various aspects. This thesis focuses on parents' fertility rates (i.e. the total number of childbirth).

In the literature, the relationship between parents' fertility rates (i.e. how many siblings the child has) and the development of the children has been intensively studied. Most studies are

motivated by the "Quantity-Quality" trade-off thesis coined by Becker and Lewis (1973). The thesis suggests a negative association between sibship size and one's development and life chances, provided that the resources that the parents offer to each child decrease as the number of children in the household increases. It is also called the resource dilution model. Numerous studies have empirically tested whether the "Quantity-Quality" trade-off thesis holds for various developmental outcomes over time (Parish & Willis 1993; Pong 1997; Maralani 2008) and across countries (Vogl 2016; Li, Dow & Rosero-Bixby 2017; Choi et al., 2020). Several lines of studies in recent years questioned the robustness of the negative relationship between sibship size and an individual's life chances (Maralani, 2008; Angrist et al., 2010; Åslund & Grönqvist, 2010; Bagger et al., 2013). Nonetheless, many empirical studies have reported evidence in favor of the "Quantity-Quality" trade-off thesis, showing a negative relationship between sibship size and a person's educational performance (Downey,1995; Rosenzweig & Zhang, 2009; Ponczek & Souza, 2012), occupational attainment (Biblarz, Raftery, & Bucur 1997), and wealth accumulation (Keister 2003).

This thesis extends the literature on the fertility of the parental generation and the educational attainment of the child generation in Chapter One and Chapter Two. First, previous studies tested the relationship between sibship size and one's achievement disproportionately at the individual level. They compare the variations among individuals with different sibship sizes and estimate the impact of having one more or less sibling on an individual's achievement. However, less is known when a society's average sibship size increases or decreases, whether it will translate into changes in the average educational attainment at the societal level. Therefore, in Chapter One, I use the case of Chinese society to investigate whether the fertility decline it experienced during the One-Child Policy era (1979-2015) increased the average educational attainment at the macro-level. Moreover, at the macro-level, fertility rates also

differ across groups. Differential fertility by socioeconomic status (Dribe, Oris and Pozzi, 2014), income level (Lam, 1986; De La Croix & Doepke, 2003), education (Westoff 1954; Vogl 2016), and race (Preston 1974; Kuo & Hauser 1995; Mare 1997) is well documented. However, whether the fertility gaps between groups can translate into between-group inequality in educational attainment lacks empirical testing. As in China, during the One Child Policy era, family size demonstrated diverging trends by gender and by rural/urban residency. In Chapter One, I also investigate how the differential fertility changes by gender and rural/urban residency influenced the educational inequality between groups during the One-Child Policy era.

Second, previous studies only consider the implications of fertility rates in the two-generational setting. In recent years, a growing literature has intended to expand the conventional two-generation model to include multiple generations. It concerns how one's life chance is determined by his family of origin beyond the parent's generation. (e.g., Jæger 2012; Pfeffer & Killewald 2018; Anderson, Sheppard & Monden, 2018; Erola et al., 2018). Previous studies have explored the direct influence of grandparents on grandchildren (e.g. Warren & Hauser 1997; Erola & Moisio 2007; Jæger 2012; Engzell, Mood & Jonsson,2020) and the mediators or pathways of the transmission process (e.g. Roksa & Potter 2011; Wightman & Danziger 2014; Fiel 2019; Klein & Kühhirt 2021). Moreover, a few studies considered the heterogeneities of grandparents' influence across subgroups (e.g. Zeng & Xie, 2014; Song, 2016; Deindl & Tieben, 2017; Lehti, Erola & Kansekane, 2019). In Chapter Two, I considered the implications of fertility rates in the multigenerational setting and proposed a new moderator of the multigenerational transmission: the grandparents' fertility rates, and examined how it moderated the educational association between grandparents and grandchildren with the three-generational data from the Panel Studies of Income Dynamics (PSID).

Assortative Mating and Intergenerational Transmission

Marriage or union formation is critical in shaping the intergenerational transmission of (dis)advantages. Marriage formation marks the creation of families, wherein children are born and grow up (Mare & Maralani 2006; Maralani 2013). The resources and structure of the family have lasting consequences on the children's development (McLanahan 2004; McLanahan & Percheski 2008). Therefore, the patterns, determinants, and consequences of marriage/union formation have long been of interest to scholars. Chapter Three and Chapter Four[1] examined the determinants and consequences of marital sorting on educational attainment (i.e. the similarity of couples in terms of their educational attainment).

Three factors are argued to shape marital sorting outcomes (Kalmijn 1998). The first is a preference for partners with specific characteristics. The growing trend of marital homogamy, in which couples have the same characteristics such as in educational attainment (Mare 1991; Schwartz & Mare 2005) or income level (Kalmjin 1994; Schwartz 2010; Gonalons-Pons & Schwartz 2017), is partially attributed to people's preference for marrying someone with similar tastes, lifestyle, or status (Kalmijn 1991, 1998; Rosenfeld 2008). Second, the outcomes of marital sorting depend on constraints and opportunities. Partner choices are subject to the availability and composition of the potential partners (Choo & Siow 2006; Xie, Cheng & Zhou 2015). Third, a less-mentioned factor is "third parties" such as friends, family members, and institutions. These can exert an external impact on partner choice. Chapter Three investigates the role of parents in adult children's marital sorting (i.e., whom the adult children marry) and explores the extent to which the parents' education is associated with the educational attainment of children-in-law. It investigates three pathways for the potential association between parents and children-in-law: a) intergenerational transmission, b) matching between

[1] Chapter Four is a co-authored work. The declaration of authorship is attached.

parents of the two families, and c) parents' direct influence on adult children's marital sorting. Furthermore, previous studies that examined parental education in marital sorting focused on first marriages (Blackwell 1998) and new marriages (Schawrtz, Zeng & Xie 2016). Chapter Three extends the literature by examining the changes in parents' direct influence on marital sorting over the life course using the Marriage History Data from PSID. Potential gender variations are also considered.

Patterns of educational assortative mating affect social stratification and inequality. The extent to which people form families within the same educational level is viewed as an indicator of the openness of society and the rigidity of social groups' boundaries (Glass, 1954; Kalmijn, 1998). The high level of homogamy, which is especially true at the top and bottom ends of the educational distribution (Schwartz & Mare, 2005), implies challenges in crossing social boundaries for union formation and strong segregation between groups. The growing resemblance between couples means the concentration and polarization of (dis)advantages, leading to more inequalities between households. Much effort has been made to investigate the interplay between educational homogamy and inequality in household income and earnings (Kremer, 1997; Western, Bloome & Percheski, 2008; Breen & Salazar, 2010; Torche, 2010; Breen & Andresen, 2012). Few studies, however, have explored the implications of educational homogamy for intergenerational reproduction. It should be an important consequence of educational homogamy as it defines the family background where the children grow up (Mare & Schwartz, 2006; Schwartz, 2013), which determines various aspects of the short-term and long-term development of the children. In Chapter Four, following the "prospective" approach, we examine this process using a "Person-Partner-Child" panel constructed from PSID and bring the previous one-sided analysis, which focused on one parent only, to the couple level. We propose an approach to study the differences between homogamous couples (i.e. couples

having the same level of education) and heterogamous couples (i.e. couples having different levels of education) in their likelihood of having a child and, if a child is born, the child's educational attainment. The role parental educational homogamy plays in intergenerational reproduction is multifaceted. Educational homogamy defines the composition of the family, that is, who the parents are, and the family milieu, that is, how the parents interact with each other and with their children. In the literature, the role educational homogamy plays in resource combination and family milieu creation is studied in separate strands of works, and their relative contributions to intergenerational reproduction have not been considered together. Our approach synthesizes the two bodies of literature and demonstrates how these two sources — resource combination and family milieu—generate the differences between homogamy and heterogamy.

Structure of the Thesis

This thesis contains four self-standing essays on the main topic of the demographic pathways of intergenerational education reproduction. They are organized roughly in the order they were conceived and loosely follow a logical sequence that can be described as follows.

Chapter One brings the previous individual-level inquiries on the relationship between sibship size and educational attainment to the societal level. Using data from China General Social Survey (CGSS) and China Family Panel Survey (CFPS) (N=44,918), It answers two questions regarding the educational consequences of fertility decline during the One-Child Policy (OCP) era in China with simulations. First, has fertility decline improved the human capital in terms of average educational attainment at the societal level by limiting the average sibship size? Results reveal that the fertility decline during the OCP era brought modest improvement in the average years of schooling. Second, how does the differential fertility between groups

contribute to educational inequality? Counterfactual simulations show that its impact on the educational disparity between males and females is limited. However, it has a marked impact on the rural-urban disparity in education.

Chapter Two examined the role of fertility in the multigenerational setting. It proposed a new moderator of the multigenerational transmission: the fertility rates of the grandparents and examined how it moderated the educational association between grandparents and grandchildren. With three-generational data from PSID (N=7,535) and mixed effect models, results show that having multiple children (i.e., multiple members in the parental generation) amplifies grandparents' influence on grandchildren. The strength of the grandparents' influence grows as the grandparents' fertility rates grow. These results highlight the heterogeneity in grandparents' influence on grandchildren across grandparents' fertility rates. When grandparents have multiple children, the extended family networks amplify grandparents' influence on grandchildren. This moderation relation between grandparents' education and fertility rates demonstrates an accumulation process of (dis)advantages in the multigenerational setting.

Chapter Three examines the role of parents in adult children's marital sorting. It focuses on the extent to which parents' education is associated with the educational attainment of children-in-law. It investigates three pathways for the potential association between parents and children-in-law: a) intergenerational transmission, b) matching between parents of the two families, and c) parents' direct influence on adult children's marital sorting. Furthermore, this study extends previous findings on first and new marriages from the life course perspective. With data from the Panel Studies of Income Dynamics 1968-2019 (N = 13,489) and mixed-effect models, results show divergent trends by gender. Parents' influence in marital sorting becomes less

important for males at older ages and in remarriages. For females, it becomes more vital over the life course, as compensation for their disadvantages when marrying at older ages and in remarriages.

Chapter Four examined the role of education homogamy in intergenerational reproduction. Following the "prospective" approach, we use a "Person-Partner-Child" panel constructed from PSID and bring the previous one-sided analysis, which focused on one parent only, to the couple level. We propose an approach to study the differences between homogamous and heterogamous couples in their likelihood of having a child and, if a child is born, the child's educational attainment. Our approach is the first to consider and distinguish two sources—resource combination and family milieu—that generate the difference between homogamy and heterogamy. Our results demonstrate that, first, the homogamous family milieu is the driving force for their higher likelihood of having a child compared to heterogamous couples. However, this reproductive advantage among homogamous couples waned over cohorts. Second, the combination of parents' resources via homogamy is the driving force that shapes the child's educational attainment, and it is associated with disadvantages at the bottom of the educational distribution, albeit with advantages at the top. Over cohorts, the magnitudes of the penalties increased at the bottom, while the benefits declined at the top.

Chapter One

Educational Dividend or Educational Disparity: The Consequences of Fertility Decline During the One-Child Policy era in China

Abstract

Rapid fertility decline has been witnessed in developing countries during the second half of the twentieth century. However, the consequences of fertility decline on average education and educational inequality at the societal level remain unexplored. Using data from China General Social Survey (CGSS) and China Family Panel Survey (CFPS) (N=44,918), this study contributes to the literature by answering two questions regarding the educational consequences of fertility decline after the implementation of the One-Child Policy (OCP) in China with simulations. First, has fertility decline improved human capital of the Chinese society by limiting average sibship size? Results reveal that the fertility decline during the OCP era brought modest education dividends in terms of improvement in the average years of schooling. Second, how does the differential fertility between groups contribute to educational inequality? Counterfactual simulations show that its impact on the educational disparity between males and females is limited. However, it has a marked impact on the rural-urban disparity in education.

Introduction

Several developing countries have witnessed rapid fertility decline during the second half of the twentieth century (Bongaarts, 2008). This demographic process is argued to affect economic outcomes, socioeconomic inequality, and the population's well-being. The consequences of the fertility decline have long been of interest to scholars. Fertility decline is believed to have an impact on economic growth (Cuaresma, Lutz & Sanderson, 2014), poverty reduction (Wietzke, 2020), and gender inequality (Yount, Zureick-Brown, Halim & LaVilla., 2014). First, scholars argue that fertility decline can boost productivity and benefit economic growth by creating the demographic dividend (Bloom & Williamson, 1998), which derives from the beneficial changes in age-dependency ratios. Following this argument, the "East Asian Growth Miracle" is attributed to countries' fertility decline and the subsequent changes in age structure (Bloom & Williamson, 1998; Bloom, Canning & Sevilla, 2003). Moreover, studies found that fertility decline raises income per capita (Ashraf et al., 2013) and positively affects the growth of GDP (Li & Zhang, 2007). Second, studies on the relationship between fertility rates and poverty emphasize the impact of the heterogeneous trends of fertility decline. Scholars argued that compared with the higher-status group, fertility decline happens later and slower for the lower-status group, which can increase inequality and influence poverty rates (Eastwood & Lipton, 1999). Furthermore, fertility decline can influence gender inequality and intensify gender gaps in societies with preference for male offspring (Yount et al., 2014). For instance, as fertility rates fell in India, girls' excess mortality grew (Das Gupta & Bhat, 1997). In China, the fertility decline is accompanied by an increasing male-to-female sex ratio at birth (Junhong, 2001; Li, Yi & Zhang, 2011).

Improvement in human capital is an often mentioned mechanism when discussing the impact of fertility decline on economic growth, poverty reduction, and gender inequality (Lee, Mason,

& Miller, 2000; Wietzke, 2020). Fertility decline can increase educational attainment since, according to the "Quantity-Quality" trade-off thesis coined by Becker and Lewis (1973), parents can offer each child more resources that benefit educational attainment as the number of children in the household decreases. Empirical studies have discussed the variations of the sibship size effect on education over cohorts (Parish & Willis, 1993; Pong, 1997; Maralani, 2008;) and across countries (Vogl, 2016; Li, Dow & Rosero-Bixby, 2017). Moreover, scholars investigated the mechanism of the effect (Chen, 2020) and its robustness against unmeasured confounders (Black et al., 2005; Angrist, Lavy & Schlosser, 2010). Though several lines of studies in recent years questioned the robustness of the negative relationship between sibship size and educational attainment (Maralani, 2008; Angrist et al., 2010; Åslund & Grönqvist, 2010; Bagger et al., 2013), numerous empirical studies have reported evidence supporting the "Quantity-Quality" trade-off thesis (Rosenzweig & Zhang, 2009; Ponczek & Souza, 2012; Liu, 2014; Choi et al., 2020).

Regarding the relationship between fertility rates and educational attainment, previous studies disproportionately tested it at the individual-level. They compare the variations among individuals with different sibship size and estimate what is the impact of sibship size on individual's educational attainment. However, less is known when the average sibship size of a society increases or decreases, whether it will translate into changes in the average educational attainment at the societal level. If the negative relationship between sibship size on education holds true at the societal level, we should expect that as fertility declines, the benefits of small sibship size lead to improvements in the average educational level of the society. However, Li et al. (2017) demonstrated with simulations that the fertility decline in Latin America and Asia can explain only a small portion of the increase in the average educational attainment of the societies. Their study does not include China in the analysis. China provides a unique case to understand the consequences of fertility decline. It experienced a rapid fertility

decline since the 1970s; however, its fertility decline did not happen entirely voluntarily like in other countries. The fertility trends in China are affected by multiple governments' birth planning suggestions, campaigns, and regulation policies, among which the One-Child Policy launched in 1979 forcefully set limits to people's fertility behavior. Whether the rapid fertility decline observed in China has translated into an improvement in human capital has not been empirically answered. The first goal of this study is to examine whether the fertility decline observed during the OCP era in China improved its human capital.

Furthermore, the heterogeneity in fertility between groups should influence between-group inequality in educational attainment. Differential fertility between groups might translate into educational disparities as groups with higher fertility rates suffer from larger sibship size penalties. Moreover, during demographic transitions, fertility rates can decline differently across groups. For instance, the "leader-follower model" suggests that higher socioeconomic groups begin to have fewer births earlier and faster than the lower-status groups (Bongaarts 2003; Wietzke, 2020). The divergence or convergence in fertility rates between groups over time can lead to long-term changes in between-group disparities in education. As in China, the implementation of the One-Child Policy set different birth limits across groups, which might forcefully create differences in fertility between groups and lead to education inequality. First, previous studies suggested the decrease in sibship size for females should promote gender equality, as more women enjoyed the only-child premium and obtained similar attainment as men (Ye & Wu, 2010; Wu, Ye & He, 2012). Moreover, during the One-Child Policy era, the relaxation of the regulations for the rural population in 1984 created differences in policy-targeted fertility between urban and rural areas. Only the urban population was strictly forced to limit their fertility, which might have amplified the fertility differences between rural and urban China. However, whether the fertility differences between groups have further translated into between-group inequality in education has not been empirically tested.

Using recent data sources, this study observed the completed education for cohorts born from 1950 to 1993 and examined the consequence of fertility decline after the implementation of the One-Child Policy (OCP) in 1979. The results reveal that the fertility decline during the OCP era brought modest education dividends in terms of improvement in the average years of schooling. Counterfactual simulations indicate that its impact on the educational disparity between genders is limited. However, during the OCP era, the divergent trends of fertility decline for urban and rural populations have a marked impact on the rural-urban disparity in education.

The literature review first summarizes relevant previous studies on fertility decline and their implications and focuses on the relationship between fertility and educational attainment. Thereafter, it reviews the trends in fertility and educational attainment in China from 1950 to 1990 and discuss why and how we should expect differential fertility to contribute to gender inequality and rural-urban inequality. Thereafter, it introduces the data and empirical strategy and report the results. The paper ends by discussing the implications of the findings for understanding human capital growth and inequality in Chinese society.

Literature Review

As a feature of demographic transitions, fertility decline and its implications have long attracted scholarly interest. Though the causal relationships are still debatable, fertility decline is believed to be at least associated with economic growth (Cuaresma, Lutz & Sanderson, 2014), poverty reduction (Wietzke, 2020), and gender inequality (Yount et al., 2014).

Scholars argue that fertility decline can boost productivity and benefit economic growth by creating a demographic dividend (Bloom & Williamson, 1998), which derives from the beneficial changes in age-dependency ratios. Fertility decline contributed to a fast growing

working-age population and expanding per capita productive capacity during the second half of the 20th century in East Asian countries, which led to the so called "East Asian Growth Miracle" (Bloom & Williamson, 1998; Bloom, Canning & Sevilla, 2003). Moreover, the literature shows that fertility decline increases income per capita (Ashraf et al., 2013) and positively affects GDP growth (Li & Zhang, 2007). Improvement in human capital is an often mentioned mechanism that links fertility decline and economic growth (Lee, Mason & Miller, 2000; Wietzke, 2020). For instance, Cuaresma, Lutz and Sanderson (2014) argued that the demographic dividend of fertility decline is an educational dividend. They pointed out the improvements in educational attainment explain a substantial portion of productivity and income growth brought by age structure changes after the fertility decline.

In the literature, the relationship between fertility and education is often studied at the individual level. The "Quantity-Quality" trade-off thesis, coined by Becker and Lewis (1973), states that as the number of children in the household decreases, parents are able to offer each child more resources that benefit educational attainment. Thus, the sibship size should be negatively related to individuals' educational attainment. Empirical studies have intensively tested the relationship between sibship size and education over cohorts (Parish & Willis, 1993; Pong, 1997; Maralani, 2008;) and across countries (Vogl, 2016; Li, Dow & Rosero-Bixby, 2017; Choi et al., 2020). Several studies have recorded a shift in the association from positive to negative over cohorts. Maralani (2008) found that the association between sibling size and children's schooling in urban Indonesia was positive for older cohorts (1950s) but turned negative for more recent cohorts (1970s). Vogl (2016) found that, in 48 developing countries, before 1960, children from larger families were more likely to attain higher education, however, the pattern had reversed in later cohorts. A similar pattern is also found in Taiwan (Parish & Willis, 1993) and Malaysia (Pong, 1997). This shift in the association has been attributed to the evolution of societal preferences and structural changes in other social regimes. Vogl (2016)

emphasized that the reversal of sibling size and education association is because of the reversal of differential fertility by parents' education. For earlier cohorts, wealthier and more educated families tended to have more children; however, the association flips with economic development.

Scholars have also investigated the mechanism of the sibship size effect on education (Chen, 2020) and its robustness against unmeasured confounders (Black et al., 2005; Angrist et al., 2010). Though numerous empirical studies have reported evidence supporting the "Quantity-Quality" trade-off thesis (Rosenzweig & Zhang, 2009; Ponczek & Souza, 2012; Liu, 2014; Choi et al., 2020), the robustness of the negative relationship between sibship size and educational attainment has been questioned (Maralani, 2008; Angrist et al., 2010; Åslund & Grönqvist, 2010; Bagger et al., 2013). Scholars have argued that confounders might bias the relationship between sibship size and education. Previous studies have usually used two approaches to overcome the endogeneity. The first was to employ instrumental variables, like twins' birth, sex composition of children, or policy intervention, that triggered exogenous changes in sibling size (Black, Devereux & Salvanes, 2005; Rosenzweig & Zhang, 2009; Angrist et al., 2010). The other was to use the individual fixed-effect models to account for time-invariant confounders (Guo & VanWey, 1999; Chen, 2020). Extant studies have reported mixed findings depending on the methods and educational outcome. For instance, Black et al. (2005) revealed that while applying the birth of twins as an instrumental variable finds no effect of increased family size on educational outcomes, using the same-sex composition as the instrument reveals a positive effect in Norway. Cáceres-Delpiano (2006) reported no significant impact of the sibling size increase from twin births on grade retention; however, it does reduce the probability of attending a private school in the U.S. Using the fixed-effect method. Guo and VanWey (1999) found that sibship size has limited effect on verbal skills however, positively affects math skills.

However previous studies have disproportionately focused on the relationship between sibship size and education for individuals. They compare the variations among individuals with different sibship size and estimate what is the impact of sibship size on individual's educational attainment. However, less is known when the average sibship size of a society increases or decreases, whether it will translate into changes in the average educational attainment at the societal level. Through simulations, Li et al. (2017) provided an exception. They found that only a small portion of the increase in the average educational attainment of the countries in Latin America and Asia can be explained by their fertility decline. Their study excluded China in the analysis. However, similar to other developing countries, China experienced a rapid fertility decline since the 1970s owing to socioeconomic changes and policy interventions. If the negative association between sibship size and educational attainment holds true at the societal level, we would expect the decrease in fertility rate to increase the average education level of the society. The first hypothesis is proposed as:

H1: Fertility decline during the One Child Policy era increases average educational attainment.

Apart from the overall decline in fertility rates, the heterogeneity in fertility decline is argued to bear consequences. Studies contend that the heterogeneous trends of fertility decline between groups are the driving forces of the relationship between fertility rates and inequality. Scholars have argued that compared with the higher-status group, fertility decline happens later and slower for the lower-status group, which can increase inequality (Eastwood & Lipton, 1999). The divergence in fertility rates between the higher-status and lower-status group tends to worsen inequality and poverty rates, while the convergence in fertility rates reduces inequality. In the literature, differential fertility by various parents' characteristics, such as socioeconomic status (Dribe, Oris and Pozzi, 2014), income (Lam, 1986; De La Croix &

Doepke, 2003), education (Westoff, 1954; Vogl, 2016), and race (Preston, 1974; Kuo & Hauser, 1995; Mare, 1997), is well documented. Demographers and stratification scholars are interested in examining the consequence of differential fertility between groups. Consider the gradient of fertility across education levels as an example. If parents with less education tend to have more children, and large sibship size penalizes educational attainment, scholars argue that the differential fertility by parental education can lead to 1) lower average education over generations; 2) increase between-group inequality in education. Empirical studies have provided mixed evidence. Preston and Campbell (1993) claimed that micro-level differential fertility by IQ does not translate into changes in the distribution of IQ in the population over generations with a two-sex model. Mare (1997) examined the differential fertility between white and African-American women in the United States and found that the effect of differential fertility on the trend of average educational attainment is not large enough to create meaningful changes over generations, and its impact is offset mainly by intergenerational mobility. However, Volg (2016) indicated that, among the 48 developing countries examined, results varied by countries for whether the differential fertility over the skill and income distribution has increased or decreased the mean educational attainment. As for between-group inequality, Mare (1997) revealed that the racial differences in fertility between white and African-American women have limited impact on educational inequality between races. As in China, as will be reviewed later, fertility rates differ across various characteristics, like regions, education levels, and socioeconomic status. Fertility decline began earlier and more rapidly for groups with higher education (Lavely and Freeman, 1990), socioeconomic status and urban residency (Merli & Smith, 2002). Moreover, the regulations of the One-Child Policy set different birth limits across groups. For instance, while the urban population is under the strict one-child limit, the rural population is subjected to more relaxed regulations, which might

enlarge the fertility differences between rural and urban population and lead to more inequality in education. The second hypothesis is proposed as,

H2: The fertility differences during the One Child Policy era lead to more inequality in education between rural and urban China.

Moreover, fertility decline can influence gender inequality as scholars asserted that fertility decline is associated with changes in gender attitudes and norms in society (Yount et al., 2014). However, empirical studies reveal that the relationship between fertility decline and gender inequality depends on the social context. Girls can benefit from fertility declines in societies with lower son preference, while in societies with strong son preference, studies indicate that decline in fertility intensifies the gender gaps in mortality and nutrition. For instance, in India, girls' excess mortality grew as fertility rates fell (Das Gupta & Bhat, 1997). In China, the fertility decline is accompanied by an increasing male-to-female sex ratio at birth (Junhong, 2001; Li, Yi & Zhang, 2011). In terms of educational attainment, previous studies have speculated that the fertility decline in China should promote gender equality as more women enjoyed the only-child premium and obtained similar attainment as men (Ye & Wu, 2010; Wu, Ye & He, 2012). However, empirical evidence is sparse. Therefore, the third hypothesis is proposed as follows:

H3: The fertility differences during the One Child Policy era reduce inequality in education between genders.

The Chinese Context

Trends in Fertility in China from 1950 to 1990

The fertility level in China has experienced drastic changes since 1950. The total fertility rates (TFR) in China throughout the 1950s and 1960s were around 5 to 6 births per mother (Banister, 1987). In the early 1970s, the Chinese government promoted a "Two is Enough" policy. The policy advocated that couples should delay marriage and childbearing and have no more than two children with wider birth spacing. It is also known as the "*wanxishao*" (later, longer, and fewer) campaign. During the 1970s, China witnessed its most rapid fertility decline. The TFR plummeted from 5.8 in 1970 to 2.7 in 1979, more than half in 10 years (Cai, 2008). The "two-child policy" and a subsequent series of fertility control policies culminated in the One-Child Policy in 1979. The initial statement of the policy was to encourage one child per couple. However, the implementation of the policy became stricter gradually. In 1983, it developed into forced sterilization and abortion campaign. The campaign backfired as the rebellion of the society led to severe unsettlement threatening security. In response, the central government relaxed the fertility control in 1984 and transferred the power to provincial governments to set fertility limits. Therefore, under the guidance of the provincial governments, lower-level governments execute the fertility control according to the local conditions. (See Gu et al. (2007) for a detailed summary of the local fertility policy variations at the provincial level.)

The fertility policies of the 31 provinces of mainland China are divided into the following categories. For the urban population, one child limit was enforced. For the rural population, there were three scenarios: 1) in six provinces, including Beijing and Shanghai, all residents followed the one-child rule; 2) in 19 provinces, rural residents were allowed to have a second child if the first birth was a girl. It is also called a "1.5-child policy"; 3) All rural couples could have two children in the remaining five provinces. Apart from these, 26 provinces permitted couples, both of whom were the only child in their families, to have two children. Moreover,

ethnic minorities were exempted from fertility control. (See Gu et al. 2007: p134 - p135, Table 1, for a summary of provincial fertility policies in China revised or changed through the 1980s to late 1990s.)

During the 1980s, the observed TFR fluctuated around 2.5 (Feeney and Wang 1993). At the beginning of the 1990s, the TFR dropped further. The 1990 census reported a TFR at 2.3 (Cai 2008). Analysis based on surveys and census suggests that the TFR in China declined to the under replacement level in the 1990s, from 1.8 in 1991 to 1.2 in 2000 (Retherford et al., 2005). Though issues like underreporting have led to a debate on the exact level of TFR in China (Hermalin & Liu, 1990; Goodkind, 2004), the consensus is that during the 1990s, fertility rates continued to decline and fell below the replacement level.

Although population policies are argued to play an essential role in shaping the fertility trends in China (Lavely & Freedman, 1990; Goodkind, 2017), scholars emphasized that socioeconomic factors became key driving forces, especially for more recent trends (Zhao & Zhang, 2018). Earlier work indicated that well before the implementation of government programs in the 1960s and 1970s, evidence of voluntary family birth control and fertility declines were observed among the better-educated population and residents in urban areas (Greenhalgh, 1989; Lavel & Freedman, 1990). More recent work stressed that social, economic, and cultural transformations became the main factors leading to fertility decline since the mid-1990s (Zhao, 2015). After several decades of high-speed development, people's fertility intentions and behavior experienced profound changes. For example, studies recorded an increase in average age at first marriage and first birth (Feng & Quanhe, 1996), contributing to the fertility decline. Moreover, the rising costs of child-rearing and education, along with other factors, have led to people's voluntary choices of having fewer children (Zhang, 1990). It is

challenging to distinguish policy intervention's impact from socioeconomic factors' impact on fertility decline, as these forces are interwoven and often work collectively.

It is less discussed whether social groups experienced the decline differently, while the focus has been on why and how the overall TRF changes gradually in China. However, there are valid reasons to expect heterogeneity in fertility decline. Policy interventions and individual characteristics, such as education, social status, and preference, can create divergent fertility trends within the population. First, regarding individual characteristics, similar to other countries, fertility decline in China began from the educated groups. Lavely and Freeman (1990) mentioned that better-educated elites intentionally practiced birth control before government's intervention. Norm or preference is another important factor to consider because of the tradition of son preference in China (Murphy, Tao & Lu, 2011). Parents with son preference might have multiple births to reach their desired result in the absence of policy or resource constraints; or practice sex-selective abortion (Goodkind, 2011; Den Boer & Hudson, 2017) if having multiple births is not an option. Second, as for policy regulations, the strict 1979 One-Child Policy and its ancillaries set varied birth limits for social groups. While most urban residents were subjected to a strict one-child limit, rural residents and ethnic minorities could have multiple births with or without conditions. Moreover, studies indicated the heterogeneity in people's degree of acceptance and compliance to the policies, as urban and industrialized areas demonstrate higher acceptance than others (Merli & Smith, 2002). Thus, we should expect the fertility decline began earlier and more rapidly for groups with higher education, socioeconomic status, weaker son preference, and urban residency.

Trends in Educational Attainment and Inequality in China Since 1950

It is well documented in the literature that educational attainment in China has increased gradually since 1950. Cohort studies reveal that the average years of schooling increased for

both men and women in rural and urban China (Wu & Zhang, 2010: Figure 2; Treiman, 2013: Figure 1).

The gender gap in education closed over cohorts (Wu & Zhang, 2010), while the rural-urban gap persisted. The average years of schooling for males increased from around seven years for the 1950 cohort to around ten years for the 1980 cohort, while that for females increased from less than six years for the 1950 cohort to around ten years for 1980 cohorts. The level of educational attainment for men and women converged over time (Treiman, 2013). Meanwhile, the urban-rural gap persisted. The average years of schooling for urban males born in 1950 was around 10; however, for rural males it was slightly above six. The gap was maintained over cohorts. Regarding the 1980 cohort, the average years of schooling for urban males was 12 years, while it was around eight years for rural males. A similar pattern can be observed for females that the urban-rural gap in education was maintained at around four years over cohorts (Wu & Zhang, 2010).

When explaining the improvement in educational attainment, fertility decline is an often mentioned driving force alongside educational expansion and economic development. However, empirical tests on the effect of fertility decline on human capital improvement are sparse. Moreover, scholars suggested that the fertility decline contributed to the convergence of educational attainment between genders. Scholars argue that fertility decline should have promoted gender equality as more girls enjoyed the only-child premium and obtained similar attainment as boys (Ye & Wu, 2010; Wu, Ye & He, 2012). Some empirical studies revealed that in urban one-child families, only daughters and only sons were being treated equally (Tsui & Rich, 2002), and no difference was found in their educational achievement (Lee, 2012). However, these findings cannot be generalized to the rural areas where only-children are not

as common as in urban areas. More importantly, whether the increase in the proportion of only-child girls is large enough to affect the overall trends in gender inequality is questionable.

As for the urban-rural disparity, the household registration system (*hukou*)[2], which institutionalizes the divide between rural and urban population, is regarded as the most critical determinant of rural-urban inequality (Wu & Treiman, 2004). Fertility differential is a less mentioned factor however, should have played a role in the process. The fertility rate is higher in rural than in urban China and the local implementations of the One-Child Policy might enlarge the difference. Rural parents tend to have more children than urban parents owing to the practical consideration of having more workforce in the household for agricultural production and cultural norms that large family size represents prosperity in traditional Chinese culture. Moreover, during the One-Child Policy era, the relaxation of the regulations for the rural population in 1984 created differences in policy-targeted fertility between urban and rural areas. Only the urban population was strictly forced to limit their fertility, which might enlarge the fertility differences between rural and urban China. Whether fertility differences affect between-group inequality in China has not been empirically tested. To fill the void, I compiled several recent data sources to observe the completed education for cohorts born from 1950 to 1993 and examined the contribution of changes in sibling size during the One-Child Policy era on 1) average education and 2) between-group inequality over cohorts.

[2] *Hukou* refers to the household registration system in China under which, everyone is assigned a *hukou* (household registration certificate) at the time of birth. The *hukou* contains two-fold information. First, the category that one's *hukou* status falls in. The *hukou* status is divided into rural vs. urban or agricultural vs. non-agricultural. Second, the local administrative unit one's *hukou* is registered with. The *hukou* must register to only one administrative unit at the lowest available level as one's official/permanent residential place and under the supervision of all the higher level of administrative authorities.

Data and Methods

Data and Measurements

This study draws on data from China General Social Survey (CGSS) 2006, 2008, 2017, and China Family Panel Survey (CFPS) 2010–2018 to construct a cross-sectional dataset. CGSS is a nationally representative cross-sectional survey on mainland China launched in 2003 (Bian and Li 2012). The respondents' number of siblings is known only for the 2006, 2008, and 2017 waves. The CFPS is a nationally representative longitudinal dataset. The survey sample is drawn from 25 provinces or administrative equivalents, representing 94.5% of the total population in mainland China. The sampling is designed to achieve regional representation using multistage probability sampling with implicit stratification (Xie and Lu 2015). They are the most recent data sources available to observe the completed education for cohorts born after the implementation of the One-Child Policy.

From the CGSS data, the analytic sample selects respondents born after the People's Republic of China (PRC) was founded (1949) and older than 25 in each survey year. The CFPS data are in the longitudinal format. To pool them with the cross-sectional CGSS data, the analytic sample selects CFPS respondents who were born after 1949 and were older than 25-years in the 2010 baseline wave and included those who would turn 25-years old in the following waves and have records of the completed education. The final sample contains 44,918 respondents born between 1950 and 1993 with complete information on their sibship size and educational attainment. Education attainment is measured as the years of education the respondent completed. Sibship size is measured as the total number of siblings, including those who had passed away at the time of the survey. Urban and rural population are distinguished according to the *hukou* registration status of the mother when the respondent is 14 years old. Table A1.1 in the Appendix (page 150) presents the sample size, average sibship size, and schooling for

each cohort. Table A.1.2 in the Appendix (page 151) presents the average sibship size and schooling by gender and rural/urban residency for each cohort.

Methods

To portray the trend over cohorts, this study calculated the 5-year moving average of sibship size and educational attainment. The average for the focal cohort, t, is computed as,

$$\widehat{y_t} = \frac{y_{t-2}+y_{t-1}+y_t+y_{t+1}+y_{t+2}}{5} \quad (1.1)$$

For each cohort, this study predicted education attainment with sibship size, gender, *hukou* status, ethnicity, parental birth years and parents' education, and thereafter explored how fertility decline has contributed to educational attainment and inequality with counterfactual simulations. First, this study fixed the average sibship size for post-OCP cohorts (1979 and onward) at the pre-OCP level (1978) to examine the difference between the hypothetical trend in educational attainment and the observed trend. Thereafter, this study examined the trends by gender and by regions (urban vs. rural). This study explored the effect of fertility on gender inequality and urban/rural inequality by making alternative assumptions about how the average sibship size changes for post-OCP cohorts (1979 and onward). One is to fix the sibship size at each group's pre-OCP level. The post-OCP cohorts are assigned with the average sibship size at the 1978 level. The other is to let females have the same level of sibship size as the males, and let rural residents have the same level of sibship size as the urban residents. The association between sibship size and educational attainment is obtained with OLS regression. The potential endogeneity concern is discussed in the Robustness Check section.

Results

Sibship Size and Educational Attainment: Trends, Group Variations, and Inequality

Figure 1.1 depicts the changes in average sibship size and year of education over cohorts. Overall, the average sibship size decreased while the education attainment increased. As illustrated in Panel.a of Figure 1.1, the average sibship size decreased from around 3.6 for the oldest cohorts (the 1950s) to around 1.05 for the youngest cohorts (the 1990s). The average sibship size declined more rapidly for cohorts born before the OCP. For the 1970–1978 cohorts, the average sibship size decreased by 1.18, from 2.85 to 1.67, while for cohorts born after the implementation of the OCP (1979-1993 cohorts), their average sibship size decreased by 0.65, from 1.67 to 1.02. This echoes with previous findings that family size began to decline in China before the implementation of OCP, and it has declined most rapidly during the 1970s (Hesketh, Lu and Xing 2005). Regarding education, as illustrated in Panel.b of Figure 1, the average years of schooling increased over cohorts, from around 7.3 years for the 1950s to 13.1 years for the 1990s, except for fluctuations experienced by the 1960s cohorts whose education was disrupted by the Cultural Revolution (1966-1976).

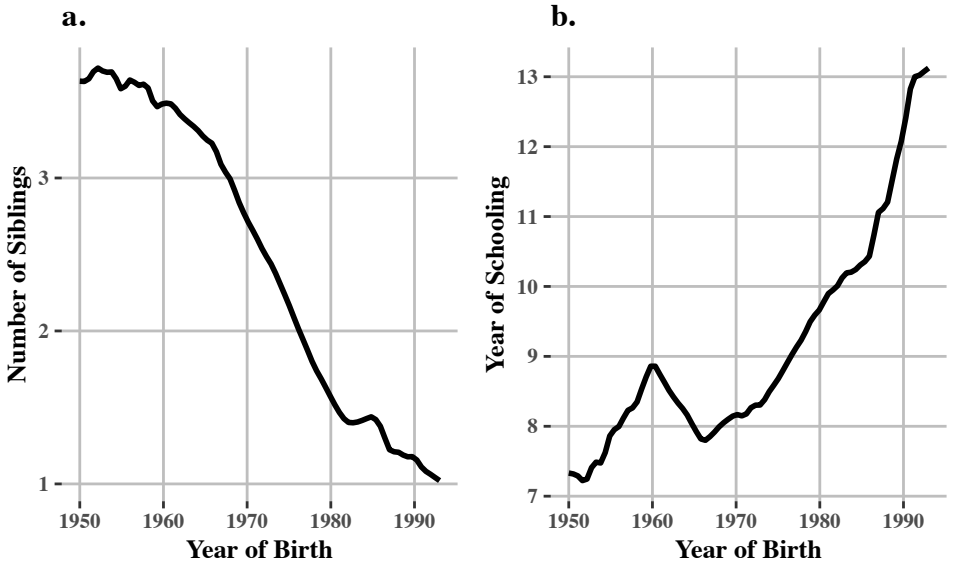


Figure 1.1 Cohort Trends of the Average Number of Siblings (Panel.a) and Average Years of Schooling (Panel.b)

As mentioned, because of the prevalence of son preference, we would expect females to have more siblings than males. We would also expect urban residents to have fewer siblings than rural residents since, on average, urban parents are more educated and with higher social status. Moreover, in rural areas, families are allowed to have multiple births conditioned or unconditioned on having a son. Thus, we would expect the group discrepancies by gender (male vs. female) and regions (urban vs. rural) in sibship size to be extravagant in the OCP era.

First, for gender differences, according to Panel.a in Figure 1.2, females had more siblings than males over cohorts. Gender difference in sibship size was maintained at around 0.3 during the observed period. Meanwhile, the gender difference in average education decreased over cohorts (Panel.b in Figure 1.2). The largest gender gap is observed for the 1960 cohort, where males had 1.6 years more education than females. The gender gap diminished afterward and closed for the 1983 cohort and onward. There is no statistically significant difference in educational attainment between genders for the OCP generations.

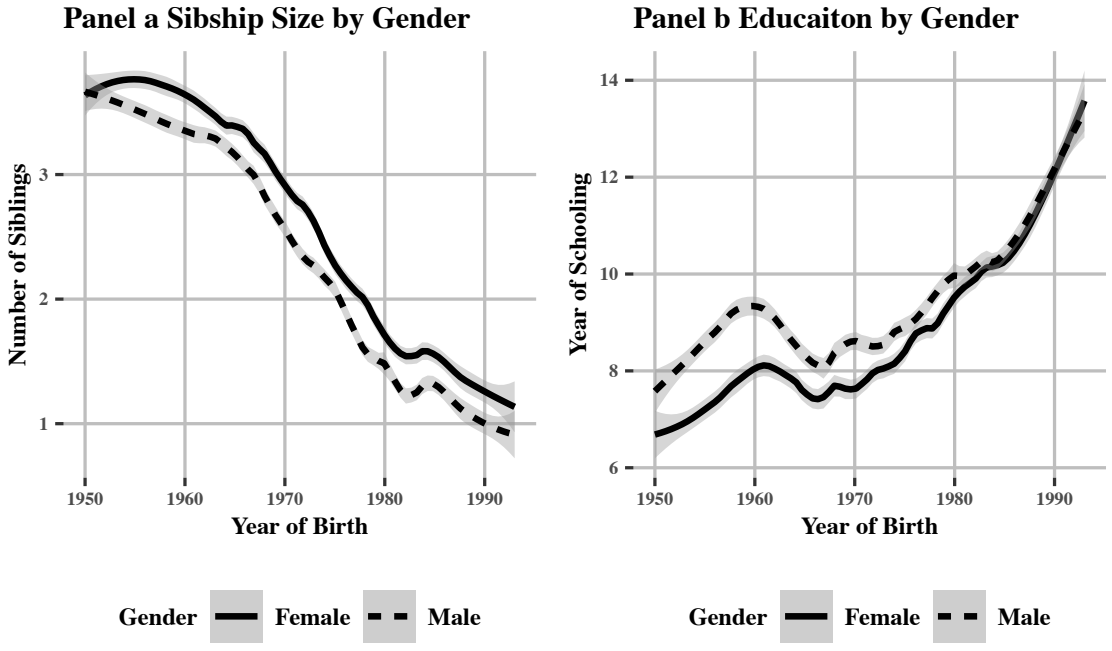


Figure 1.2 Cohort Trends of Sibling Size (Panel.a) and Average Years of Schooling (Panel.b) by Gender; Shadows indicate standard errors.

Regarding rural/urban discrepancy, rural residents had more siblings than urban residents, and the difference first decreased from around one for the 1960 cohort to 0.67 for the 1970 cohort (Panel.a in Figure 1.3). Thereafter, it fluctuated at around 0.7 for the 1970s cohorts and increased after the implementation of the OCP. It oscillated at around one for the younger cohorts. It is worth noticing that the average sibship size for urban residents fell below one after 1979, which suggests a high proportion of the only-children among urban residents. Figure 1.4 depicts the share of only-child within urban and rural residents. For cohorts born before 1970, the percentage of the only-children is less than 5% in both urban and rural populations. Since 1970, the share of the only-child among urban residents has increased dramatically. The number increased from less than 5% for the 1970 cohort to 40% for the 1979 cohort. After the implementation of OCP, the share of the only-children in urban increased by around 38%, from 40% to 78% for the 1993 cohort. By comparison, the increase in the share of only-children among rural residents was relatively modest. It slowly increased from less than 5% for the 1970 cohort to less than 10% for the 1980 cohort and around 20% for the 1993 cohort. As for educational attainment (Panel.b in Figure 1.3), over cohorts, though urban and rural residents both experienced improvement in average educational attainment, urban residents constantly had around four more years of education than rural residents, and this gap only started to diminish for recent cohorts (the 1990s).

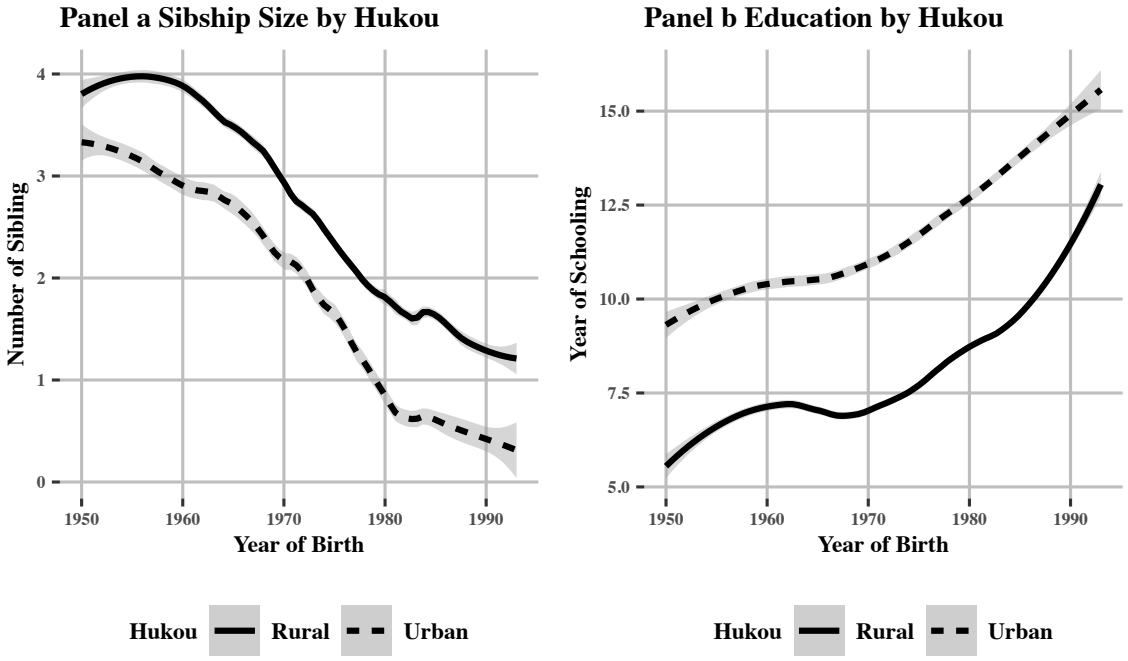


Figure 1.3 Cohort Trends of Sibling Size (Panel.a) and Average Years of Schooling (Panel.b) by *Hukou ;*Shadows indicate standard errors.

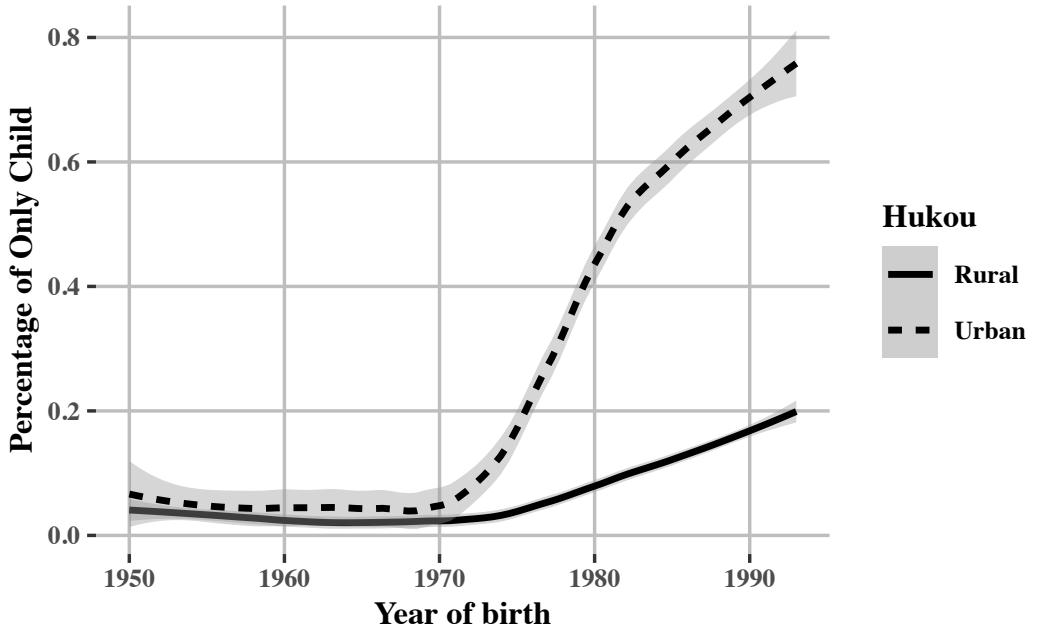


Figure 1.4. Cohort Trends of Share of Only Child in the Respondents by *Hukou;* Shadows indicate standard errors.

To link the changes in sibship size with changes in educational attainment, we need to answer two questions: first, whether sibship size has an influence on one's educational attainment; second, how much of the gender inequality and urban/rural inequality in the year of schooling is explained by the differential sibship sizes. For the former, I estimated the association between one's sibship size and educational attainment over cohorts with OLS regressions and thereafter employed the exogenous changes in sibship size owing to the One-Child Policy as instruments to address the endogeneity problem in the Robustness Check section. For the second question, I reported two sets of counterfactual analysis to see a) what would have happened if the sibship size had remained at pre-OCP level for the post-OCP cohorts; b) what would have happened if females had had the same sibship size as males, and rural residents had had the same sibship size as the urban residents over cohorts.

Sibship Size and Educational Attainment

Figure 1.5 illustrates how the association between sibship size and educational attainment evolves over cohorts. The estimate for each cohort is obtained with OLS regression controlling for child's gender, *hukou* status, ethnicity, parental birth years, and parents' education. In accordance with previous work, sibship size is negatively associated with one's educational attainment (Li et al., 2008; Rosenzweig & Zhang, 2009; Liu, 2014; Chen, 2020), and the negative association became stronger gradually (Lu & Treiman, 2008; Choi et al., 2020). Having one more sibling is associated with around 0.1 years less education (statistically insignificant, $p>0.01$) for the oldest cohorts (the 1950s). The association increased to around 0.6-unit less of education ($p<0.000$) for the youngest cohorts (the 1990s). For the early cohorts (the 1950s and 1960s) and some of the recent cohorts (the 1980s), the sibship size disadvantage is larger for females than for males (Panel.b in Figure 1.5). There is no statistically significant difference between urban and rural residents in the sibship size penalty (Panel.c in Figure 1.5).

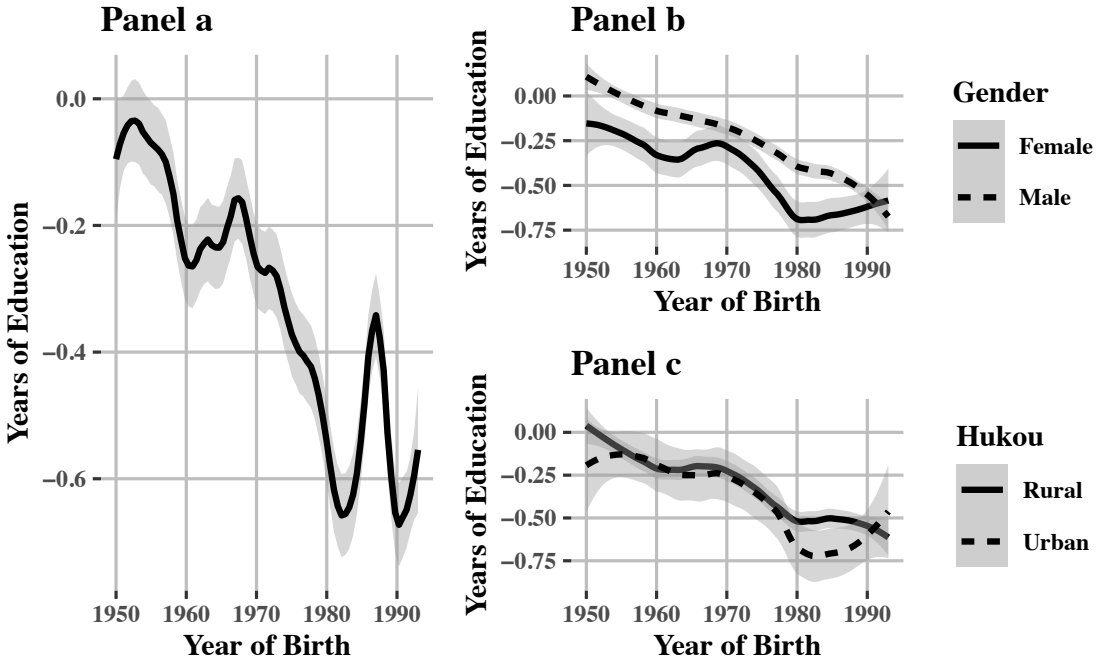


Figure 1.5 Cohort Trends in Sibship Size Disadvantage in the Years of Education (Panel a) and Trends by Gender (Panel b) and by *Hukou* Status (Panel c).
Note: Shadows indicate 95% confidence intervals of the coefficient. Parental education, ethnicity, gender, hukou, age, and age square are controlled.

Differential Fertility and Group Inequality

First, I kept the average sibship size for the OCP generations (1979-1993 cohorts) constant at the 1978 level, which is one year before the official implementation of the One-Child Policy. As illustrated in Figure 1.6, for the OCP generations (1979–1993 cohorts), their observed educational attainment increased by 3.84 years from 9.28 to 13.12. If the average sibship size had remained at its 1978 level, the increase in educational attainment for the OCP generations would have been 3.29 years, from 9.28 to 12.56, which is a 0.6-year or 9%-less than the observed.

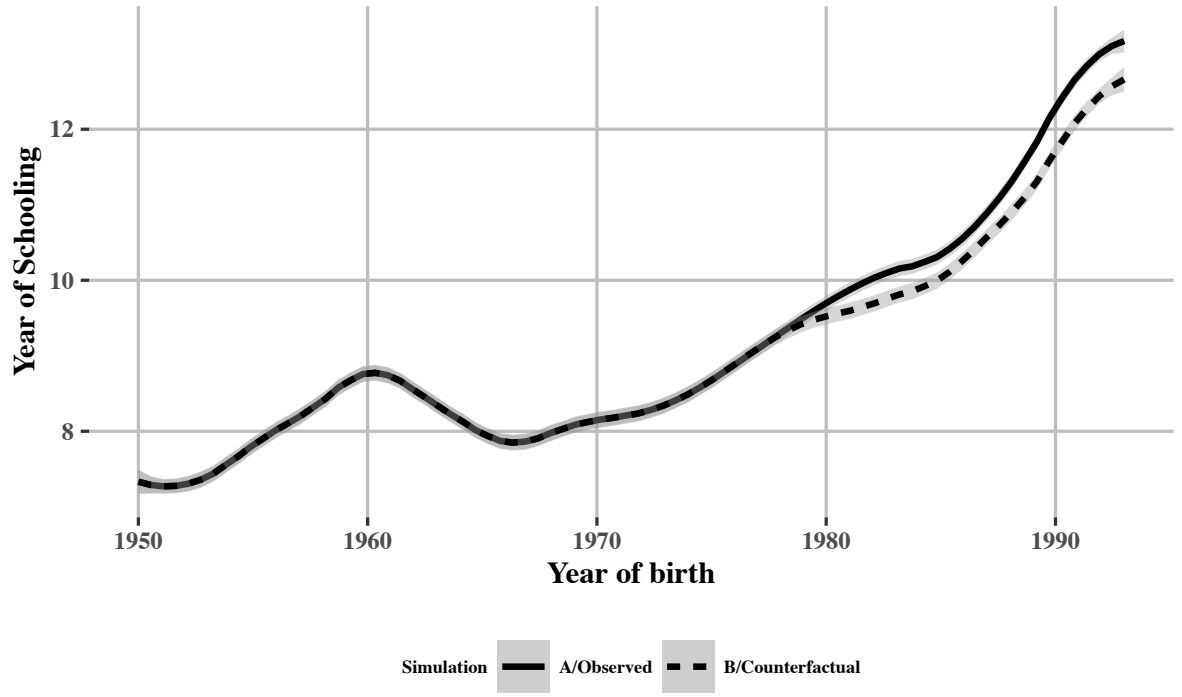


Figure 1.6 Observed and Counterfactual Trends (Sibling Size Fixed at 1978 Level) of Average Years of Schooling.
Note: Dash line represents the counterfactual scenario. Shadows indicate 95% confidence intervals.

Regarding gender gap in education, it started to diminish before the OCP was implemented and closed for cohorts from 1983 onward. I reported two counterfactual scenarios in Figure 1.7. First, if the sibship size had remained constant for males and females of the OCP era at the 1978 level, the hypothetical trends (Panel.a in Figure 1.7) suggest that it would have slightly suppressed the improvement in education for both genders and postponed the achievement of gender equality in education. The gender gap would not have closed until the 1990 cohort under the counterfactual scenario. Second, Panel.b in Figure 1.7 illustrates what if females had had the same level of sibship size as males. The hypothetical trends are almost the same as the observed. The gender gap in education would have closed as early as the 1980 cohort, and females would have surpassed males in educational attainment for the 1990 cohorts. In all, the fertility changes during the OCP era has moderately accelerated the closing of the gender gap

in education. However, the gender gap in education would have disappeared over cohorts even if there had been no difference between genders in their sibship sizes.

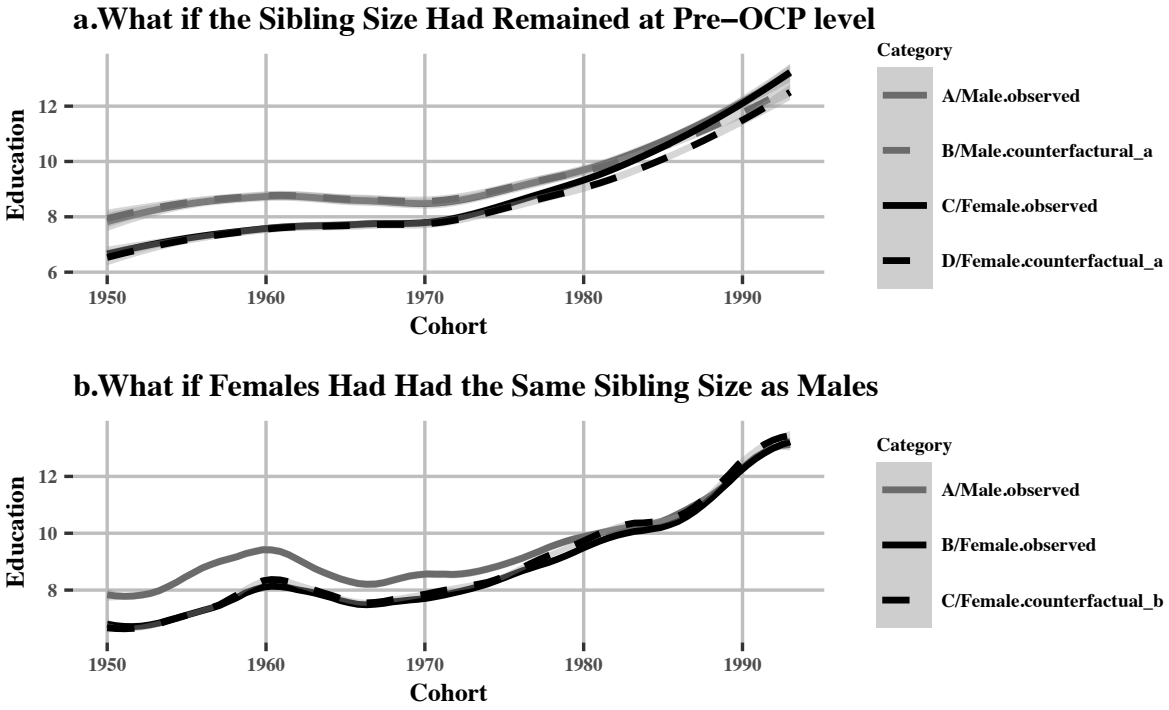


Figure 1.7. Observed and Two Counterfactual Trends of Gender Inequality in Schooling.
Note: Dash lines represent the counterfactual scenarios. Shadows indicate 95% confidence intervals.

Regarding rural/urban differences, under the first counterfactual, Panel a in Figure 1.8 illustrates what would have happened if the sibship size had remained at the pre-OCP level for the OCP cohorts. As shown, the rural/urban differences in education would have been significantly smaller if the sibship size for the OCP cohorts of the two groups had remained at the 1978 level. The counterfactual sibship size has limited impact on the rural residents' educational attainment. The development under the counterfactual is essentially the same as the observed. For rural residents, their observed average attainment for the 1990 cohort is 11.53 years and would have been 11.32 years under the counterfactual. However, urban residents' educational attainment would have increased less rapidly under the counterfactual. The observed attainment for the 1990 cohort urban residents is 15.10 years. If they had had the

sibship size at the pre-OCP level, the average attainment would have been 13.13 years, a near two-year less of improvement. The observed urban/rural gap for the 1990 cohort is 3.57 years, and it would have been 1.81 years under the counterfactual, which is 49.3% less than the observed. Under the second counterfactual, Panel.b in Figure 1.8 illustrates that if rural residents had had the same sibship size over cohorts as their urban counterparts, it would have increased the rural residents' educational attainment by 0.7 years for the 1970 cohort (7.13 vs. 7.83), 0.98 years for the 1980 cohort (8.74 vs. 9.72), and 1.08 years for the 1990 cohort (11.53 vs. 12.61). The rural/urban gap would have decreased by 18.4% for the 1970 cohort, 24.9% for the 1980 cohort, and 30.3% for the 1990 cohort, respectively.

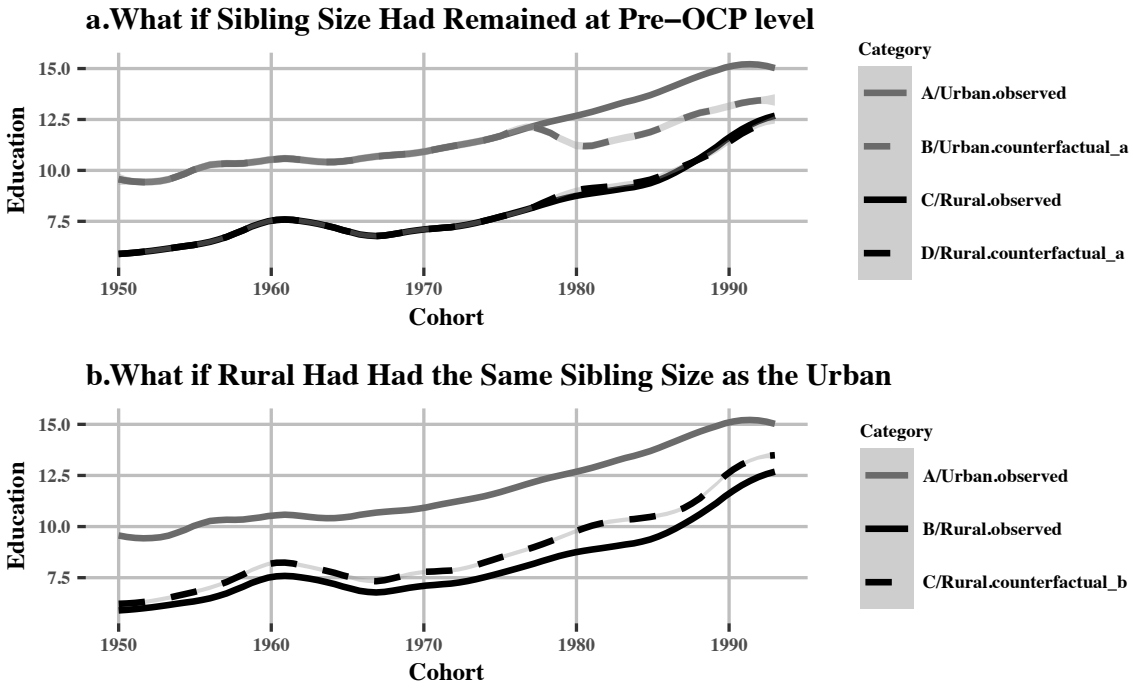


Figure 1.8. Observed and Two Counterfactual Trends of Urban/Rural Inequality in Schooling. *Note: Dash lines represent the counterfactual scenarios. Shadows indicate 95% confidence intervals.*

Robustness Check

Internal Migration

When examining the cohort trends, I defined rural and urban populations according to the mother's *hukou* status when the respondent is young. However, China has experienced massive rural-to-urban migration since the early 1980s. In 2007, about 10% of China's population were rural-to-urban migrants (Kwong, 2011), while in 2011, 29.7% of the population with a rural origin lived in the urban areas. If only the policy intervention is considered, not isolating the internal migrants from the rural sample should not be a concern because one's fertility behavior is subjected to local regulation where the person's *hukou* is registered. For a migrant who lives in the urban areas, if his/her mother has the rural *hukou* when the respondent is young, his/her sibship size is affected by the rural rather than the urban regulations. However, the assimilation theory of migration (Warner & Srole, 1945) expects migrants and their children to adapt to the hosting environment and to have similar attitudes and behaviors as residents at their destinations. Thus, rural-to-urban migrants may voluntarily adopt the fertility strategies of urban residents to have fewer children. Moreover, migration experience influences one's educational attainment. Empirical studies report mixed findings on the impact of migration on one's educational attainment (Liang & Chen, 2007; Xu & Xie, 2015; Wu & Zhang, 2015). The concern is that if migrants are positively or negatively selected and intrinsically different in childbearing and rearing from their rural counterparts, including them in the rural sample might bias the results. According to the literature, the most advantaged migrants are those who successfully switch to urban *hukou* (Wu & Treiman, 2004), as the government set quota on *hukou* conversion to 1.5 to 2.0 per thousand persons each year (Yilong, 2003). The conversion can be achieved mainly by obtaining high education, party membership, and military services. Among the 32,815 rural cases in the sample, 3,033(9.24%) cases switched to urban *hukou* at the time of the survey. To test the robustness of the results against selection, I

replicated the analysis by excluding the migrants from the sample. Results do not reveal a substantial difference as reported.

The Endogeneity Problem of Sibship Size

The simulation model is constructed based on the assumption that changes in sibship size are exogenous. However, as reviewed, previous studies raised concerns about the endogeneity problem of sibship size, and estimates from OLS regression might be biased. In response, I used the instrumental variable approach and compared the 2SLS estimates, and the OLS estimates to see whether and how the endogeneity problem can affect the conclusions.

In the literature, studies often employ twin births or the sex composition of the first two births as instruments for sibship size (Black, Devereux & Salvanes, 2005; Conley & Glauber, 2006; Angrist et al., 2010). However, these instruments have drawbacks when applied to the Chinese context. Neither of them can capture the increase in sibship size from zero to one, which is the most common scenario in China during the observational periods. In practice, the variation in family size owing to these instruments is confined to families that have at least two children.[3] Moreover, the sex composition itself is endogenous in a society with a strong son preference. Instead, I used the variations in the One-Child Policy in rural China as instruments. Several previous studies employed this policy intervention as an instrument however they have suffered from two shortcomings. First, the policy regulation is often measured at the aggregated level, for instance, the urban and rural differences (Wu & Li, 2012) or provincial or county-level

[3] When using twin births as instrument, the effects of sibship size are uncovered by estimating the effect of a twin birth at birth N, on the outcomes of children born prior to this birth, conditional on families having at least N births. Owing to the fact that twins and singleton child are different in their birth-endowment, like birth weight, and various other aspects that related to future development, it is not appropriate to use births of twins as instrument at N = 1, i.e., to compare twins with single child at first birth, to estimate the effect of increase in sibship size from 0 to 1. Similarly, the sex composition can only be used for families with at least two children to estimate the effect of family size increase from 2 to more.

differences (Liu, 2014; Qian, 2009). Second, previous studies measured outcomes for children who reside in the same household as their parents often at relatively young ages (Liu, 2014). In this study, I used the detailed policy regulations available at the community/village level: a) whether more than one birth is allowed; 2) the amount of fine on the excess births, from 2010 China Family Panel Studies (CFPS) as instruments to assess sibship size's effect on the highest completed education. Details on the sample and variables used for the IV analysis are in the Appendix.

The instrument exogeneity assumption requires that the local fertility regulations should not be correlated with unmeasured confounders that affect a child's education. The most mentioned candidate of the unmeasured confounders in the literature is the parental preference for the high-quality child, which is also associated with a smaller sibship size. The local governments set the fertility policy. It can only be correlated with parental preference if a culture of "Quality-Quantity" trade-off preference exists at the community level. It is tested in previous studies whether the family size preferences varied at the community level. There is no evidence suggesting that communities with more relaxed fertility policies also have a higher proportion of parents preferring a larger family (Liu, 2014). I further set control for educational resources measured by educational expenditure and number of schools in the communities in 2010, in case of local governments with stricter fertility policy to invest more in education. Another potential violation of the exogeneity assumption is that local variations in policy may motivate migration for fertility purposes. Communities with fewer restrictions on fertility may have more migrants who wish to have more children, and if the migrants are intrinsically different in educating their children, the exogeneity assumption is violated. In response, I excluded the migrants from the analysis. Moreover, I checked the exogeneity assumption with a placebo test

and the robustness of the results against potential measurement errors in the instrumental variables. Details are provided in the Appendix.

The OLS and IV results are presented in Table 1.1. All the models controlled for the following variables: 1) the demographic features of the child: gender and age gap between the oldest and youngest children in the family; 2) the characteristics of the mother: her age at first birth and year of schooling; 3) father's year of schooling and the logarithm of annual net family income; 4) local educational resources measured by the educational expenditure of the government and number of schools in the communities in 2010. Furthermore, since in the literature, birth order (De Haan,2005; Booth and Kee, 2009; Bagger et al., 2013) and birth spacing (Blake et al., 2005) are argued to confound the sibship size effect, the robustness analysis focuses on the firstborn only to avoid potential bias.

Table 1.1 OLS and IV Estimates of the Effect of Sibling Size on Education Outcomes

	OLS	IV	
		1st Stage	**2SLS**
Outcome Variables		Sibling size	Education of the 1st born
Number of Siblings	**-.583*****		**-1.847***
	(.107)		(.851)
Instruments			
One Child Limit (No=0; Yes=1)		-.182**	
		(.076)	
Log of Fine		-.291***	
		(.074)	
N		1,461	
adj. R^2	.157	.182	.072
1st Stage Statistics			
Partial R^2		.035	
Robust F-statistics		14.680	

Note: Four sets of variables included as controls: 1) the demographic features of the child: gender and age gap between the oldest and youngest children in the family; 2) the characteristics of the mother: her age at first birth and year of schooling; 3) father's year of schooling and the logarithm of annual net family income; 4) annual educational expenditure and number of schools of the communities. Parameters for control variables are omitted here. Standard errors in parentheses. Standard errors are adjusted to account for the clustering of residents within communities.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

According to the OLS estimates, a one-unit increase in sibship size is associated with a 0.583-year (p<.000), or 7-month, decrease in the educational attainment of the first child. As for the IV estimates, the first stage regression results indicate that the one-child fertility limit is negatively associated with sibship size. Living in communities where only one birth is allowed, *ceteris paribus*, is associated with a .185-unit (p<0.01) decrease in sibship size. As for the level of fine, it is negatively associated with sibship size. A 1% increase in the fine charged on excess birth is associated with a 0.3% decrease (p<.000) in sibship size. The two instruments together explained 3.5% of the variance in sibship size, and the F-statistics passed the threshold of 10 (Bound et al., 1995).

The IV models indicate the same patterns that the sibship size has a negative effect on the educational attainment of the firstborn children. Compared with the OLS estimate, the IV estimate has a sizeable standard error, and its 95% confidence interval contains the point estimate from the OLS regression. To decide which estimator is preferred, I tested the endogeneity of sibship size with the Hausman (1978) test. It compares the OLS estimator and the 2SLS estimator to see whether the difference is statistically significant. The test results give large p-values (p=.091), suggesting that there lacks sufficient evidence to reject the null hypothesis that the OLS estimate and the 2SLS estimate are statistically indifferent. Thus, the OLS estimate is preferred for its efficiency.[4]

Conclusion and Discussion

This study answered two questions regarding the educational consequences of fertility decline using the case of China.

First, has fertility decline improved human capital via shrinking sibship size? The educational consequences of fertility decline depend on: a) the magnitude of fertility changes; b) the magnitude of the effect of sibship size on educational attainment. Regarding the former, the amount of sibship size changes during the OCP era is limited. After the official implementation of the One-Child Policy, China's average sibship size decreased by 0.65 for the observed cohorts (1979–1993). Counterfactual analysis suggests that if the sibship size had remained at the pre-OCP level, the average educational attainment would have been 0.6-year less than the observed. During this period, the total increase in educational attainment is 3.84 years. The

[4] In the Appendix, I discussed the validity of the instruments and provide evidence for the exclusion restriction assumption with placebo test and robustness check.

contribution of sibship size decline is relatively modest at 9%. Although during this period, the draconian policy intervention and rapidly developed social factors, like increase in mothers' education and labor force participation rate, led to a further decline in fertility, the amount of decline observed in this period compared with the decline in the previous decade (1970–1979) is limited (1.18 vs. 0.65). Thus, the contribution of fertility decline to human capital improvement during the OCP era is modest.

Regarding the second component, the magnitude of the effect of fertility on educational attainment, a methodological concern is whether the OLS estimates of the effect of fertility on educational attainment are biased. I employed two policy instruments from the local variations of the One-Child Policy in rural areas to address the endogeneity concern. IV results confirm a negative link between sibship size and educational attainment. The OLS estimate is preferred for its efficiency in the analysis since the difference between the OLS and IV estimates is not statistically significant. The decision is also made because IV analysis requires its own set of strong assumptions, and its estimate is a local effect for the compliers.

The second question answered is how does the differential fertility between groups contribute to educational inequality? First, the results indicate that, over cohorts, females have more siblings than males, and the gap in sibship size between genders was maintained at 0.3. The observed gender gap in education closed for the 1983 cohort and onward. Counterfactual analysis suggests that if females had had the same number of siblings as males, the gender gap in education would have disappeared slightly earlier for the 1980 cohort and onward. The impact of sibship size on gender inequality in education is limited. Previous studies argue that fertility decline should have promoted gender equality as more girls enjoyed the only-child premium and obtained similar attainment as boys (Tsui and Rich 2002; Lee 2012). Results

suggest that the magnitude of the impact is rather modest. Factors other than fertility should have driven the convergence of females' and males' educational attainment in China. Figure A1.1 in the Appendix depicts the cohort trends of educational attainment by gender for those with and without siblings, respectively. As revealed, there is no statistically significant difference in educational attainment between only-child females and only-child males over cohorts. For those with siblings, the gender gap closed over cohorts as well. It further illustrates that despite females having more siblings and the disadvantage of sibship size on education appears to be more vital for females than males, the sibship size does not play an important role in explaining the closed gender gap in education in China.

Second, regarding rural-urban discrepancy, results reveal that differential fertility has a marked impact on rural-urban inequality in education. Findings first highlight that fertility declined differently in rural and urban China. Over cohorts, rural residents had more siblings than urban residents, and the difference first decreased to 0.7-unit for the 1970s cohorts and increased to one after the implementation of the OCP. During the One-Child Policy era, urban residents' sibship size decreased more rapidly. It might be because only urban populations are subjected to the strict one-child limit. Fertility regulations are more relaxed for rural populations. The counterfactual analysis reveals that if the average sibling size had remained at the pre-policy level, it would have suppressed the educational improvement for the urban residents but, had limited impact on rural residents. Thus, it would have diminished the urban-rural inequality in education. These findings highlight a less mentioned perspective: the differential fertility between groups in understanding educational inequality in contemporary China. By fixing the sibship size for urban and rural populations at the same level, findings from this analysis reveal that differential fertility can explain up to 30% of their education gap. It should inspire future research on the inequality of other dimensions where differences in fertility rates between

groups are observed. For instance, a promising candidate is the inequality between ethnic groups (Han Chinese vs. ethnic minorities). Ethnic groups might cherish different childbearing and rearing values, which leads to discrepancies in fertility outcomes between groups. Moreover, ethnic minorities are exempted from the one-child limit during the OCP era, further enlarging the fertility gap between groups. As ethnic inequality in educational attainment (Hannum, 2002) and occupation status (Hannum & Xie, 1998) is documented, it is a fruitful avenue of research to explore the long-term impact of fertility differences on these ethnic inequalities.

It is emphasized that the findings of this study should not be interpreted as the impact of the one-child limit set by the One-Child Policy because, for one, the policy regulations varied across groups. Only urban populations and residents in several provinces are subjected to the strict one-child limit. For another, multiple factors have led to fertility decline during this period. The effects of policy intervention and socioeconomic factors on fertility decline are interwoven. Scholars of population policy might be interested in the contribution solely made by the One-Child Policy intervention. To answer this inquiry, one has to isolate the impact of policy on fertility decline from other socioeconomic factors. MacElroy and Yang (2000) provided an estimate of a third of a child in family size reduction owing to policy intervention. Rosenzweig and Zhang (2009) used this result and computed the contribution of the One-Child Policy on human capital improvement, concluding that the policy at most increased schooling attainment by 4%. However, this result should be interpreted with caution since the estimate of the family size reduction owing to policy intervention is based on local policy variations in rural areas only. Thus, it should not be generalized nationally and directly compared with findings from this analysis. Evaluating the consequence of the One-Child Policy bears its own significance. Findings from this analysis suggest that future work should first, focus on urban

populations as they are subjected to the strict one-child limit; second, find approaches to isolate the impact of policy intervention from other socioeconomic factors.

Finally, based on the findings, the answer to the question raised in the title is, the fertility decline during the One-Child Policy era in China brought modest education dividends in terms of improvement in the average years of schooling. Its impact on the educational disparity between genders is also limited. However, during this period, the divergent trends of fertility decline for urban and rural populations had a marked impact on the rural-urban disparity in education.

Chapter Two

The More the Merrier? How Family Size Moderates Grandparents' Role in Educational Attainment

Abstract

The role of grandparents in status attainment and intergenerational transmission has drawn much scholarly attention in recent years. Previous studies have explored the direct influence of grandparents on grandchildren and the mediators or pathways of the transmission process. However, the heterogeneities of grandparents' influence across subgroups have not been sufficiently examined. This study proposes a new moderator of the multigenerational transmission: the fertility rates of the grandparents, and examined how it moderates the educational association between grandparents and grandchildren after controlling parents' characteristics, using three-generational data from Panel Studies of Income Dynamics 1968-2019 (N=7,535) and mixed effect models. The results show that having multiple children (i.e., multiple members in the parental generation) amplified grandparents' influence on grandchildren. The magnitudes of the grandparents-grandchild educational associations grow as the extended family size increases. These results highlight the heterogeneity in grandparents' influence on grandchildren across grandparents' fertility rates. This moderating relationship between grandparents' education and fertility rates demonstrated an accumulation process of (dis)advantages in the multigenerational setting.

Introduction

Intergenerational reproduction of traits, such as education, income and social status, is a central concern of social stratification research. In recent years, a growing number of studies have sought to expand the conventional two-generation model to include multiple generations. This concerns how one's life chances are determined by his family of origin beyond the parents. Though early work in stratification proposed questions on whether and how the characteristics of distant ancestors beyond the parental generation matter in multigenerational transmission (Hodge, 1966), only recently empirical studies with appropriate data expanded the conventional two-generational model to the multigenerational setting (e.g., Jæger 2012; Pfeffer & Killewald 2018; Anderson, Sheppard & Monden, 2018; Erola et al., 2018). While the two-generational model considers only the transmission between parents and their children, multigenerational studies include grandparents and other extended family members, like uncles, aunts and cousins, in the kinship networks.

Three research agendas guided multigenerational studies. One is to estimate the direct or "pure" effect of grandparents or distant ancestors on their inconsecutive generations (Warren & Hauser,1997; Erola & Moisio,2007; Jæger, 2012; Chan & Boliver, 2013; Song & Mare, 2017; Breen, 2018). Studies made inferences based on non-zero grandparent-grandchild associations after controlling the characteristics of both parents or all members of the parental generation and reported mixed findings contingent on countries and measurements. Secondly, instead of estimating the direct effect of grandparents, some studies consider the transmission pathways from grandparents to grandchildren. Factors such as parents' childrearing practices (Roksa & Potter, 2011), childhood experiences and attributes (Fiel, 2019), neighborhood (Sharkey & Elwert, 2010), and home environment (Wightman & Danziger, 2014) have been found to mediate the grandparents' effect. Finally, the third line of research focuses on the heterogeneity

of the grandparents' effects, i.e., how the influences of grandparents differ across subgroups. For instance, Zeng and Xie (2014) revealed that the grandparents' effect was contingent on the multigenerational co-residence. Song (2016) found that the effect of grandparental education on grandchildren's education was stronger in intact families than in those where parents were separated. Moreover, some studies reported evidence supporting the argument that grandparents have a more substantial impact when parents experience disadvantaged situations (Deindl & Tieben, 2017; Lehti, Erola & Kansekane, 2019). This present study falls in the third category and explores how grandparents' fertility rates can moderate the educational association between grandparents and grandchildren – something which has not been considered in the literature to date.

The two-generation studies have intensively examined the relationship between parents' fertility and the outcomes of children. Following the "Quantity-Quality" trade-off thesis coined by Becker and Lewis (1973), empirical studies have investigated the relationship between a person's sibship size and various outcomes, such as educational performance (Downey,1995; Rosenzweig & Zhang, 2009; Ponczek & Souza, 2012), occupational attainment (Biblarz, Raftery, & Bucur, 1997), and wealth accumulation (Keister, 2003). However, the role of fertility has not been considered in the multigenerational setting. Whether grandparents' fertility rates moderate their influence on grandchildren remains an open question. This study used three-generation data from Panel Studies of Income Dynamics (PSID) 1968-2019 and mixed effect models to test two competing hypotheses regarding this moderating relationship.

On the one hand, from a contact-based perspective, the influence of grandparents' education on grandchildren should decrease as grandparents have multiple children. In the literature, the influence of grandparents' education on grandchildren's education is argued to depend on their

interactions and contacts. When grandparents have multiple children, they would need to allocate their time and effort between grandchildren from different families. Compared to grandchildren in a large extended family (i.e. with many cousins), grandchildren in a small extended family (i.e. with few or no cousin) are likely to spend more time with their grandparents; thus, the influence of grandparents' education is likely to be stronger when the parents have fewer siblings. On the other hand, from an exposure-based perspective, the influence of grandparents on grandchildren should increase as grandparents have multiple children. Grandchildren are exposed to broader extended family networks when grandparents have multiple children. Grandparents' education shapes their children's educational attainment through intergenerational reproduction and their children-in-law's educational attainment through involvement in adult children's marital choices. When grandparents have multiple children, grandchildren have greater exposure to the legacy of grandparents' achievement in a large extended family; thus, the influence of grandparents is likely to be stronger when the parents have more siblings.

The results demonstrate that having multiple children, i.e., multiple members in the parents' generation (G2), amplifies grandparents(G1)' influence on grandchildren(G3). The magnitudes of the grandparents-grandchild educational associations grow as the extended family size increases. This moderating relationship demonstrated an accumulation process of (dis)advantages in the multigenerational setting. When G1 grandparents have educational advantages, their advantages are reproduced and amplified via the extended family networks. When they have more offspring, their grandchildren, compared to those from smaller families, enjoy the benefits of having better-educated parents and multiple better-educated relatives in the extended kinship network. However, when G1 parents have educational disadvantages, their disadvantages are also reproduced and amplified via the extended family networks. Thus,

when they have more offspring in the G2 generation, their grandchildren suffer from having less-educated parents and multiple less-educated relatives, and obtain lower educational attainment, compared to those from smaller families. These findings present a new perspective to view the role of family size in the transmission of (dis)advantages over generations.

Literature Review

Grandparents and Multigenerational Transmission

Intergenerational reproduction of traits, such as education, income and social status, is a central concern of social stratification research. The extent to which one generation's attainment determines the next generation's attainment is deemed an important indicator of social fluidity and inequality in opportunities. Previous studies have provided abundant evidence on how (dis)advantages are transmitted between generations by comparing the attainment of parents and children. Though early work in stratification proposed questions on whether and how the characteristics of distant ancestors beyond the parental generation matter in multigenerational transmission (Hodge 1966), only recently empirical studies with appropriate data expanded the conventional two-generational model to the multigenerational setting (e.g., Jæger 2012; Pfeffer & Killewald, 2018; Anderson, Sheppard & Monden, 2018; Erola et al., 2018). While the two-generational model considers only the transmission between parents and their children, multigenerational studies include grandparents and other extended family members, such as uncles, aunts and cousins, in the kinship networks.

Three research agendas guided multigenerational studies. The first line of research sought to test the hypothesis of the Markovian process (Hodge,1966; Mare, 2011). Mare (2011) noted that the two-generation paradigm assumes that the intergenerational transmission follows a Markovian process, where the outcome of the grandchildren is independent of the grandparents'

characteristics once the parents' characteristics are controlled. In other words, status, resources and other properties of interest are only transmitted within two consecutive generations. If so, the two-generation model suffices to explain the transmission of (dis)advantages across multiple generations. However, if grandparents have legacy effects over generations, which is a violation of the Markovian assumption, it alters our understanding of how (dis)advantages persist across generations in the long term. Under the non-Markovian scenario, one's life chances are affected by both his/her parents and higher-order ancestors; thus, the inequality observed in one generation would cast a long shadow along the family lineages.

Grandparents can have a direct influence on the achievement of the grandchildren in several ways. First, grandparental endowments, including material resources (Hank & Buber, 2009, Hällsten & Pfeffer, 2017), cultural capital (Møllegaard & Jæger,2015) and social capital, can have extended consequences across generations. Grandparents may provide financial support to their grandchildren through direct transfer or bequest. They can also use their social networks to provide opportunities for their grandchildren's educational and occupational achievements. Moreover, as the life expectancy increases over time, the grandparents and the grandchildren generations share a longer overlapping time in life (Lehti, Erola and Tanskanen 2019). Studies also found that the share of children who lived in a three-generation household grew from 5.7% in 1996 to 9.8% in 2016 in the U.S. (Pilkauskas & Cross, 2018). By living and spending time with grandchildren, grandparents can provide considerable care to grandchildren (Gauthier 2002; Mathews & Sear, 2013) and directly influence their grandchildren via daily interactions.

Empirical evidence on the direct effect of grandparents is mixed. For instance, early work by Warren and Hauser (1997) with data from the Wisconsin Longitudinal Study and structural

equation model supports the Markovian hypothesis. They found that after controlling for parents' characteristics, grandparents had insignificant effect on grandchildren's educational attainment and occupational status. Jæger (2012) used the same data sources as Warren and Hauser (1997) and reported that grandparents have little effect on grandchildren's educational attainment on average. Moreover, Erola and Moisio (2007) reached a similar conclusion with Finnish data and the mobility table approach. Likewise, Engzell, Mood and Jonsson (2020) found no grandparental influence on earnings in Sweden. However, some studies reported the opposite findings. Chan and Boliver (2013) found a net association between grandparents' and grandchildren's occupational classes in England. Hertel and Groh-Samberg (2014) reported a direct grandfather effect on class attainment in the U.S with data from the Panel Studies of Income Dynamics (PSID). Moreover, Song and Mare (2017) demonstrated that grandparents' educational attainments were directly associated with grandchildren's education with PSID data. The mixed findings also raised concerns regarding methodologies and interpretations of the results (Becker & Tomes, 1979; Breen, 2018). [5]

Secondly, instead of estimating the direct effect of grandparents, a few studies have considered the pathways of transmission from grandparents to grandchildren. Studies aimed to identify the mediators that intervene in the multigenerational transmission. The primary candidates are the characteristics of the parents. Grandparents and grandchildren are linked through parental characteristics in various ways. For instance, Roksa and Potter (2011) demonstrated that grandparents' social class was associated with grandchildren's academic achievement via parents' childrearing practices. Wightman and Danziger (2014) found that by shaping the home

[5] Another line of research attempts to gauge the multigenerational educational transmission by comparing the sibling correlation and the cousin correlation within the immediate and extended family (Jæger,2012; Hällsten, 2014; Knigge, 2016; Pfeffer, Killewald & Sillunas, 2016). Studies tend to interpret findings where the cousin correlation is larger than the square of sibling correlation as an indication of the direct effect of grandparents on grandchildren. However, Lundberg (2020) noted various sources that can generate such correlations and questioned their validity as evidence of the grandparent effect.

environment of the parental generational, grandparents' status was associated with grandchildren's education via the reproduction of the home environment. Similarly, Sharkey and Elwert (2010) showed that grandparents' characteristics determined the poverty level of the neighborhood where the parents grew up, which had an independent effect on grandchildren's reading performance. Moreover, Fiel (2019) revealed that most of the grandparent-grandchildren educational association was explained by the childhood experiences and attributes of the parents. Klein and Kühhirt (2021) reached a similar conclusion, indicating that more than two-thirds of the grandparents' influence on grandchildren's cognitive ability was transmitted through parental cognitive ability. By transmitting material resources, cultural capital, social capital, and other endowments to the parental generation, grandparents realize multigenerational influence via intergenerational inheritance and reproduction.

Furthermore, grandparents' influence on parents' assortative mating is an important but less mentioned mechanism. Parents can play an active role in the marital sorting of adult children. Studies on college students found that compared to students who have college-educated parents, first-generation college students struggled to find compatible partners both during and after college (Musick, Brand & Davis, 2012; Armstrong & Hamilton 2013, 2021; Hamilton & Armstrong, 2021; King, 2021). By involving in the marital sorting of the parental generation, grandparents can influence the life chances of the grandchildren by defining the family composition where the grandchild grow up. However, the role of assortative mating in the multigenerational transmission has been largely overlooked. Previous studies controlled for the characteristics of the parental generation in three manners: 1) following the "one-sex" model that considers either the paternal line (i.e., from the father's parents to father to grandchildren) or the maternal line (i.e. from the mother's parents to mother to grandchildren); 2) considering

one quantity: either the highest education or the average of educational attainment of parents; and 3) more commonly, including both parents. Either way, grandparents' involvement in parents' assortative mating has been blocked or unrecognized. Few studies reported the changes in grandparents' effect before and after the inclusion of children-in-law (Stuhler, 2012; Braun & Stuhler, 2018). The attenuation of the effect suggests that a significant amount of grandparents' effect is explained by the characteristics of children-in-law, that is, the assortative mating of the parental generation.

Finally, the third line of research focuses on the heterogeneity of the grandparents' effects, that is, how the influences of grandparents differ across subgroups. Studies are interested in what modifies the effects of grandparents on grandchildren. Some scholars argued that the strength of grandparents' influence on grandchildren depends on the frequencies and durations of their interactions with their grandchildren, suggesting a stronger influence when grandparents and grandchildren have more interactions. However, empirical findings are mixed. Zeng and Xie (2014) found that the grandparents' effect was contingent on the multigenerational co-residence in rural China. There was a sizeable grandparent effect on grandchildren's educational attainment for grandparents who were coresident with grandchildren but not for the non-coresident and deceased grandparents. On the contrary, studies that used the geographic distance between grandparents and grandchildren or the overlap in lifetimes as the proxies for the frequency of contact found little evidence of the moderation between contact and grandparent effect (Jæger, 2012; Knigge, 2016).

Moreover, some scholars argued that the strength of grandparents' influence on grandchildren depends on the conditions of parents. The traits of grandparents are argued to have a compensating or stabilizing function. Grandparents are more likely to intervene when parents

experience disadvantaged situations, such as lack of resources, parental separation, or unemployment (Bengston, 2001). Therefore, the effect of the grandparents should be stronger when parents are disadvantaged. Some studies reported evidence in favor of this argument. For instance, Deleire and Kalil (2002) found that co-residency with grandparents compensated for the disadvantage of living with single mothers on teenagers' development. Deindl and Tieben (2017) demonstrated that the grandparents' resources compensated for the lack of parental resources for grandchildren's education. Lehti et al. (2019) reported that the positive effect of maternal grandmothers on grandchildren's education was concentrated in low-income families. However, an opposite argument has been raised, which predicted that the grandparents' trait is a multiplier of parents' (dis)advantages and grandparents' resources are more beneficial when parents are in advantaged situations. For instance, Song (2016) found that the effect of grandparents' education on grandchildren's education was stronger in intact families than in those where parents were separated.

To sum up, previous studies on the multigenerational transmission of status explored the direct influence of grandparents on grandchildren, the mediators or pathways of the transmission and the moderators or heterogeneities of the process. This study falls in the final category and explored whether the fertility rates of the grandparents (i.e., the sibship size of the parents) moderate the educational association between grandparents and grandchildren.

Family Size in the Multigenerational Setting

Two-generation studies have intensively examined the relationship between parents' fertility and the outcomes of children. Most studies were motivated by the "Quantity-Quality" trade-off thesis coined by Becker and Lewis (1973), which suggests a negative association between sibship size and one's life chances, provided that resources the parents offer to each child

decrease as the number of children in the household increases. This has also been referred to as the resource dilution model. Numerous studies have empirically tested whether the "Quantity-Quality" trade-off thesis holds true for various developmental outcomes over time (Parish & Willis, 1993; Pong, 1997; Maralani, 2008) and across countries (Vogl, 2016; Li, Dow & Rosero-Bixby, 2017; Choi et al., 2020). Several lines of studies in recent years questioned the robustness of the negative relationship between sibship size and an individual's life chances (Maralani, 2008; Angrist et al., 2010; Åslund & Grönqvist, 2010; Bagger et al., 2013). Nonetheless, many empirical studies have reported evidence in favor of the "Quantity-Quality" trade-off thesis, showing a negative relationship between sibship size and a person's educational performance (Downey,1995; Rosenzweig & Zhang, 2009; Ponczek & Souza, 2012), occupational attainment (Biblarz, Raftery, & Bucur, 1997), and wealth accumulation (Keister, 2003).

However, the role of fertility has not been considered in the multigenerational setting. Even if it is reasonable to extend the "Quantity-Quality" trade-off predictions to the three-generation setting and expect that grandparents' fertility rates will dilute the resources that each member in the parent (G2) and grandchildren (G3) generations can receive, thus, negatively affecting grandchildren's outcomes, how it moderates grandparents' influence on grandchildren remains an open question. This study focuses on how the sibship size of the parent moderates the impact of grandparents' education on grandchildren rather than the effect of the sibship size of the parent *per se*. Hypotheses regarding the moderation relationship can be drawn from two perspectives.

On the one hand, from a contact-based perspective, having multiple members in the parental generation may weaken the influence of grandparents' education on grandchildren. As

suggested in the literature, one way that grandparents can influence their grandchildren is to act as their caregivers or role model. The strength of grandparents' influence on grandchildren should depend on the frequencies and durations of their interactions with their grandchildren. We should expect that the more time the grandparents spend with their grandchildren, the stronger their influence will be. When the grandparents have only one child, they are more likely to devote their time and effort to the offspring of their only child. However, when the grandparents have multiple children, they would need to allocate their time and effort between grandchildren from different families. Compared to grandchildren in a large extended family, grandchildren in a small extended family are likely to spend more time with their grandparents. Therefore, from a contact-based perspective, we would expect that,

H1a: Grandparents' education is associated with grandchildren's education. The association becomes stronger as the number of members in the parental generation decreases.

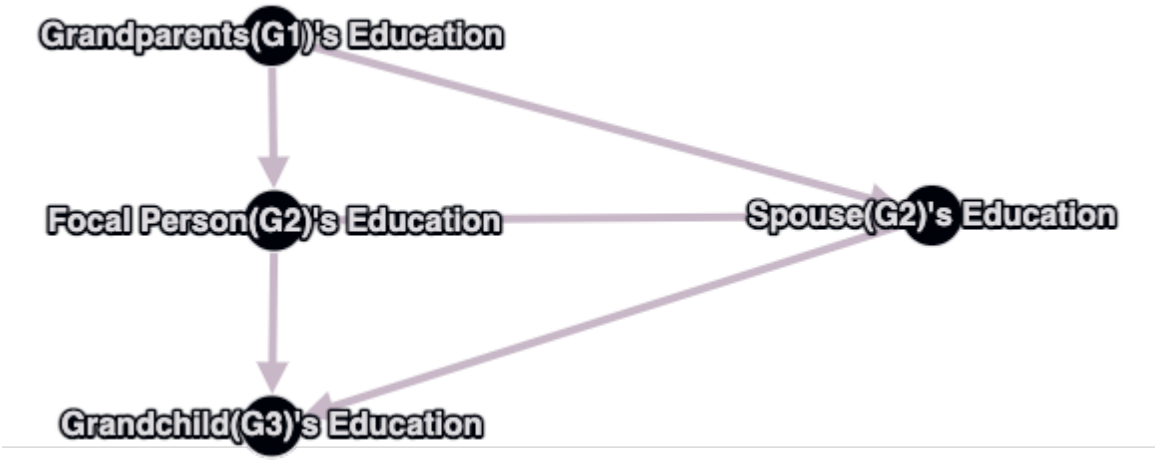
On the other hand, from an exposure-based perspective, having multiple members in the parental generation may amplify the influence of grandparents' education on grandchildren. Grandchildren are exposed to broader extended family networks when grandparents have multiple children. As shown in Panel.A of Figure.2.1, when the grandparents have only one child, the grandchildren are exposed to a kinship network that only involves the grandparents and their own parents. When grandparents have multiple children (Panel.B of Figure.2.1), the grandchildren are exposed to a kinship network involving the grandparents and several adults in the parental generation, including the parents, aunt(s)/uncle(s) and aunt(s)/uncle(s)-in-law. From the grandparents (G1) to the parental generation (G2), grandparents not only shape the educational attainment of their own children but also that of their children-in-law, thus, defining the composition of the immediate family of the grandchildren. Moreover, if

grandparents have multiple children, they will influence the educational attainment and marital sorting of every member of the parental generation, thus, defining the composition of the extended family of the grandchildren. Furthermore, the educational attainment of the extended family members, such as uncles and aunts(G2), has been found to be associated with the attainment of their nieces and nephews (G3) (Jæger 2012[6]; Erola et al. 2018). In other words, within a large extended family network, grandparents' education can utilize multiple pathways in the kinship system to influence the educational attainment of the grandchildren. The influence of grandparents' education is likely to be amplified and multiplied in a large extended family. When the grandparents have multiple children, their educational attainment reproduces on multiple members of the G2 generation and brings in additional education resources through marital sorting. The grandchildren are exposed to a larger extended family network with multiple sources that can influence their educational attainment. The education of grandparents and their fertility rates together define the overall educational resources or cultural capital in the extended family. Therefore, from the exposure-based perspective, we should expect that,

H1b: Grandparents' education is associated with grandchildren's education. The association becomes stronger as the number of members in the parental generation increases.

[6] Jæger (2012) found that the education of aunts but not uncles was associated with the attainment of the nephews and nieces. However, the analysis did not distinguish biological uncles/aunts from uncles- and aunts-in-law.

Panel A



Panel B

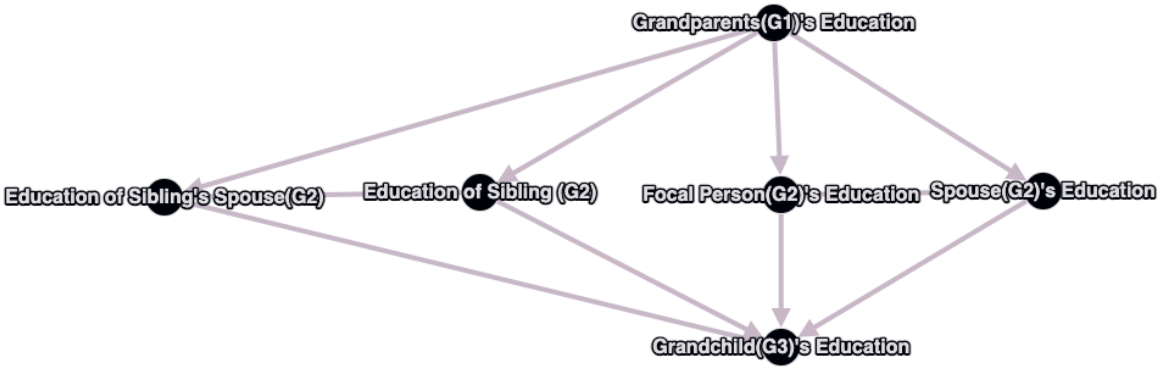


Figure 2.1 Graphic Illustrations of Three-Generation Kinship

Data and Analytic Sample

This study drew on data from Panel Studies of Income Dynamics(PSID) 1968 – 2019 and constructed a three-generational sample to test the hypotheses. PSID provides representative longitudinal data on U.S. individuals and families. Compared to other data sources, PSID has the longest time span to trace family members' attainment across generations. The genealogical sample design of PSID can facilitate the identification of family members of multiple

generations and provide information on the respondent's parents, siblings, spouses and children. Therefore, PSID provides a complete picture of the extended family for the three-generation analysis. Information on the grandparents (G1), G2 members (parents and their siblings) and their spouses and grandchildren (G3) is available.

To construct the three-generation sample, this study linked PSID 1968-2019 survey members from non-immigrant families, as the G2 focal person, with their parents (G1) and children (G3)[7]. The parental generation (G2) was matched with their biological children (G3) using the PSID Childbirth History File and PSID Family Identification Mapping System (FIMS). Moreover, the FIMS provides sibling identifiers to link G2 respondents with their full biological sibling(s). Information on the spouses of the G2 members (the focal person and their siblings) was obtained from the PSID Marriage History File. Finally, the information on grandparents (G1) was obtained following the methods presented by Song (2016) and Song and Mare (2017). If the grandparents were PSID sample members, their information from the PSID individual files was used. Otherwise, the grandparents' information was obtained based on the retrospective records from the family interviews of household heads and their partners (G2).

The analytic sample was restricted to grandchildren (G3) aged 18-65 in the 2019 wave of the survey. The final analytic sample included three generations: 1) the grandparents' generation (G1), including the parent(s) of the G2 focal person; 2) the parental generation (G2), including the focal person, the focal person's spouses(s), the focal person's full sibling(s), and the sibling's spouse, and 3) the grandchildren (G3) generation. The final analytic sample included 7,535 grandchildren from 2,267 lineages without missing values of variables used.

[7] The original PSID core sample was drawn from the Survey of Economic Opportunity (the SEO sample) and the nationally representative Social Research Center sample (SRC sample). This study excluded the Latino and immigrant samples that entered the PSID survey only since the 1990s

Methods and Measurements

The analytic data were in a hierarchical structure. One focal person of G2 could have multiple marriages and offspring and generate several three generational lineages. To account for the non-independence in the data, this study used the linear mixed-effect models with random intercepts. For hierarchical data with N cases generated from J groups, a mixed-effect model can be written with matrix notations as,

$$\boldsymbol{Y} = \boldsymbol{X\beta} + \boldsymbol{Zu} + \boldsymbol{\varepsilon} \quad (1)$$

where $\boldsymbol{Y}$ is a $N * 1$ column vector of the outcome variable; $\boldsymbol{X}$ is a $N * p$ matrix of the p predictor variables; $\boldsymbol{\beta}$ is a $p * 1$ column vector of the regression coefficients. $\boldsymbol{Z}$ is the $N * J$ design matrix for the random effects and J groups; $\boldsymbol{u}$ is a $J * 1$ vector of random effects for J groups; and $\boldsymbol{\varepsilon}$ is a $N * 1$ column vector of the residuals. Here only one random effect, the random intercepts, was considered. The reason for having a random effect is that the outcomes within groups may be correlated. The mixed-effect model allows the intercept to vary across groups and obtain the parameter estimates for $\boldsymbol{\beta}$**s** at the means. The mixed-effect models can 1) explore the difference between effects within and between groups; and 2) correct standard errors for non-independence in the data.

The outcome of interest was the year of schooling of the grandchildren (G3). It was measured as the *highest grade or year of school the individual has completed*. It was collected in every wave of the survey, and this study used the latest available value during the 1968–2019 survey period. The key independent variables were the educational attainment of the grandparents (G1), the number of siblings in the G2 generation and their interactions. For grandparents' education, this study used the average education of grandparents to minimize the sample loss due to missing values. If the educational attainment of both parents of the G2 focal person were available, the mean value was taken. If the education of either parent was missing, the value of

the available parent was taken. The number of G2 members was measured as the sibship size of the G2 focal person.

Furthermore, this study included educational measures for G2 sibling(s) and sibling's spouse. If the G2 focal person had multiple married siblings, information on the oldest sibling and his/her spouse was taken. If none of the siblings were married, the education of the oldest sibling was taken, and the education of the sibling's spouse was coded as zero. If the focal person did not have any siblings, the education values for the sibling and the sibling's spouse were coded as zero.

Besides the variables mentioned, this study further controlled for the following covariates that might influence the results. First, this study considered the characteristics of the grandchild, including his/her gender, age, race, the region of birth and number of siblings. Second, this study included both parents'(G2) year of birth, race[8], age at marriage, age at first childbirth, marital status, educational attainment, and logarithm of income at childbirth. Income measures were adjusted to 2019 dollars using the Consumer Price Index (CPI).

Descriptive statistics of variables are shown in Table 2.1. The distributions of the key independent variable (the number of siblings of the focal G2 person in the sample) are depicted in Figure 2.2. The number of siblings of the parental generation ranged from zero to fourteen. Those with ten or more siblings were combined into one group in Figure 2.2. As shown, the majority of the G2 parents had siblings. Only approximately two percent has no sibling, and

[8] PSID has collected information on the ethnicity of the household head from 1968 but only from 1985 for the spouse. Those whose ethnicity is missing are assigned that of the household head. There are too few cases of interracial marriage in our sample (N = 57) to conduct a meaningful separate analysis.

55.35% of the parental generation has one to three siblings. The most common family size was three siblings (21.64%).

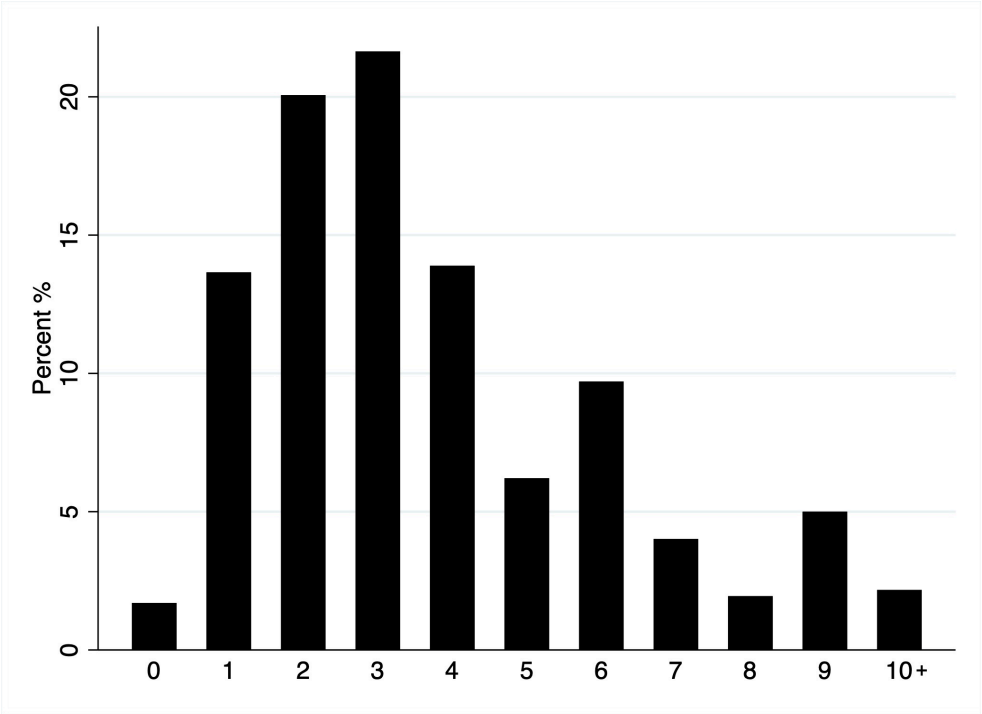


Figure 2.2 The Distribution of the Number of Siblings of the Focal Person (G2) in the Sample
Note: The final category combines cases with number of siblings equal to or larger than 10.

Table 2.1 Descriptive Statistics of the Three-generation Sample

	Three-generation Sample			
	Mean	S.D.	Min	Max
Generation 1 (G1)				
Average Education of Focal Person's (G2) Parents	10.57	3.24	1	17
Generation 2 (G2)				
Focal Person				
Gender				
Male	46.52%			
Female	53.48%			
Race				
White	60.06%			
African American	37.61%			
Other	2.33%			
Year of birth	1958.09	8.06	1950	1984
Age at marriage	24.26	5.53	14	64
Number of marriages	1.09	.32	1	3
Logarithm of income at marriage	6.08	4.13	0	11.56
Completed education	13.34	2.26	4	17
Number of siblings	4.34	2.82	0	13
Selected sibling's education	12.94	2.94	0	17
Education of the selected sibling's spouse	12.95	2.84	0	17
Spouse				
Race				
White	60.06%			
African American	37.61%			
Other	2.33%			
Year of birth	1957.67	8.47	1920	1986
Age at marriage	24.82	6.19	15	66
Completed education	13.25	2.31	3	17
Marital status				
Married	59.05%			
Unmarried	41.95%			
Generation 3 (G3)				
Year of education	13.35	2.24	3	17
Age	29.09	8.86	18	65
Gender				
Male	52.88%			
Female	47.12%			
Number of siblings	2.59	1.28	0	15
N of Observation		7,535		
N of Lineages		2,267		

Results

This study used the three-generation sample to fit the mixed-effect model and estimated the grandparents-grandchild association. Results are reported in Table 2.2. In Model 1, the education of only one G2 parent, the focal person, was controlled. Grandparents' average education was positively associated with grandchildren's education. Conditioning on the focal person's education (G2) and other covariates, every unit increase in grandparents' education was associated with 0.079 unit (p<0.001) increases in grandchildren's education. Model 2 adds in the education of the focal person's spouse. Both G2 parents' educations were controlled. Compared to the results of Model 1, the grandparents-grandchildren association attenuated by 26.6% in Model 2. The magnitude of the grandparents-grandchildren association decreased from 0.079 in Model 1 to 0.058 (p<0.001) in Model 2. This aligned with evidence reported in previous three-generation studies revealing the changes in grandparents' effect before and after the inclusion of children-in-law (Stuhler,2012, Braun and Stuhler, 2018). The attenuation of the association suggested that a significant amount of grandparents-grandchild association was transmitted through grandparents' influence on parents' marital sorting. From the grandparents (G1) to the parental generation (G2), grandparents not only shaped the educational attainment of their own children but also that of their children-in-law, thus, defining the composition of the immediate family of the grandchildren. If grandparents have multiple children, they should influence the educational attainment and marital sorting of every member of the parental generation, thus, defining the composition of the extended family of the grandchildren. Model 3 added the education measures for the selected sibling of the G2 focal person and the education of the sibling's spouse. As shown, the education of extended family members was related to the education of G3. Both variables were positively associated with the education of G3. As suggested in previous studies (Jæger 2012; Erola et al. 2018; Lehti et al., 2019), the educational attainment of aunt/uncle and aunt/uncle-in-law was associated with the educational attainment

of their nieces or nephews. Moreover, the grandparents-grandchildren association decreased further to 0.043 (p<0.001) after controlling for the education of members other than parents of the parental generation (G2).

Table 2.2 Estimates from Mixed-Effect Models for Grandparents-Grandchild Associations

Dependent Variable	Grandchild's (G3) Educational Attainment			
	Model 1	Model 2	Model 3	Model 4
Grandparents'(G1) Average Education	.079***	.058***	.043***	.036**
	(.008)	(.009)	(.009)	(.012)
Focal Person's (G2) Education	.272***	.189***	.189***	.189***
	(.010)	(.012)	(.012)	(.011)
Spouse's (G2) Education		.180***	.180***	.182***
		(.011)	(.011)	(.011)
Sibling's (G2) Education			.038***	
			(.010)	
Education of Sibling's Spouse (G2)			.025**	
			(.010)	
Number of Siblings of G2 Focal Person(G2)				-.052*
				(.021)
Grandparents'(G1) Average Education # Number of Siblings of Focal Person(G2)				.006**
				(.002)
Number of Lineages	2,267			
Number of Grandchildren(G3)	7,535			

Note: Parameter estimates for other control variables are omitted here, including grandchild's (G3) gender, age, race, region of birth, and number of siblings; and parents'(G2) year of birth, age at marriage, marital status, age at first childbirth, and logarithm of income at child birth. *p<0.05; ** p<0.01; ***p<0.001.

Model 4 included an interaction term between grandparents' education and the sibship size of the G2 focal person. Results revealed a complex picture of how the fertility of G1 parents moderated the multigenerational transmission. The main effect of the grandparents' education was positive. The average education of grandparents was positively associated with grandchildren's educational attainment. However, the main effect of the sibship size was negative. This indicated that having multiple members in the G2 generation harms the attainment of the G3 generation. This could be because siblings dilute parents' financial

resources and nonmaterial resources, such as time and support; thus, adult children (G2) from larger families possess fewer resources for the development of their children (G3). For instance, adults from larger families are found to receive less inheritance and accumulate less wealth than those from smaller families (Keister, 2003). However, in line with *Hypothesis 1b* the interaction effect between grandparents' average education and sibship size of G2 was positive. The positive interaction effect indicated that the influence of grandparents' education on grandchildren was amplified as the number of G2 members increased. With other factors held constant, the association between grandparents' and grandchildren's education increased by 0.006 years (p<0.01), as the number of siblings of G2 parents increased by one. Figure.2.3 depicts the marginal effect of grandparents' education on grandchildren's education by the number of siblings of G2. As shown, the grandparents-grandchild association increased as the sibship size of the G2 grows. The association was 0.037 when the G2 parent did not have a sibling and it increased as the extended family size grew. When the G2 focal person had three siblings, which was the most common scenario in the sample, the educational association between grandparents and grandchildren rose to 0.055. When the G2 focal person had six siblings, it further increased to 0.074. This demonstrated that the strength of grandparents' influence on grandchildren's educational attainment was moderated by the fertility of grandparents and by the size of the extended family. The influence of grandparents on grandchildren magnified as the extended family enlarges.

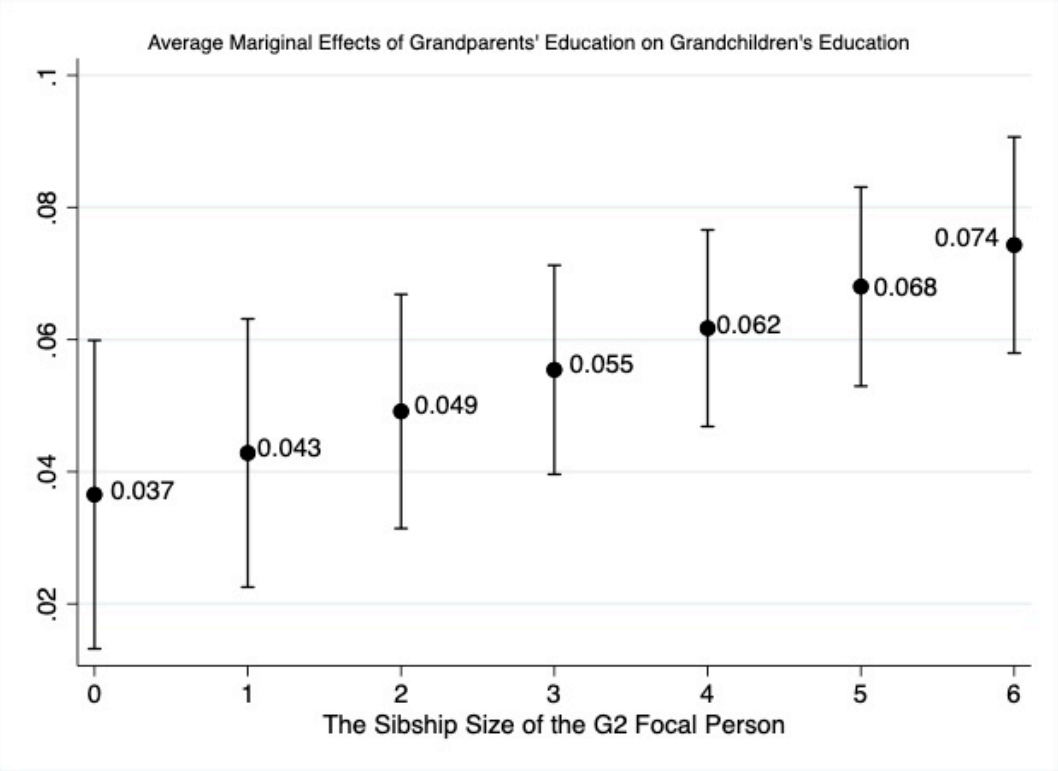


Figure 2.3 Educational Associations Between Grandparents and Grandchildren Across the Sibship Size of the G2 Focal Person
Note: Based on results from Model 4 in Table 2.2. Point estimates and 95% confidence intervals are shown. Other covariates are held constant.

Considering the main effect of grandparental education and its interaction effect with the sibship size of G2 together, the moderating relationship between G1 grandparents and G2 sibship size further suggested that the educational attainment of G1 grandparents can have a resource accumulation property and bear consequences over generations. The sibship size of G2 amplified both the advantages and the disadvantages of G1. To demonstrate this property, Figure 2.4 plots the predicted attainment of G3 across the education level of G1, when the sibship size of G2 equals zero, three and six. As shown, across the educational distribution of G1 grandparents, advantages and disadvantages accumulated as the number of G2 members increased. At the lower end of the educational distribution of G1, grandchildren from larger extended families fared less well than grandchildren from smaller extended families. The predicted attainment of grandchildren from large extended families was lower than that of

grandchildren from small families. For example, when the grandparents had only three-years of education, grandchildren with six uncles/aunts obtained less education than grandchildren with three uncles/aunts and those without uncles/aunts. However, this relationship flipped as the education level of grandparents increased. At the upper end of the distribution, grandchildren from larger extended families obtained more education than grandchildren from smaller families. When grandparents had on average 15 years of education, grandchildren with six uncles/aunts attained more education than those with three uncles/aunts and those without uncles/aunts. When G1 grandparents have educational advantages, their advantages are reproduced and amplified via the extended family networks. When they had more offspring, their grandchildren, compared to those from smaller families, enjoyed the benefits of having better-educated parents and multiple better-educated relatives compared to those from smaller families. However, when G1 parents had educational disadvantages, their disadvantages were also reproduced and amplified via the extended family networks. Thus, when they had more offspring in the G2 generation, their grandchildren's attainment suffered from having less-educated parents and multiple less-educated relatives.

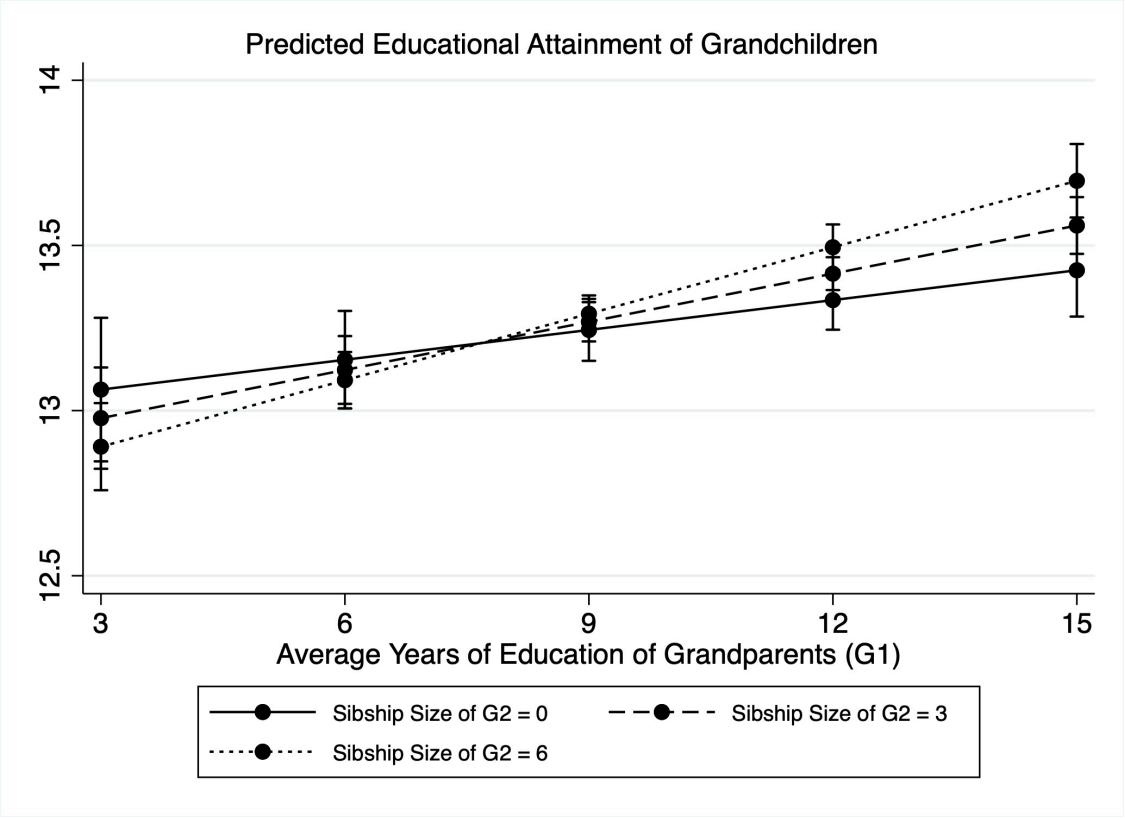


Figure 2.4 Predicted Educational Attainment of Grandchildren by Grandparental Education Level and the Sibship Size of the G2 Focal Person
Note: Based on results from Model 4 in Table 2.2. Point estimates and 95% confidence intervals are shown; Other covariates are held constant. The percentiles distribution of grandparents' education in the sample are 1% at three-year of education, 10% at six-year of education, 25% at eight-year of education, 50% at twelve-year of education, 75% at thirteen-year of education, and 90% at fifteen-year of education.

Robustness Check

Missing Values

The sample size of the three-generation sample in this study was comparable with previous studies that used the multigenerational education information from the PSID data. For instance, the analytic sample of Song (2016) included 5,357 grandchildren, that used by Song and Mare (2017) included 6,737 grandchildren, and that used by Daw, Verdery and Margolis (2016) included 7,186 grandchildren. Several decisions mentioned earlier, such as taking the average education of grandparents and zero-coding the education of non-existing member(s), were made to minimize the sample loss due to missing values. However, the concern here was that data were not missing completely at random. An investigation of the pattern of missing values

revealed that focal people (G2) who were older, less educated, from an ethnic minority, female, and had a non-married mother at birth were more likely to have missing information on other family members. In other words, more advantaged groups were more likely to have complete information and be selected into the analytic sample. To address this potential bias, this study predicted the probability of having complete three-generation information (i.e. the probability of being selected into the analytic sample) for all G2 respondents and reweighted the data by its inverse. The idea was to give more weight in the analysis to respondents who were less likely to be found in the analytic sample. The main analysis presented in Table 2.2 was replicated with the reweighted data. The results are reported in Table.2.3. Compared with the results presented in Table 2.2, the results using the reweighted data yielded estimates with relatively larger standard errors; however, the findings remain unchanged. According to Models 1-3 presented in Table 2.3, grandparents' education was positively associated with the educational attainment of grandchildren. This grandparents-grandchildren association was partially explained by the parental assortative mating and the educational attainment of other extended family members of the G2 generation. Model 4 added in the interaction between grandparents' education and sibship size of G2. The results demonstrated the same pattern as reported in Table 2.2. Grandparents' education was positively associated with grandchildren's educational attainment, and the influence of grandparents' education increased as the number of siblings of the G2 generation grew. It is worth noticing that after reweighting, the magnitudes of the interaction effects between grandparents' education and sibship size of G2 enlarged, which supported the argument that a large extended family amplified the influence of grandparents' education on the educational attainment of G3.

Table 2.3 Reweighted Estimates from Mixed-Effect Models for Grandparents-Grandchild Associations

Dependent Variable	Grandchild's (G3) Educational Attainment			
	Model 1	Model 2	Model 3	Model 4
Grandparents'(G1) Average Education	.079***	.059***	.041**	.035**
	(.011)	(.011)	(.012)	(.018)
Focal Person's(G2) Education	.291***	.220***	.204***	.220***
	(.014)	(.017)	(.017)	(.011)
Spouse's (G2) Education		.151***	.147***	.152***
		(.015)	(.015)	(.015)
Sibling's (G2) Education			.042***	
			(.013)	
Education of Sibling's Spouse (G2)			.023**	
			(.013)	
Number of Siblings of Focal Person (G2)				-.103**
				(.032)
Grandparents'(G1) Average Education # Number of Siblings of Focal Person(G2)				.010***
				(.003)
Number of Lineages	2,267			
Number of Grandchildren(G3)	7,535			

*Note: Parameter estimates for other control variables are omitted here, including grandchild's (G3) gender, age, race, region of birth, and number of siblings; and parents'(G2) year of birth, age at marriage, marital status, age at first childbirth and logarithm of income at child birth. *p<0.05; ** p<0.01; ***p<0.001.*

Conclusion and Discussion

This study examined the transmission of educational attainment in the three-generation setting. It focused on how grandparents' fertility rates moderated the influence of their education on grandchildren's education.

This study used three-generation data from PSID 1968-2019 and mixed-effect models and results demonstrated that having multiple children (i.e., multiple members of the parental generation) amplified grandparents' direct influence on grandchildren. The strength of the grandparents' effect enhanced as the extended family size increased. When grandparents had multiple children, their educational achievement shaped the educational attainment of multiple members of the next generation. Moreover, by involving in their adult children's marital

sorting, grandparents' education also shaped the educational attainment of their children-in-law(s). Therefore, in a large family, grandparents' education influenced the educational attainment of multiple members in the kinship network. In line with the exposure-based hypothesis (*Hypothesis 1b*), grandchildren had greater exposure to the legacy of grandparents' achievement in large extended families. The direct influence of grandparents' education was amplified and multiplied by the extended family network. This moderation effect of the extended family size on grandparents' effect demonstrated a resource accumulation process in the multigenerational setting. While the advantages accumulated in large families with multiple better-educated members, disadvantages also accumulated in large families with multiple less-educated members. When grandparents(G1) had educational advantages, their advantages were reproduced and amplified via the extended family networks. When they had more offspring, their grandchildren, compared to those from smaller families, enjoyed the benefits of having better-educated parents and multiple better-educated relatives. However, when grandparents(G1) had educational disadvantages, their disadvantages were also reproduced and amplified via the extended family networks. Thus, when they had more offspring in the G2 generation, their grandchildren's attainment suffered from having less-educated parents and multiple less-educated relatives.

These findings advance our understanding of the effect of grandparents on grandchildren. The growing interest in grandparents' role in multigenerational transmission is motivated by the fact that grandparents enjoy increasing life expectancy, and more grandchildren are growing up in multigenerational households. This leads to the argument that the strength of grandparental influence is contingent on their interactions and contacts with grandchildren. However, results from this study, as well as some previous studies (Knigge, 2016), rejected the contact-based hypothesis (*Hypothesis 1a*). Grandparents can exert an impact without directly

participating in grandchildren's daily life or living in the same household or neighborhood. The present findings suggest that grandparents play an important role in grandchildren's development by maintaining the extended family networks. By shaping the parental generation's education and marital sorting outcomes, grandparents can influence the life chances of the grandchildren by defining the family characteristics of both the immediate family and the extended family where the grandchildren grew up. Grandparents' characteristics define what kind of extended family network that the grandchildren are exposed to. The larger the network, the stronger the influence of grandparents.

This study had some limitations. First, the results revealed that the extended family size moderated grandparents' influence. Results also show that the educational attainments of uncles(-in-law) and aunts(-in-law) are positively related to the educational attainment of the grandchildren generation. However, the reasons for the impact of extended family members remain unknown. Future studies should develop and test hypotheses on kin relationships in addition to the parents-children pair. Uncles(-in-law) and aunts(-in-law) could directly transfer education-related resources to their nephews/nieces or indirectly influence them as inspiring role models. They may also influence parents' child-raising behaviour and parenting practices via sibling similarity effects (Lyngstad and Prskawetz 2010). Moreover, previous studies speculate that the influence of uncles/aunts on nephews/nieces was contingent on uncles' or aunts' own fertility (Jæger 2012; Lawrence & Breen, 2016). However, few studies have attempted to unpack extended family members' role in multigenerational transmission.

Second, this study demonstrated that the (dis)advantages of grandparents are amplified by the size of the second generation in multigenerational settings. However, the measurement of grandparents' (dis)advantages was limited to educational attainment in the analysis. This study

focuses on education for two reasons. For one, this minimised the sample loss due to missing values. Measurements of other characteristics of grandparents, such as income, wealth, and social status, suffered from a more severe problem of missing values than educational variables. For another, educational attainment was a relatively stable measurement of grandparents' characteristics. It is less likely to experience temporal changes than other characteristics. Nevertheless, the (dis)advantage of one generation is multifaceted. Future studies should employ other data sources and high quality measurements to examine whether the pattern found for grandparents' education in this study holds true for other characteristics.

Chapter Three

The Role of Parents' Education in Marital Sorting over the Life Course

Abstract

Marriage or union formation is key in shaping one's life chances and the intergenerational transmission of (dis)advantages. This study examines the role of parents in adult children's marital sorting. It focuses on the extent to which parents' education is associated with the educational attainment of children-in-law. It investigates three pathways for the potential association between parents and children-in-law: a) intergenerational transmission, b) matching between parents of the two families, and c) parents' direct influence on adult children's marital sorting. Furthermore, this study extends previous findings on first and new marriages from the life course perspective. With data from the Panel Studies of Income Dynamics 1968-2019 (N = 13,489) and mixed-effect models, results show divergent trends by gender. Parents' influence in marital sorting becomes less important for males. For females, it becomes more vital over the life course, as compensation for their disadvantages when marrying at older ages and in remarriages.

Introduction

Marriage or union formation is key in shaping one's life chances and the intergenerational transmission of (dis)advantages over the life course. From the intra-generational perspective, marriage formation marks a milestone in the transition to adulthood (Hogan & Astone, 1986). The timing of marriage formation, the form of the union, and the characteristics of the spouse impact an individual's earnings (Antonovics & Town, 2004; Ginther & Zavodny, 2001; Juhn & McCue, 2016), social status (Sunder, 2019), wealth accumulation (Cheng & Zhou, 2021), and wellbeing (Chapman & Guven, 2016). From the intergenerational perspective, marriage formation marks the creation of families, wherein children are born and grow up (Mare & Maralani, 2006; Maralani, 2013). The resources and structure of the family have lasting consequences for the children's development (McLanahan, 2004; McLanahan & Percheski, 2008). Therefore, the patterns, determinants, and consequences of marriage/union formation have long been of interest to scholars. This study investigates the role of parents in adult children's marriage formation—specifically marital sorting (i.e., whom the adult children marry)—and explores the extent to which the parents' education is associated with the educational attainment of children-in-law as well as how that association changes over the adult children's life course. Understanding this association can help explain educational segregation in marriage formation and how (dis)advantages transmit across generations.

Many studies on marriage formation consider the role of parents. For example, they examine how parental characteristics are associated with the timing of marriage (Axinn & Thornton, 1992; Wiik, 2009; Cavanagh, 2011) and the type of union formed (i.e., marriage or cohabitation; Seltzer, 2004; Lichter & Qian, 2008; Mooyaart & Liefbroer, 2016). Individuals from more advantaged backgrounds are found to postpone union formation and be more likely to get married than those from disadvantaged backgrounds, a finding that holds when the individuals'

personal traits are controlled. However, less is known about the role of parents in marital sorting—specifically, how parental characteristics are associated with the characteristics of their children-in-law.

Parents can play a role in adult children's marital sorting through three pathways, as shown in Figure 3.1. The first pathway (a) is intergenerational transmission. Parents indirectly influence their adult children's marriage outcomes by shaping children's characteristics, such as education and intelligence. In the second pathway (b), parents indirectly determine the characteristics of their children-in-law by matching between two families. Parents may have preferences about the type of families with which they wish to match. Highly educated parents may want to match with another highly educated household with similar values, preferences, and lifestyles (Kalmijn, 1991b; Blackwell, 1998). Parents with advantaged socioeconomic resources, such as wealth (Charles, Hurst & Killewald, 2013) or status (Mäenpää, 2015; Hu, 2016; Henz & Mills, 2018), are more willing to match with another advantaged household to accumulate resources and avoid a status downgrade (Chung, Lee & Zhu, 2022). Third, in pathway (c), parents participate in their adult children's marital sorting directly. They can help their children meet potential partners through their social networks, while their advice and attitudes can also influence their children's decision-making. Moreover, the parents' educational attainment can be a valuable trait attracting potential children-in-law since people tend to evaluate a package of attributes of a potential spouse. However, few studies have examined the direct parental involvement in children's marital sorting in a way that accounts for both the children's education (pathway a) and the education of the parents-in-law (pathway b).

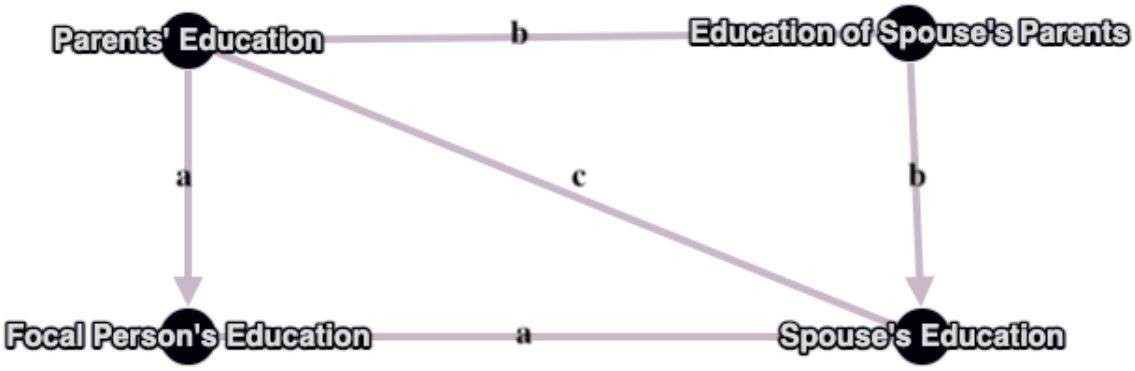


Figure 3.1 Graphic Illustrations of Parents' Role in Adult Children's Marital Sorting

This study used data from the Panel Studies of Income Dynamics (PSID) 1968–2019 (N = 13,489) and mixed-effect models to demonstrated that parents can play a role in adult children's marital sorting through three pathways: a) intergenerational transmission, b) matching with the parents of children-in-law, and c) direct involvement either by providing opportunities and advice or attracting potential children-in-law. The educational association between parents and their children-in-law highlights a vital process in the (dis)advantages transmission over generations, involving the acquisition of in-laws—specifically, in-laws with specific traits. Anthropology studies on marriage posit that acquiring in-laws is a vital purpose of marriage as the organization of reproduction (Friedl 1975). It converts strangers into relatives and expands the family network via affinity relations (Coontz 2005). The educational association between parents and children-in-law shows that (dis)advantages persist and expand over generations, as parents not only reproduce their (dis)advantages onto their own children but also accumulate (dis)advantages by bringing similarly (dis)advantaged members into the family via marriage.

Furthermore, previous studies that have examined both parental education and adult children's education in marital sorting have used data on first marriages (Blackwell, 1998) and new

marriages (Schawrtz, Zeng & Xie, 2016). This study extends the literature by examining the changes in parents' direct influence on marital sorting over the life course. Potential gender variations are also considered. Using PSID Marriage History Data, this study examines how the influence of parents in marital sorting changes for marriages formed at different ages and, for individual with multiple marriages, whether there is a difference between first marriages and remarriages.

This study derives hypotheses regarding life course changes from two perspectives: the "transition" perspective and the "compensation" perspective. From the "transition" perspective, modernization theory posits that a transition occurs in the importance of parental and child characteristics for marriage outcomes over cohorts. Due to the general increases in educational attainment, social mobility, and female's socioeconomic achievements, mating outcomes become more dependent on achieved characteristics such as education and income than on ascribed characteristics such as race, family background including parental education, status and wealth over cohorts (Kalmijn, 1991a; Kalmijn, 1991b; Rosenfeld, 2008). Likewise, a transition may occur in the importance of parental characteristics over the life course (Sassler & Goldscheider, 2004; Wiik, 2009). As individuals accumulate their own status and gain autonomy, parents' influence in marital sorting should become less important for marriages at older ages and remarriages.

From the "compensation" perspective, people may be disadvantaged in marriage formation when they marry at older ages or after experiencing marriage dissolution; this is especially true for women (Chamie & Nsuly, 1981; Brown, Bulanda & Lee, 2006; Lichter, 1990; Qian & Lichter, 2018). Social exchange theory suggests that, in marital sorting, an individual compensates for his/her disadvantage in one domain with an advantage in another (Davis, 1941;

Merton, 1941). When facing challenging situations in marital sorting at older ages and remarriages, the parents' educational achievement may compensate for individual disadvantages. Thus, family background gains more weight in the marital decision over the life course.

The results demonstrate divergent life course trends by gender. Aligning with the "transition" predictions, parents' influence in marital sorting becomes less important for males. The direct parents–children-in-law association declines for men married at older ages and higher order, and it even disappears for those married after age 30 and in remarriages. However, aligning with the "compensation" predictions, females who marry at older ages or retreat from a previous marriage face challenges in finding better-educated partners. Parental education appears to compensate for their disadvantages. The direct parents–children-in-law association increases for marriages formed at older ages and higher orders for females.

Literature Review

Parents' Role in Marital Sorting

Many studies on marriage formation have considered the role of parents when examining the timing of the marriage (Axinn & Thornton, 1992; Wiik, 2009; Cavanagh, 2011) and the type of union formed (i.e., marriage or cohabitation) (Seltzer, 2004; Lichter & Qian, 2008; Mooyaart & Liefbroer, 2016). However, less is known about the role of parents in marital sorting—that is, how parental characteristics are associated with the adult children's marriage decisions on whom to marry.

Three factors are argued to shape marital sorting outcomes (Kalmijn, 1998). The first is a preference for partners with specific characteristics. For instance, the specialization model

(Becker, 1981) contends that people who acquire socioeconomic resources prefer partners with household care skills, and *vice versa*, to maximize the family utility via the division of labor. This is used to explain the prevalence of male breadwinning and female house-making patterns in earlier days. Moreover, the growing trend of marital homogamy, in which couples have the same characteristics such as in educational attainment (Mare, 1991; Schwartz & Mare, 2005) or income level (Kalmjin, 1994; Schwartz, 2010; Gonalons-Pons & Schwartz, 2017), is also partially attributed to people's preference for marrying someone with similar tastes, lifestyle, or status (Kalmijn, 1991a, 1998; Rosenfeld, 2008). Second, the outcomes of marital sorting depend on constraints and opportunities. Partner choices are subject to the availability and composition of the potential partners (Choo & Siow, 2006; Xie, Cheng & Zhou, 2015). For instance, in examining educational homogamy, Mare (1991) argues that, since schools provide potential partners of similar educational levels, couples who meet in school and marry at school age are more likely to have similar educational attainments. Lichter, Anderson, and Hayward (1995) found that women are more likely to marry better-educated men when the local sex ratio is favourable (i.e., with more men than women). Third, a less-mentioned factor is "third parties" such as friends, family members, and institutions. These can exert an external impact on partner choice. For instance, in earlier times, religious communities maintained social boundaries that influenced peoples' marital sorting on religion (Herberg, [1955]1960; Kalmijn, 1991b). Furthermore, despite the widespread individual-choice marriages, parent- or family-determined arranged marriages are still common in some parts of the world (Ghimire, Axinn, Yabiku & Thornton, 2006). Even in individual-choice marriage settings, third parties can still influence the process. For instance, by providing advice and incentives, friends and family members are found to encourage individuals to form homogamous relationships (Clark-Ibáñez & Felmlee, 2004). Moreover, studies show that parents' attitudes influence children's marriage

behavior in both Western (Axinn & Thornton, 1996) and non-Western countries (Jennings, Axinn & Ghimire, 2012).

Accordingly, parents can play a role in their adult children's marital sorting by shaping their preferences and opportunities or via direct participation. Figure 3.1 illustrates the three potential pathways. First, the individual characteristics that are important for marital sorting—such as education (Mare, 1991), physical attractiveness (Stevens, Owens & Schaefer, 1990), earning potential (Schwartz, 2010), intelligence (Smith, 1941), health status (Couch & Liamputtong, 2007), and values and attitudes (Kalmijn, 1994)—are partially attributed to his/her family origins via intergenerational transmission. By shaping these characteristics, parents indirectly influence the adult child's marriage outcomes, corresponding to pathway (a) in Figure 3.1. Second, parents have their own preferences in marital sorting, regarding the kinds of families and in-laws they would like their child to tie the knot with. For instance, highly educated parents may want to match with another highly educated household with similar values, preferences, and lifestyles (Kalmijn, 1991b). Parents with advantaged socioeconomic resources (i.e., wealth, status) may wish to match with another advantaged household to accumulate resources and avoid status-downgrading (Chung et al., 2022). Empirical studies find strong correlations between married couples' parents in terms of education (Blackwell, 1998), wealth (Charles et al., 2013), and social class (Mäenpää, 2015; Hu, 2016; Henz & Mills, 2018) after controlling for the couples' own attributes, suggesting that the correlations in parental attributes are above and beyond the marital sorting between the couples. In other words, matching on family backgrounds is not a byproduct of matching on the individuals' own attributes. Rather, systematic sorting occurs between parents in a marriage of adult children. Thus, following pathway (b) in Figure 3.1, parents can indirectly influence the characteristics of children-in-law via matching between the two families. Besides the indirect

pathways through intergenerational transmission and matching with another family, parents can also participate directly in marital sorting by 1) providing their adult children opportunities and advice and 2) attracting potential children-in-law. On the one hand, the parents' social network and the family's residential neighborhood, which are determined by the parents' characteristics, can provide opportunities for adult children to meet with potential partners. On the other hand, mating is a mutual process. As most marriages are formed at the relatively early stages of the life course of adult children, parental characteristics can have a signaling effect indicating the future development of the individual. The literature points out that marital sorting happens on multiple dimensions (Kalmijn, 1991b; Blackwell & Lichter, 2000; McClintock, 2014; Qian, 2017; Maralani & Portier, 2021). People evaluate a package of potential spouse attributes. The individual's own characteristics and family background are both influential in the decision making. For instance, studies on college students have found a marriage mismatch for college students from disadvantaged social backgrounds. Unlike their peers who have college-educated parents, first-generation college students struggle to find compatible partners during and after college (Musick, Brand & Davis, 2012; Armstrong & Hamilton, 2013, 2021; Hamilton & Armstrong, 2021; King 2021).

To sum up, as illustrated in Figure 3.1, parents can influence adult children's marital sorting through three pathways: a) intergenerational transmission, b) matching between parents of the two families, and c) direct influence by either providing opportunities and advice or attracting potential children-in-law.

Parents' Role in Marital Sorting over the Life Course

Among the three pathways via which parents can influence the characteristics of their children-in-law (see Figure 3.1), matching between families (b) and direct influence (c) represent active

parental involvement in the marriages of the next generation. This active involvement should show changes over the adult children's life course, mainly due to variations in the parents' direct influence (c) in the marital sorting. Concerning matching between families (b), the degree of sorting between parents should be fixed over the life course. First, when the offspring generation reaches marriageable age, parental status, especially educational attainment, tends to be stable and is likely to remain constant afterwards. Second, parental preferences regarding the educational backgrounds of in-laws should also remain constant. If, as suggested, parents hold a preference for matching with households of similar attributes, the degree of attraction between parents should be the same regardless of whether the individual is married at 20 or at 30.

However, the strength of the direct influence of parents in the marital decision should change over the life course. This study derives hypotheses regarding how the direct association between parents and children-in-law can change over the life course from two perspectives: the transition perspective and the compensation perspective. Previous studies on marriage formation over the life course have reported variations across the age span (Wiik, 2009; Mooyaart & Liefbroer, 2016) and between the first marriage and remarriages (Sweeney, 1997; De Graaf & Kalmijn, 2003; Schwartz & Mare, 2012; Qian & Lichter, 2018). Thus, this study focuses on life course variations by considering two factors: the age at marriage and the order of marriage.

First, from a transition perspective, one would expect a decline in parents' influence on marriages formed at later stages. Studies based on modernization theory argue that, due to the general increase in educational attainment, social mobility, and female's socioeconomic status, mating outcomes become more dependent on achieved characteristics such as education and

income than on ascribed characteristics such as race, parental education, wealth, and status over cohorts (Kalmijn 1991a). A decline in matching on ascriptive characteristics has been found for parental occupation (Kalmijn, 1991a), religion (Kalmijn, 1991b), and race (Rosenfeld, 2008), but recent evidence shows that matching on parental wealth has strengthened over cohorts (Wagner, Boertien & Gørtz, 2020).

Likewise, a transition can occur in the importance of parental characteristics over the life course (Sassler & Goldscheider, 2004; Wiik, 2009). At earlier stages, individuals have accumulated limited resources and are at the initial stage of status achievement. Marital sorting is more likely to consider family origins at such stages. Young people are found to rely on external sources to meet potential romantic partners (Rosenfeld & Thomas, 2012). Parental resources and networks can be important for young people finding partners. Thus, parents may play a more critical role in marriages formed at younger ages. However, over the life course, as an essential aspect of the transition into adulthood, individuals accumulate their own resources and gain autonomy as they move out of parental houses and attain their own social status (Bucx, van Wel & Knijn, 2012). Their experiences and preferences become more decisive than family origins in marital sorting. They are more likely to meet potential partners through their own friend- or work-related networks (Kalmijn & Flap, 2001; McClendon, Kuo & Raley, 2014). Thus, marital sorting at older ages may put more weight on individuals' own achievements than on family origins. Therefore, following the transition perspective, we expect that parents' influence on marriage formation will wane over the life course. We thus propose the following:

H1a: Parents' influence on children-in-law's education decreases as adult children's age at marriage and order of marriage increase.

However, people may face disadvantages in marriage formation when they marry at later stages or after experiencing marriage dissolution. For instance, Lichter (1990) found that women who marry after 30 are more likely to marry less-educated partners. Empirical evidence shows that previously married persons are worse-positioned than their never-married counterparts to marry attractive partners (Qian & Lichter, 2018). Moreover, remarriage rates are found to decrease as age increases for both genders (Chamie & Nsuly, 1981 [Table 3]; Brown, Bulanda & Lee, 2006). Under these disadvantaged circumstances, parents' educational achievement may compensate for individual disadvantages in marital sorting. In other words, family backgrounds gain more weight in the marital decisions of those facing difficult situations in marital sorting at older ages and in remarriages. The idea of compensation between traits derives from social exchange theory, which predicts that an individual compensates for his/her disadvantage in one domain with an advantage in another in marriage formation (Davis, 1941; Merton, 1941). This is often used to explain the status–race exchange in interracial marriages in the United States (Qian, 1997; Kalmijn, 2010; Hou & Myles, 2013) and the exchange between other traits and characteristics, such as status–beauty exchanges (McClintock, 2014; Gullickson, 2017). Using the status exchange notion, studies speculate that an advantaged family background can compensate for an individual's disadvantages, such as low educational attainment, in marriage. Nevertheless, the empirical evidence is not clear-cut. Blackwell (1998) found that family backgrounds and the individual's education are complements in first marriages, as individuals sorted (dis)advantages on their own education and family backgrounds simultaneously. Having highly educated parents is more valuable in marriage formation when their education is also high, and *vice versa*. However, Schwartz, Zeng, and Xie (2016) reported evidence in favor of the status exchange prediction by examining the trade of relative advantage on the traits of couples. They show that, among intermarried couples, the spouse with higher parental education status tends to have lower educational attainment. This

study borrows the status exchange notion to examine whether parental education can compensate for the potential disadvantages an individual face over the life course. Since the evidence suggests that people, especially women, at older ages or after union dissolution may face challenges in marital sorting, we expect—following the compensation perspective—that the parents' educational achievement plays a more important role in marital sorting over the life course. We thus propose the following:

> *H1b: Parents' influence on their children-in-law's education increases as their adult children's age at marriage and order of marriage increase*.

Furthermore, marriage formation is a gendered process. The literature shows that the same attribute, such as educational attainment (Torr, 2011), income (Qian, 2017), or divorce status (Cornell, 1989), has different impacts on marriage formation depending on gender. Therefore, it is reasonable to speculate that parents' role in marital sorting will demonstrate distinct patterns over the life course according to gender. On the one hand, males and females have varied prospects of marriage across life stages. Women are more likely to be in a disadvantaged position in marriage formation over the life course. Marrying at older ages is associated with lower partner education for women but not for men (Lichter, 1990). Males have a better position in remarriage than females (Chamie & Nsuly, 1981 [Table 2]). The negative ageing effect of remarriage is also more vital for women than for men (De Graaf & Kalmijn, 2003). On the other hand, studies show that parental influence on marriage in the next generation is more salient for females than for males. For instance, Blackwell (1998) found that the effect of parental education on marital homogamy benefits daughters more than sons. Moreover, parents are found to affect the family income of the next generation via marital sorting, but only among daughters and at older ages (Choi, Chung, & Breen, 2020). Thus, we expect that the parents'

influence in marital sorting is more likely to align with the prediction of the compensation perspective for females.

Data and Analytic Samples

This study uses data drawn from the PSID 1968–2019 to answer the research questions and test the hypotheses. The PSID provides representative longitudinal data on individuals and families in the United States. The PSID has a longer timespan than other data sources, allowing researchers to trace complete marriage histories and obtain information on individual characteristics and family backgrounds at the time of marriage and afterwards for both spouses.

Respondents' marriage histories are retrieved from the PSID Marriage History File,[9] which collects retrospective details about the timing and circumstances of every marriage event of eligible PSID family members up to and including 2019.[10] Longitudinal information on the characteristics of the focal person and his/her spouse is matched using individual files from PSID 1968–2019. Information on the couples' family background is matched from PSID 1968–2019 family files. The analytic sample is restricted to cohorts born between 1950 and 1990 to observe their marriages from 1968 to 2019. The lower cutting-off point is set at 1950 because cohorts born before 1950 are likely to marry (at least for the first marriage) before 1968, the panel's starting point. The upper cutting-off point is set at 1990. As the age at first marriage delays over time, cohorts born after 1990 are likely to marry after 2019, the ending point of the panel. The final analytic sample comprises 13,489 marriage records from 6,635 respondents without missing values in variables used.

[9] The PSID Marriage History File is designed to collect histories of marriages of individuals living in a PSID family at the time of the interview in any wave between 1985 and 2019.

[10] The original core sample of the 1968 wave was drawn from the Survey of Economic Opportunity (the SEO sample) and the nationally representative Social Research Center sample (SRC sample). I exclude the Latino and immigrant samples, which entered the PSID survey only in the 1990s.

Method and Measurements

The analytic sample is in a hierarchical structure. One focal person can generate several marriage records. To account for non-independence in the data, the analysis uses the linear mixed-effect models with random intercepts. For hierarchical data with N cases generated from J groups, a mixed-effect model can be written with matrix notations:

$$\boldsymbol{Y} = \boldsymbol{X\beta} + \boldsymbol{Zu} + \boldsymbol{\varepsilon} \quad (3.1)$$

where $\boldsymbol{Y}$ is a $N * 1$ column vector of the outcome variable; $\boldsymbol{X}$ is a $N * p$ matrix of the p predictor variables; and $\boldsymbol{\beta}$ is a $p * 1$ column vector of the regression coefficients. $\boldsymbol{Z}$ is the $N * J$ design matrix for the random effects and J groups; $\boldsymbol{u}$ is a $J * 1$ vector of random effects for J groups; and $\boldsymbol{\varepsilon}$ is a $N * 1$ column vector of the residuals. Here, only one random effect, the random intercepts, is considered. A random effect is considered so that the outcomes within groups may be correlated. The mixed-effect model allows the intercept to vary across groups and produce the parameter estimates for $\boldsymbol{\beta}$**s** at the means. The mixed-effect models can 1) explore the difference between effects within and between groups and 2) correct standard errors for non-independence in the data.

In the analysis, the outcome of interest is the educational attainment of the focal person's spouse. Specifically, the analysis measures the couple's educational attainment when the union was formed. It is important to have a clear time sequence among measurements of individual characteristics and marriage formation. As noted in previous research, individuals might experience education upgrades after marriage due to prolonged education or the need to increase the family income with further education. Although no formal analysis has examined couples' educational attainment after marriage, descriptive evidence provided in Schwartz and Mare (2012) with data from the National Longitudinal Survey of Youth suggests that 24.2% of the unions formed by women born between 1957 and 1964 witnessed an education category

upgrade within 10 years of marriage for either party (Schwartz & Mare, 2012: 639). Education measured at the time of the marriage is a better option when examining how parents influence adult children's partner choice than using other measures, such as completed education. The latter might lead to biased estimates by picking up changes in spouses' education after marriage that are unrelated to the parents. In the robustness check, several education outcomes measured after marriage are used to test whether the temporal changes in couples' attainment affect the conclusions.

The key independent variable of interest is the education of the focal person's parents. The quantity of interest is its association with the education of the focal person's spouse. As shown in Figure 3.1, this association can arise through a) the focal person, b) the matching with the spouse's parents, and c) the direct influence of parents in the marital sorting. The analysis uses a series of nested models to see the changes in the association between parents and children-in-law and tests whether the changes in the coefficients are statistically significant (Clogg, Petkova and Haritou, 1995). The analysis first controls for the focal person's own education. It also controls for the economic position of the individual at the time of marriage, measured as the logarithm of his/her income in order to examine whether traits other than the education of the focal person can explain the educational association between parents and spouses. Income measures are adjusted to 2019 dollars using the Consumer Price Index (CPI). Then, it controls for the education of the children-in-law's parents to account for the matching between the couples' parents. To minimize sample loss due to missing values, it uses the average years of education to measure the parents' education. If both parents' educations are available, the mean value is taken. If the education of either parent is missing, the value of the available parent is taken.

Next, the study examines whether the parents–children-in-law association varies over the life course by gender. As mentioned, the importance of the direct influence of parents in marital sorting is expected to vary according to the focal person's age at marriage and the order of marriage. Furthermore, the moderation relationship might differ by gender. After controlling for the characteristics of the focal person and the spouse's parents, it adds in interaction terms between 1) the parents' average education and the focal person's age at marriage; and the 2) parents' average education and the order of the marriage. It then fits the models for the male and female samples separately.

Besides the variables mentioned above, the analysis controls for the following covariates, which might influence the results. First, it considers the characteristics of the focal person that might influence his/her assortative mating outcomes, including race, region of birth, year of birth, and birth cohorts. The sample's focal respondents were born between 1950 and 1990, and they are divided into four cohorts with 10-year intervals. Second, it includes the characteristics of the spouse that might influence his/her educational attainment, including race, age at marriage, year of birth, and region of birth. Descriptive statistics for all variables used are shown in Appendix Table A3.1 (page 160).

Results

Parents–Spouse Educational Association

Table 3.1 reports the educational associations between parents and children-in-law ("parents–spouse association" hereafter) estimated with the mixed-effect models. According to Model 1, parents' education is positively associated with the education of their children-in-law. When other factors are held constant, the parents–spouse association is 0.282 years ($p < 0.001$). Every one-unit increase in the parents' average education is associated with a 0.282 increase in the

educational attainment of the children-in-law. This association can arise via three sources: a) the focal person, b) the matching with the spouse's parents, and c) the direct influence of parents in the marital sorting. Model 2 controls for the focal person's education. The results show that the magnitude of the parents–spouse association decreases by half (50.7%) to 0.139 years ($p < 0.001$). The magnitude of the parents–spouse association is around one-third of the association between the couples' own education (0.139 vs. 0.428). This shows that, among individuals with the same educational achievement, having better-educated parents is associated with marrying a better-educated spouse. Model 3 adds the focal person's income at marriage. The results show that controlling for the economic perspective of the focal person does not affect the parents–spouse educational association. Controlling traits other than the education of the focal person that might influence his/her assortative mating outcomes does not further explain the educational association between parents and spouse. Model 4 considers the sorting on family backgrounds by controlling for the average education of the spouse's parents. The magnitude of the parent–spouse association declines by 53.2%, from 0.139 to 0.065($p < .001$). This means that, among individuals with the same educational achievement, more than half of the benefits of having more-educated parents in marital sorting is attributed to the matching with more-educated parents-in-law. The remaining parents–spouse association is still statistically significant. Following the method proposed in Clogg et al. (1995), the changes in the coefficients from Model 1 to Model 2 to Model 4 are tested to be statistically significant. Assuming no other explanatory factors, this suggests that parents' education directly influences the partner choice of the next generation. This could emerge due either to the parents' help and advice in partner seeking or from the signaling effect and attractiveness of parental education in marriage formation.

Table 3.1 Estimates from Mixed-effect Models for Parents–Spouse Associations

Dependent Variable	**Spouse's Education at Marriage**			
	Model 1	Model 2	Model 3	Model 4
Parents' Average Education	.282***	.139***	.139***	.065***
	(.010)	(.009)	(.009)	(.011)
Own Education at Marriage		.428***	.425***	.409***
		(.010)	(.010)	(.010)
Log Income at Marriage			.018***	.017***
			(.003)	(.003)
Average Education of Spouse's Parents				.119***
				(.010)
Number of Persons	6,635			
Number of Observations	13,489			

Note: Parameter estimates for other control variables, including the focal person's gender, race, region of birth, year of birth, birth cohorts, age at marriage, and order of marriage and the spouse's race, region of birth, and age at marriage, are omitted.
*$p < 0.05$; ** $p < 0.01$; ***$p < 0.001$

Gender Variations in Parents–Spouse Association over Life Course

Next, the study considers how the direct parent–spouse association changes over the life course. Using Model 4, after controlling for the characteristics of the focal person and spouse's parents, it adds an interaction term between the parents' average education and the focal person's age at marriage in Model 5, and an interaction term between the parents' average education and the order of the marriage for the focal person in Model 6. It then fits the models for the male and female samples separately.

Table 3.2 reports the results. For males, the parents–spouse association weakens over the life course, aligning with the "transition" perspective (*Hypothesis 1a*). For females, the parents–spouse association strengthens over the life course, compensating for their disadvantaged positions in mating at older ages and remarriages (*Hypothesis 1b*).

First, the direct parents–spouse associations varied according to the focal person's age at marriage. In Model 5, for males, the strength of the parents–spouse association decreases as

the age at marriage of the focal person increases, as predicted in *Hypothesis 1a*. The main effects of the parents' education and the focal person's age are positive. Having better-educated parents and marrying at older ages are related to marrying better-educated spouses, when other factors are held constant. The interaction effect between the parents' education and the focal person's age is negative. The parents–spouse association decreases by 0.005 years ($p < 0.000$) as the age at marriage of the focal person increases by one year. In Figure 3.2, the left panel plots the marginal effect of the parents' education on spouse education by the age at marriage for the male sample. The direct association between parents and children-in-law attenuates as the marriage age of the male adult children increases. The direct parents–spouse association is 0.075 ($p < 0.000$) for men married at age 20. It decreases to 0.003 for men married at age 35. The direct parents–spouse associations are not statistically significant for men married after age 30. This demonstrates that, as predicted by the transition perspective (*Hypothesis 1a*), the direct influence of parents in marital sorting declines and becomes unimportant for males over the life course.

Table 3.2 Estimates from Interactive Mixed-effect Models for Direct Parents–Spouse Associations by Gender

Dependent Variable	**Spouse's Education at Marriage**			
	Male Sample		Female Sample	
	Model 5	Model 6	Model 5	Model 6
Parents' average education	.172***	.099***	.014***	.043**
	(.026)	(.020)	(.00)	(.013)
Age at marriage	.076***	.019***	-.018*	-.012*
	(.013)	(.006)	(.008)	(.005)
Parents' average education #	-.005***		.003***	
Age at marriage	(.001)		(.001)	
Order of marriage	.025	.113***	-.128**	-.203*
	(.053)	(.025)	(.046)	(.088)
Parents' average education #		-.048***		.037**
Order of marriage		(.011)		(.014)
Own Education at Marriage	.447***	.446***	.403***	.420***
	(.015)	(.015)	(.013)	(.012)
Average Education of	.111***	.110***	.088***	.086***
Spouse's Parents	(.013)	(.012)	(.012)	(.012)
Number of Persons	3,123		3,521	
Number of Observations	6,345		7,159	

Note: Parameter estimates for other control variables, including the focal person's race, region of birth, year of birth, and logarithm of income at marriage and the spouse's race, region of birth, and age at marriage, are omitted.
*$p < 0.05$; ** $p < 0.01$; ***$p < 0.001$

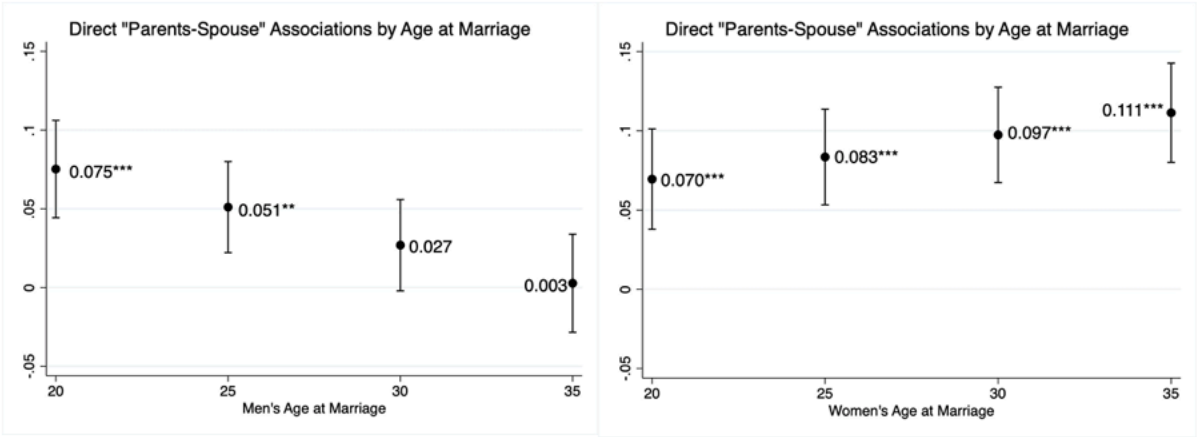


Figure 3.2 Direct Educational Associations between Parents and Children-in-law by Age at Marriage (Left panel = Male Sample; Right panel = Female Sample)
Note: Based on results from Model 5 in Table 3.2. Point estimates and 95% confidence intervals are shown; other covariates are held constant.

A reversed pattern is observed for the female sample. According to Model 5, the main effect of parents' education is positive, but, in contrast to the effect for males, the main effect of age at marriage is negative for females. When other factors are held constant, marrying at older ages is associated with less spouse education than marrying at younger ages for females. In other words, women face disadvantages in terms of marital sorting on educational attainment when marrying at older ages. The interaction effect between parents' education and females' age at marriage is positive. The parents–spouse association increases by 0.003 years ($p < 0.000$) as the age at marriage of the focal person increases by one year. Parental education becomes more important for marriage formation over the life course, compensating for women's disadvantaged position in marital sorting at older ages. For women, as shown in the right-hand panel of Figure 3.2, the direct parents–spouse association increases from 0.070 ($p < 0.001$) for marriages formed at age 20 to 0.111 ($p < 0.001$) for marriages formed at age 35. Having better-educated parents becomes more important for females in marital sorting over the life course, aligning with the compensation prediction (*Hypothesis 1b*).

Second, the direct parents–spouse association varies according to marriage order. Compared to the first marriage, the parents–spouse association at remarriage decreases for males but increases for females. According to Model 6, the main effects of parental education and order of marriage are positive for males. When other factors are held constant, men tend to marry a spouse with more education if they have more-educated parents, and they tend to marry a spouse with more education at remarriage than at the first marriage. The interaction effect between parental education and the order of marriage is negative. Though having better-educated parents is associated with marrying a better-educated spouse, the parents–spouse association decreases by 0.048 years ($p < 0.000$) from the first marriage to the second. Consistent with the transition perspective (*Hypothesis 1a*), parental education becomes less

important for males over the life course. As shown in the left-hand panel in Figure 3.3, the direct parents–spouse association decreases from the first marriage to the second. For the first marriage, the parents–spouse association is 0.051 ($p < 0.000$), and it declines to 0.002 and becomes statistically insignificant in the second marriage.

For the female sample, according to Model 6, the main effect of parental education is positive but is negative for the order of marriage. When other factors are held constant, females tend to match with spouses with less education in remarriage than in the first marriage. In other words, women face disadvantages in terms of marital sorting on educational attainment in remarriage. The interaction effect between parental education and the order of marriage is positive. The parents–spouse association increases by 0.037 years ($p < 0.000$) from the first marriage to the second. Consistent with the compensation perspective (*Hypothesis 1b*), parental education plays a more important role for females over the life course. Having better-educated parents compensates for the disadvantages they face in retreating from a previous marriage. As shown in the right-hand panel of Figure 3.3, the direct parents–spouse association increases from 0.080 ($p < 0.001$) for the first marriage to 0.118 ($p < 0.001$) for the second in the female sample.

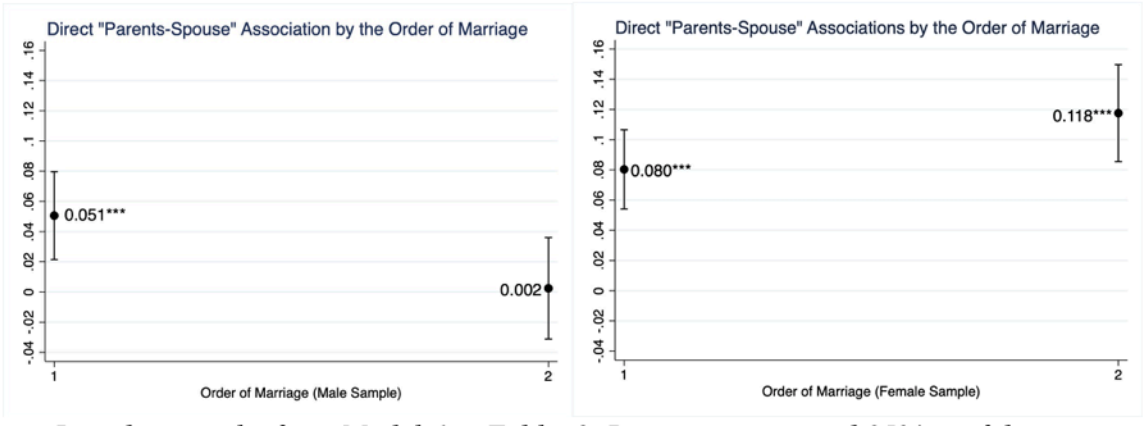


Figure 3.3 Direct Educational Associations between Parents and Children-in-law at First Marriage and Second Marriage (Left panel = Male Sample; Right panel = Female Sample)
Note: Based on results from Model 6 in Table 3.2. Point estimates and 95% confidence intervals are shown; other covariates are held constant.

Robustness Check

Temporal Changes in Couples' Educational Attainment

One of the benefits of using longitudinal data is that we can observe couples' characteristics at the point of union formation and thus avoid potential bias due to possible educational upgrades after marriage. Educational upgrading after marriage has been observed in some couples (Schwartz and Mare 2012). Measurements taken after marriage might pick up temporal changes in couples' education. Appendix Figure A3.1 (Page 159) plots the unconditional correlations between couples' education based on different educational measurements taken at various time points. As shown, the unconditional correlations between couples' education increase after marriage. The couples' educational correlation is 0.549 at marriage and rises to 0.565 in the second year and then to 0.575 in the fourth year of marriage. The correlation between couples' completed education is 0.585. Couples' educational attainment converges after marriage, possibly due to educational upgrading for either or both. Thus, studies should ensure a clear time order between measurements of couples' characteristics and marriage formation when making inferences on assortative mating. Appendix Table A3.2 (Page 161) reports the replication results of the analysis in Table 3.1 using measurements of couples' education taken at different time points. The results show that the parents–spouse association using different educational measurements displays no statistically significant differences after the education of the focal person at the corresponding time points is controlled for. Thus, parents' role in their adult children's assortative mating occurs mainly at the searching and formation stages. The results in Table A3.2 confirm that the parents–spouse associations do not pick up the convergence in couples' educations after marriage once the focal person's own education is controlled for.

Conclusion and Discussion

This study examined the role of parental education in adult children's marital sorting, focusing on how parental educational attainment is related to the educational attainment of children-in-law. It further examined how the influence of parents in marital sorting changes over the life course according to gender.

First, this study demonstrated that parents can play a role in adult children's marital sorting through three pathways: a) intergenerational transmission, b) matching with the parents of children-in-law, and c) direct involvement either by providing opportunities and advice or attracting potential children-in-law (see Figure 3.1). The educational association between parents and their children-in-law highlights a vital process in the (dis)advantages transmission over generations. The intensively studied parents–children association captures the extent to which parental educational attainment shapes the achievement of the next generation and represents a reproduction process of (dis)advantages. The parent–children-in-law association studied here captures an accumulation process of (dis)advantages over generations. Parents not only affect their children's educational attainment but also influence whom their children will marry and who their in-laws will be. Anthropologists claim that acquiring in-laws is a vital function of marriage, as it converts strangers into relatives and expands cooperative networks (Friedl 1975; Coontz 2005). By influencing their adult children's marital sorting, parents attract in-laws with certain traits and integrate their resources. Among people with the same educational attainment, those with more-educated parents tend to have more-educated spouses from better-educated family backgrounds. However, the family origins of those with less-educated parents, conditioned on their own educational attainment, can put them in a disadvantaged position in marital sorting. Thus, the parents–children-in-law association

demonstrates that the (dis)advantages of one generation not only reproduce over generations but also amplify, because similarly (dis)advantaged people join in via marriages.

Furthermore, studies have recorded a growing trend towards marital sorting on an individual's own educational achievement in the United States (Mare, 1991; Qian, 1998, Schwartz & Mare, 2005; Hou & Myles, 2008) and elsewhere (Blossfeld, 2009; Smits & Park, 2009). Strong resemblance between couples' education levels indicates rigid boundaries between social groups (Glass, 1954; Kalmijn, 1998), especially at the top and bottom ends of the educational distribution (Schwartz & Mare, 2005). By demonstrating the active involvement of parents in marital sorting, this study suggests that the resemblance between couples' education levels is generated not only by the sorting of an individual's own educational achievement but by a multifaceted sorting process wherein family origins and self-achievement jointly determine marriage outcomes. As argued in other studies that consider multiple dimensions in marital sorting (Kalmijn, 1991b; Blackwell & Lichter, 2000; McClintock, 2014; Qian, 2017; Maralani & Portier, 2021), this study suggests that marital sorting is based on a package of attributes instead of matching on a single trait. Future studies should advance this line of inquiry on how the multiple traits of the same person contribute to his/her marital sorting outcomes.

Finally, this study investigates how parental involvement in marital sorting changes over the life course. The results demonstrate divergent life course trends according to gender. In line with the transition prediction, parents' influence in marital sorting becomes less important for males. The direct parents–children-in-law association declines for men married at older ages and higher marriage orders, and it even disappears for those married after age 30 and in remarriage. However, in line with the compensation prediction, females who marry at older ages or retreat from a previous marriage face challenges in finding better-educated partners.

Parental education appears to compensate for their disadvantages. The direct parents–children-in-law association increases for marriages formed at older ages and higher marriage orders for females. These findings demonstrate the divergent experiences of marriage formation by gender. They align with previous findings that the intergeneration transmission process, especially when demographic behaviors such as fertility and marriage are considered, vary by gender (Blackwell, 1998; Lawrence & Breen, 2016; Choi, Chung, & Breen, 2020). Parental attributes appear to play a more important role in shaping the daughter's life chances. Findings of this study extend this line of argument from the life course perspective. Regarding marital sorting, parental attributes play a more critical role in shaping the daughter's outcomes, and their influence lingers on and strengthens for daughters over the life course. While males become less dependent on their family origins, the influence of parental education on finding a better-educated spouse increases for females when they marry at older ages and in remarriage. This finding stresses the gender inequalities in marriage formation over the life course. In contrast to males, the marriage prospects of females are worsened by age and a retreat from a previous marriage. Instead of gaining autonomy over the life course in finding a better-educated spouse, females have to rely on parental attributes to compensate for their disadvantaged positions in marital sorting. Previous studies on the gender disparities in marriage formation often adopt cross-sectional data and examine the issue from a static perspective. However, the results of this study illustrate the dynamic and divergent patterns in marital sorting by gender. Future studies should take the longitudinal perspective and investigate how the same characteristics can influence men's and women's marital outcomes differently over the life course.

Chapter Four

Two Sides of the Coin: How Educational Homogamy Shapes the Intergenerational Educational Reproduction

Abstract

Sociologists have a long-standing interest in educational homogamy, however, few studies have explored its role in intergenerational reproduction. We examine this process using a "Person-Partner-Child" panel constructed from the Panel Studies of Income Dynamics 1968–2019 and apply the "prospective approach" to bring the previous one-sided analysis, which focused on one parent only, to the couple-level. We propose a method to study the differences between homogamous and heterogamous couples in their likelihood of having a child and, if a child is born, the child's educational attainment. Our approach considers and distinguishes the two sources—resource combination and family milieu—that generate the difference between homogamy and heterogamy. Our results demonstrate that, first, the homogamous family milieu is the driving force for their higher likelihood of having a child compared to heterogamous couples. However, this reproductive advantage among homogamous couples waned over cohorts. Second, the combination of parents' resources via homogamy is the driving force that shapes the child's educational attainment. It is associated with disadvantages at the bottom of the educational distribution and advantages at the top. Over cohorts, the magnitudes of the penalties increased at the bottom, while the benefits declined at the top.

Introduction

Sociologists have a long-standing interest in educational assortative mating: the tendency for people to choose mates who are similar (positive) or dissimilar (negative) to themselves. During the past few decades, the similarities between couples in multiple characteristics such as education (Mare, 1991; Schwartz & Mare, 2005), income (Kalmijn, 1994; Schwartz, 2010; Gonalons-Pons & Schwartz, 2017), social class (Kalmijn, 1991a), religion (Kalmijn, 1991b), and ethnicity (Rosenfeld, 2008) have been intensively studied in the U.S. and around the world (Blossfeld, 2009; Smits & Park, 2009; Schwartz, 2013; Pesando, 2021a). Among these, the strong resemblance between couples' educational levels, which is referred to as educational homogamy, is well documented in the U.S. (Mare, 1991) and is argued to have grown during the late 20th century (Kalmijn, 1991a, b; Qian, 1998; Schwartz & Mare, 2005; Hou & Myles, 2008).

Patterns of educational homogamy affect social stratification and inequality. The extent to which people form families within the same educational level is viewed as an indicator of the openness of society and the rigidity of social groups' boundaries (Glass, 1954; Kalmijn, 1998). The high level of homogamy, which is especially true at the top and bottom ends of the educational distribution (Schwartz & Mare, 2005), implies challenges in crossing social boundaries for union formation and strong segregation between groups. The growing resemblance between couples means the concentration and polarization of (dis)advantages, leading to more inequalities between households. Much effort has been made to investigate the interplay between educational homogamy and inequality in income and earnings (Kremer, 1997; Western, Bloome, & Percheski, 2008; Breen & Salazar, 2010; Torche, 2010; Breen & Andresen, 2012). Few studies, however, have explored the implications of educational homogamy for intergenerational reproduction. It should be an important consequence of

educational homogamy as it defines the family background where the children grow up (Mare & Schwartz, 2006; Schwartz, 2013), which determines various aspects of the short-term and long-term development of the children.

The role parental educational homogamy plays in intergenerational reproduction is multifaceted. Educational homogamy defines the composition of the family, that is, who the parents are, and the environment of the family, that is, how the parents interact with each other and with their children. From the family composition perspective, by matching people with the same education, educational homogamy determines the overall quantity of the family's educational resources. When two parties form a new family, they pool together not only the resources that stem from their own education but also the resources from their family origins, such as those derived from their parents (Chan & Boliver, 2013; Song & Mare, 2017; Choi, Chung, & Breen, 2020) and extended family members (Jæger, 2012; Erola, Kilpi-Jakonen, Prix, & Lehti, 2018). The combination of resources is the first source of difference between homogamous couples and others. From the family environment perspective, in addition to resources, educational homogamy indicates a strong resemblance between couples in values, tastes, and lifestyles (Mare, 1991; Kalmijn, 1998). These similarities are proposed to create a beneficial family milieu that facilitates couples' daily interactions and parenting. Compared to heterogamous couples, educationally homogamous couples enjoy a lower risk of relationship dissolution (Grow, Schnor, & Bavel, 2017; Van Bavel, Schwartz, & Esteve, 2018), fewer conflicts (Surra & Longstreth, 1990), a lower level of stress (Rauscher, 2020), and a higher level of relationship satisfaction (Wilson & Cousins, 2003). They are more effective in parenting and socializing the next generation (Beck & González-Sancho, 2009; Edwards & Roff, 2016). The family milieu created by the homogamous couples is the second source that differentiates them from others. In the literature, the role educational homogamy plays in

resource combination and family milieu creation is studied in separate strands of work, and their relative contributions to intergenerational reproduction have not been considered together. In this paper, we propose an approach to synthesize the two bodies of work and demonstrate how these two sources generate the differences in the intergenerational transmission of educational attainment between homogamous couples and others.

The intergenerational transmission of educational attainment has been a central concern of stratification research. Two approaches have guided the studies in the field: the "retrospective approach" and the "prospective approach." When studying the consequences of marital sorting, most previous studies adopted the "retrospective approach" that uses a sample of the child generation and compares their educational attainment with their parents. They neglect the demographic processes of the parental generation that determine whether there is a second generation and what kind of resources have been matched via assortative mating. This line of research usually takes the combination of parental education as given and focuses solely on the differences in the family milieu between homogamous couples and others.

Though the importance of the demographic process in intergenerational transmission was recognized early (Duncan, 1966), empirical studies started formally developing the "prospective approach" to account for it only recently (e.g., Mare & Maralani, 2006; Mare, 2011; Kye & Mare, 2012; Maralani, 2013; Lawrence & Breen, 2016; Breen & Ermisch, 2017). In contrast with the "retrospective approach," the sampling strategy of the "prospective approach" is to follow a cohort of potential parents and observe whether and how they marry and produce the next generation. Studies of this strand provide insights into how parental assortative mating and differential fertility affect the status distributions of the child generation. For example, Mare and Maralani (2006) found that a woman's high educational attainment can

enhance her children's chances of attaining a better education via assortative mating. However, the beneficial effect is partially offset by the low fertility rate in Indonesia. Likewise, Lawrence and Breen (2016) found that obtaining a college degree increases male graduates' probability of having a child who completes college. However, it did not affect a woman's probability of having a child who also graduated from college in the U.S. Female college graduates were less likely to marry and less likely to have children. Though previous prospective studies account for the marriage formation process in intergenerational transmission, they do not distinguish between the influence of resource combination and the influence of family milieu. Moreover, previous studies usually rely on a one-sided model and estimate the effect of assortative mating for one sex only, that is, from mothers to daughters, or for the female sample and the male sample of the parental generation separately. However, assortative mating is a mutual process. A potential father matches with a potential mother via assortative mating, and the same process applies to a potential mother. In this study, we go a step further and develop the one-sided model into a two-sided model and examine the intergenerational transmission process at the couple level.

Following the "prospective" approach, we construct a "Person-Partner-Child" panel from the Panel Survey of Income Dynamics 1968–2019. We follow two cohorts born in the years 1919–38 and 1939–53 and record every individual's mating and fertility history from 1968 to 2019. We first ask whether homogamous and heterogamous couples differ in their likelihood of having a second generation; second, given there is a child generation, how do their children's educational attainment differ?" In addition, how do these patterns change across cohorts? With the proposed two-sided model, we consider and distinguish the two sources—resources combination and family milieu—that generate the difference between homogamy and heterogamy at the couple level.

This study first contributes to the literature on the consequences of assortative mating. The proposed approach synthesized the two realms of literature on how educational homogamy shapes families' resources and environment. We demonstrate how these two sources drive the outcomes. They play different roles depending on the outcomes concerned. While the family milieu is the driving force behind the higher likelihood of homougamous couples having children than heterogamous couples, the combined resources are the driving force that shapes the children's educational attainment. Second, this study contributes to the literature on the intergenerational transmission of educational attainment. We demonstrate how (dis)advantages are generated and reproduced between homogamous and heterogamous couples and how the patterns change over cohorts. For the oldest cohort, educational homogamy is associated with lower attainment for the next generation than heterogamy at the bottom of the educational distribution but higher attainment at the top. Since homogamous couples are more likely to have children, the (dis)advantages at the extreme ends are more likely to be reproduced. Over cohorts, the magnitude of the penalties increased at the bottom, whereas the benefits declined at the top. Moreover, the fertility advantage of homogamous couples evaporated for the highly educated, leading to only the disadvantages at the lower ends being more likely to be transmitted to the next generation.

The rest of the paper is structured as follows. In the literature review, we first review studies on the trends of assortative mating in the U.S. concerning two aspects: 1) how the degree of educational homogamy changes over time; and 2) within educational heterogamy, how educational hypergamy loses its dominant position to hypogamy over time. Then, we review studies focusing on the consequences of increasing homogamy and different mating patterns from the following perspectives: 1) the family structure or compositional perspective; 2) the family milieu perspective and its derivative, the gender dynamic perspective. Studies following

these perspectives demonstrate two sources that generate differences between homogamous and heterogamous marriages: 1) the resources combination of couples; 2) the interaction and dynamics between couples. Next, we turn to two paradigms in studying intergenerational transmission: the "retrospective approach" and the "prospective approach," and we illustrate how previous studies adopt these two approaches to examine the role of assortative mating in intergenerational transmission. Our approach follows the "prospective approach" and develops the previous one-sided model into a two-sided model. We derive hypotheses based on the two sources that drive the outcomes. Then, we introduce our approach and data. We present the results and discuss the significance and limitations of the findings in the subsequent sections.

Literature Review

Assortative Mating and Its Trends in the U.S.

The trend and variations of assortative mating over time have been extensively studied during the last few decades (Blossfeld, 2009; Schwartz, 2013). Studies suggest that marriage sorting on achieved characteristics, such as education and income, is growing, whereas sorting on ascribed characteristics, such as race and parental class status, is decreasing, which is consistent with the predictions of modernization theory (Kalmijn, 1991a, b; Rosenfeld, 2008; Rosenfeld & Thomas, 2012).

Stratification studies view the extent to which people form families within the same educational level as an indicator of the openness of society and the rigidity of boundaries between social groups (Glass, 1954; Kalmijn, 1998). Though there is a strong resemblance between spouses in the U.S., the empirical findings concerning the changes over time are inconsistent depending on measurements and samples. Mare (1991) reported that educational homogamy increased between the 1930s and 1970s, then stabilized or declined in the 1980s. However, Kalmijn

(1991a, 1991b) concluded that educational homogamy steadily increased during the same period. Findings of an increasing trend in the 1980s were also reported by Qian (1998). Later, Schwartz and Mare (2005) found that educational homogamy declined between 1940 and 1960 and increased from 1960 to 2003. Increasing educational homogamy during the late 20th century was also reported by Hou and Myles (2008). Contrary to all these studies, Rosenfeld (2008) concluded that educational homogamy in the US had been stable over the 20th century (see also Raymo & Xie, 2000). Besides the average association between spouses' education, studies also pointed out that education homogamy was mainly generated at the top and bottom ends of the educational distribution (Schwartz & Mare, 2005), as groups at the extreme ends are more closed than others, and college-graduates, in particular, became less likely to marry downwards over time (Mare, 1991; Kalmijn, 1991a).

While educational homogamy attracts attention as a measure of social stratification, another strand of studies highlights the changes in educational heterogamy to capture the development of gender equity and ideological progress. Since the 1940s, steady growth in females' educational attainment has been observed in the U.S., and the college completion rates for women surpassed men in the mid-1980s among whites (Buchmann & DiPrete, 2006; McDaniel, DiPrete, Buchmann, & Schwed, 2011). As for African Americans, women have long held an advantage over men in college completion since the 1940s (Cross, 1999; McDaniel et al., 2011). There were also changes in the norms and preferences for mating. The male-dominated breadwinner-homemaker ideal type prevailed in the 1950s and early 1960s. However, in more recent periods, people prefer more egalitarian mating patterns and exhibit a declining aversion to female-dominated relationships (Gerson, 2010; Van Bavel et al., 2018). As a consequence of the reversed gender gap in education and/or changes in mating preferences (Xie, Cheng, & Zhou, 2015; Grow & Bavel, 2015), educational heterogamy reversed from a tendency for

hypergamy to a tendency for hypogamy. When couples are at different educational levels, it is more common for the wife to be the more advantaged than the opposite (Schwartz & Mare, 2005; Qian, 2017).

Assortative Mating and Its Consequences

Previous studies have analyzed the consequences of assortative mating from two main perspectives: 1) the family structure or compositional perspective; 2) the family milieu perspective and its derivative—the gender dynamic perspective. These are associated with two sources that generate differences between homogamous and heterogamous marriages: 1) the resource combination of couples; 2) the interaction and dynamics between couples.

From the family structure or compositional perspective, assortative mating determines the combinations of parental education, income, socioeconomic status, and other traits in the family. The degree of assortative mating on a specific trait will shape its distribution at the family level in society. Scholars argue that homogamy of education, earnings, income, and others can contribute to aggregate inequality (Schwartz & Mare, 2005; Torche, 2010; Schwartz, 2010). The growing resemblance between couples indicates the concentration and polarization of (dis)advantages, leading to more inequalities between households. As for educational homogamy, assortative mating determines the distribution of educational resources in the family, which is important for the achievement of the next generation (Mare, 1991). When two parties form a new family, they pool together not only the resources that stem from their own education but also the resources from their family origins, such as those derived from their parents (Chan & Boliver, 2013; Song & Mare, 2017; Choi et al., 2020) and extended family members (Jæger, 2012; Erola et al., 2018). Thus, by matching people with the same education, educational homogamy determines the total educational resources that are available for the

next generation. While resources that are beneficial for educational attainment are concentrated in families with highly educated homogamous parents, resources that are detrimental to educational attainment are concentrated in families where both parents are less educated. Furthermore, taking education as an indicator of earnings potential, previous studies empirically tested whether more educational homogamy has resulted in more inequalities in household earnings. Evidence indicates that increasing educational homogamy has not necessarily translated into growing household inequality (Western et al., 2008; Breen & Salazar, 2011).[11] It depends on the degree of educational homogamy (Rosenfeld, 2008) and the interplay between educational attainment and labor force participation (Breen & Andersen, 2012). Several studies also suggested that growing educational homogamy should bear implications for inequality in education and intergenerational transmission as well, as the combinations of parents' education determine the family background where the children grow up (Mare, 2006; Schwartz, 2013). However, empirical evidence is sparse, with few exceptions, reaching conflicting conclusions on whether the strengthening correlation of parental education can increase the educational inequality of the next generation (see Kremer, 1997 for the U.S.; and Bratsberg et al., 2018 for Norway).[12] In sum, from the family structure or compositional perspective, the resources the two parties bring into their unions drive the difference between homogamous and heterogamous marriages.

The family milieu perspective understands the consequences of assortative mating by examining the social-psychological properties of the family. It emphasizes the distinction

[11] Opposite evidence is reported in Greenwood, Guner, Kocharkov and Santos (2014) that educational assortative mating increases inequality measured as Gini coefficient from 0.34 under the counterfactual random mating scenario to the 0.43 observed scenario in 2005.

[12] Kremer (1997) calibrated data from PSID (up to 1988) with models and demonstrated that if the correlation between spouses' education increased from 0.6 to 0.8, the standard deviation of education in the next generation would only grow by 1 per cent (or three days). However, Bratsberg et al. (2018) reported that the decline in assortative mating in Norway has contributed to a decline in offspring inequality.

between marrying with alike (homogamy) and marrying with different (heterogamy). These two types of mating result in substantial differences in the family atmosphere and environment, affecting both adults and children in the households. First, social exchange theory (Emerson, 1972) has led scholars to argue that homogamy creates positive dynamics between couples to be interdependent and exchange benefits in the long term, resulting in higher relationship quality and stability than heterogamy (Lewis & Spanier, 1979). Empirical studies find that educationally homogamous couples have a lower risk of marriage dissolution (Grow et al., 2017; Bavel et al., 2018), and their relative marital stability increased over cohorts (Schwartz & Han, 2014). Moreover, the attractions between people with similar values, tastes, and lifestyles have often been mentioned as a cause for the strong tendency towards educational homogamy (Mare, 1991; Kalmijn, 1998). These similarities are argued to facilitate couples' daily interactions and promote relationship satisfaction. Similarities in tastes and lifestyles lead to more joint activities and time spent together by couples, reducing conflicts (Surra & Longstreth, 1990) and increasing relationship satisfaction (Wilson & Cousins, 2003). Couples who share more agreement on, for instance, family and gender-oriented values have higher marital satisfaction (Gaunt, 2006). Second, as for the children in the household, educational homogamy is expected to benefit children's development as it brings advantageous social-psychological properties to the family. Rauscher (2020) suggested that homogamous couples have lower stress levels, which is beneficial for infant health. Shared values and better agreement in parenting practices make them more effective in educating and socializing the next generation (Van Bakel & Riksen-Walraven, 2002; Beck & González-Sancho, 2009; Edwards & Roff, 2016). From the family milieu perspective, education homogamy is superior to heterogamy for both adults and children in the family.

Finally, the gender dynamic perspective, as a derivative of the family milieu perspective, stresses the power relations between couples. Like the family milieu perspective, it focuses on comparing homogamy, the power symmetry pattern, and heterogamy, the power asymmetry pattern. It extends the family milieu perspective by paying special attention to which gender is the dominant party within the power asymmetry patterns. It implies that hypergamy, the traditional male-dominated mating pattern, and hypogamy, the historically non-normative female-dominated mating pattern, should lead to different outcomes. Once the prevailing pattern, the hypergamous union fits the specialization model coined by Becker (1991) and is argued to maximize the utility of marriage. It is argued that hypergamous unions enjoy contextual benefits as the paradigm of the ideal pattern. Some empirical studies find that hypergamous unions where the male partner earns more report higher life satisfaction for both partners than dual-earner couples (Stutzer & Frey, 2006; Keizer & Komter, 2015). On the contrary, as a historically non-normative pattern, hypogamous unions are suspected to lead to negative marital outcomes. Inconsistence in couples' status that favors women is argued to increase stress, tension, and conflicts, leading to a higher likelihood of emotional abuse towards women (Kaukinen, 2004), intimate partner violence (Behrman, 2019), and union dissolution (Kalmijn, 2003; Goldstein & Harknett, 2006; Blossfeld, 2009). Moreover, the economic burden faced by female breadwinners is related to a higher level of depression among women in hypogamous unions (Potarca & Rossier, 2022). However, as women's education and employment status improve, the relative advantage of women's status in partnerships is argued to benefit children's development as mothers gain more control over the family resource allocation and decision-making. Some early work suggested that the discrepancy in parents' educational achievements, especially the mothers outranking the fathers, is a significant source of high aspirations in children's achievement (Krauss, 1964; Sewell & Shah, 1968). Studies also indicate that the relative higher achievement of mothers than fathers benefits children's

health outcomes, but the conclusions vary by context (Behrman, 2020; Pesando, 2021b). Moreover, there are other outcomes, for instance, couples' fertility rates, where hypergamy and hypogamy are expected to demonstrate distinctions. However, the empirical findings are far from conclusive.[13] In sum, according to the gender dynamic perspective, hypogamy tends to be associated with negative outcomes as a non-normative type of heterogamy. However, the negative influences might attenuate over time as hypogamy becomes more common: indeed Schwartz and Han (2014) showed that the previously negative association between hypergamy and divorce disappeared in recent cohorts.

Taken together, studies from the family structure or compositional perspective focus on the resources the two parties bring into their unions. Studies following the family milieu or gender dynamic perspectives emphasize the interaction and atmosphere between couples. However, when examining the consequences of parental assortative mating on the attainment of the next generation, previous studies either account for only one factor or choose not to distinguish between them.

Assortative Mating and Intergenerational Transmission

The intergenerational transmission of educational attainment has been a central concern of stratification research. Two approaches have guided the studies in the field: the "retrospective approach" and the "prospective approach." Previous studies on the consequences of parental assortative mating for the attainment of the next generation also follow these two paradigms.

[13] Trimarchi and Van Bavel (2017) and Nitsche, Matysiak, Van Bavel, and Vignoli (2018) empirically tested whether and how parents' educational pairings are associated with couples' fertility in European countries. Trimarchi and Van Bavel (2017) found that hypergamous couples have higher second and third birth rates than hypogamous couples but do not statistically differ from highly educated homogamous couples. However, Nitsche et al. (2018) established that hypergamous couples have the lowest second-birth transition rate.

The "retrospective approach" uses a sample of the child generation and compares their educational attainment with their parents. Retrospective studies focus on the extent to which parents' education can explain a child's educational attainment. For decades, studies that adopted the retrospective approach have examined the intergenerational association in attainment (e.g., Breen & Johnsson, 2005) and how the strength of the association changed overtime (Shavit & Blossfeld, 1993; Hertz et al., 2007) and in different countries (Chevalier, Denny, & McMahon, 2003; Pfeffer, 2008; Burger, 2016). Though the model specification of this approach is straightforward, as the attainment of the children is a function of their parents' attainment, there are different views on how to treat the status of both parents. Some earlier works considered only one side of the parent, usually the father, others adopted the "dominance" model (McDonald, 1977; Erikson, 1984), in which the family context is mainly determined by the status of the higher status parent. Some studies chose to rely on the "one-sex or sex-role" model, claiming that sons and daughters are more influenced by the parents of the same sex (Acock & Yang, 1984; Boyd, 1989). As women's education and employment status have improved, scholars suggest that the educational attainments of both parents are important (Beller, 2009), and both should be included in the model to estimate the independent influences of mothers and fathers.

The "retrospective approach" has attracted criticism for two reasons. First, child generation sampling results in a non-representative parental generation (Duncan, 1966). The analyses are restricted to those with children and might oversample parents with multiple offspring while necessarily excluding those who never had children. It neglects the critical interplay between education and fertility of the parental generation, which decides whether there is a child generation in the first place. Second, by taking the parents' education as given, it also neglects the family formation process, which shapes the family context where the children grow up. The

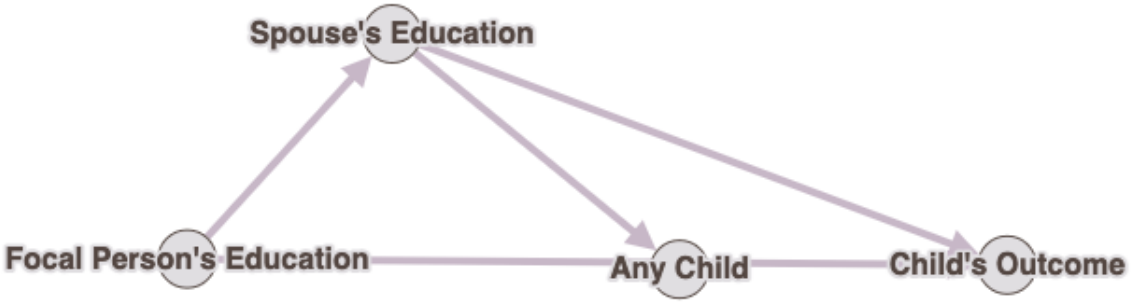
education of a potential parent affects his/her chance of every marrying and the educational attainment of his/her spouse. As reviewed earlier, the combination of the parents' attainment will be important in deciding their relationship stability, fertility, parenting practices, and other factors that can affect the transmission of outcomes. The "retrospective approach" focuses only on the final stage of intergenerational transmission but neglects the important demographic processes determining whether a second-generation exits and what resources have been matched via assortative mating.

When studying assortative mating, most previous studies adopted the "retrospective approach" to examine the relationship between assortative mating and outcomes of interest. As presented in Equation 4.1, x_1 and x_2 represent mothers' and fathers' education respectively. Previous studies include x_3, a categorical variable representing the patterns of assortative mating, that is, homogamy, hypergamy, hypogamy, or an interaction term between x_1 and x_2 to capture the effect of assortative mating. β_3 is claimed to be the separate effect of assortative mating over and above the partners' own education. Previous studies adopting this approach usually follow the family milieu or gender dynamic perspectives. As displayed in Figure 4.1 Graph A, among the two sources that generate the differences between mating patterns, they take the combination of parental education as given and consider only the portion driven by the family milieu.

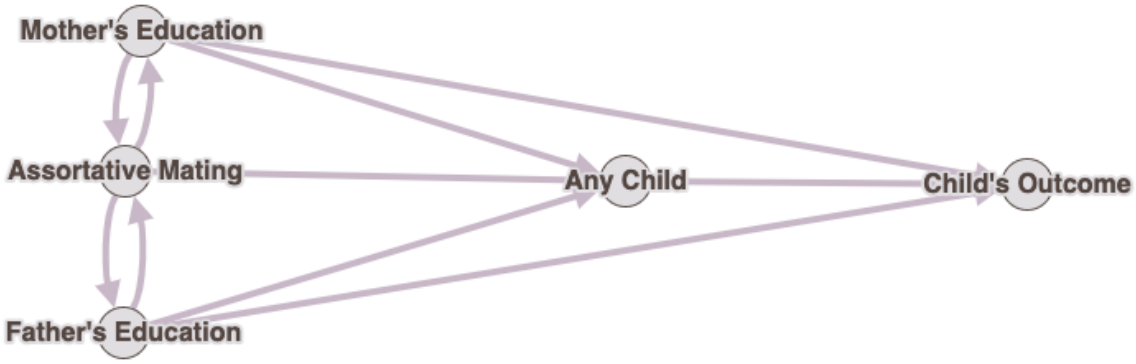
$$y = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \varepsilon \quad (4.1)$$



A. Retrospective Model



B. One-side Prospective Model



C. Two-Side Prospective Model

Figure 4.1 Graphic Illustration of: A. Retrospective Model; B. One-side Prospective Model; C. Two-Side Prospective Model

As for the "prospective approach," though the importance of considering the dynamic demographic process in intergenerational transmission has long been recognized (Duncan 1966), it was only recently that empirical studies started formally developing the "prospective approach" (e.g., Mare & Maralani, 2006; Mare, 2011; Kye & Mare, 2012; Maralani, 2013;

Lawrence & Breen, 2016; Breen & Ermisch, 2017). In contrast with the "retrospective approach," the sampling strategy of the "prospective approach" is to follow a cohort of potential parents and observe whether and how they marry and produce the next generation. It enables us to see a more complete picture of the intergenerational reproduction process by including the demographic processes ignored by the conventional retrospective approach. For example, Mare and Maralani (2006) first suggested that the overall effects of increasing women's educational attainment on the educational attainment of the next generation in Indonesia depend on two mechanisms. A woman's high educational attainment can enhance her children's chances of attaining a better education via assortative mating with someone with high education. However, it is offset by the low fertility rate of highly educated women. Likewise, Lawrence and Breen (2016) found that obtaining a college degree increases male graduates' probability of having a child who also completes college. However, it did not affect a woman's probability of having a child who also graduated from college in the U.S because they were less likely to marry and less likely to have children. Maralani (2013) found that the differential strength of "parent-child" educational associations between white and African American women is driven by their differential fertility and assortative mating patterns: while assortative mating amplifies the chance of having a highly-educated daughter for white women, it has a weaker effect for African American women. These and other pioneering works employing the "prospective approach" have revealed a more complex picture of intergenerational transmission of educational attainment by considering the demographic pathways, especially for women.

When studying assortative mating, studies that adopt the "prospective" approach decompose the total effect of one parent's education into the direct effect of his/her education and the indirect effect through his/her spouse's education (Mare & Maralani, 2006; Kye & Mare, 2012;

Lawrence & Breen, 2016), as shown in Figure 4.1 Graph B. This model relies on a one-sided approach by assuming that a focal person's education determines his/her spouse's attainment. Consequently, previous prospective studies frequently estimate the effect of assortative mating, if they did, for one-sex only, that is, from mothers to daughters, or they treat the female and male samples of the parental generation separately. However, assortative mating is a mutual process. A potential father matches with a potential mother via assortative mating, which also applies to a potential mother. As presented in Figure 1 Graph C, forming a family is a two-way joint process. In this study, we go a step further and develop the previous one-sided prospective model into a two-sided model. Our approach starts with one potential parent, say, the husband. As in the one-sided model, we treat the wife's attainment as the reward for the husband's own attainment via assortative mating. This corresponds to the family structure perspective and considers the effect of marital sorting that derives from the resource combination of couples. After the union is formed, both spouses' attainments jointly determine whether the couple has any children and the child's attainment. This corresponds to the family milieu perspective and considers the effect of the interaction and atmosphere between couples. We estimate the effect for the father and the mother, respectively, and then take the average as the overall effect. The benefit of doing this is that we take into account the two sources that generate the differences between mating patterns and distinguishes their contributions to the outcome. Moreover, using the two-sided model, we extend previous findings from the "prospective approach" to the couple-level and answer the question of how the intergenerational transmission process, that is, from having the next generation to the attainment of the next generation, differs according to couples' mating patterns. In this study, the focus is on the difference between homogamy and heterogamy.

Hypotheses

Based on the above, following the "prospective approach" and using the two-sided model developed, in this study, we examine how couples' mating patterns shape their intergenerational transmission process. We first ask what is the difference between homogamous and heterogamous couples in terms of their chances of having the next generation; second, given that they have children, what is the difference between homogamous and heterogamous couples in their children's educational attainment? Our approach considers and distinguishes the two sources—resource combination and family milieu—that generate the difference between homogamy and heterogamy. We derive hypotheses by considering these two sources, respectively. Furthermore, as previously discussed, the pattern of assortative mating has evolved in the U.S., therefore, we also consider how the outcome of assortative mating might change over time.

From the family milieu perspective, for the relationship between mating and having any child, homogamous couples are believed to have more shared ideologies and attitudes, which should benefit their childbearing decision-making (Nitsche et al., 2018). As reviewed, the similarity between couples can improve their relationship satisfaction and marital stability, which should also promote their fertility. Sporadic studies do find evidence supporting this argument (Huber & Fieder, 2011). Educational homogamy is viewed as a more egalitarian setting and a more suitable arrangement for having children than a gender-specialized household setting (Oppenheimer, 1997). Shared egalitarian ideologies among couples favor an equal division of household labor (Nitsche & Grunow, 2016), which should also promote the couple's fertility. However, empirical evidence has pointed out that such an egalitarian ideology is determined not only by the relative educational attainment of the couples but also by their absolute education, with higher education being associated with more egalitarian views. For instance,

England and Srivastava (2013) found that fathers' child care time is affected more by the mother's education level than their own education level, leading highly educated homogamous parents to spend more time in child care compared to others. Likewise, Bonke and Esping-Andersen (2011) report that educational homogamy is associated with more intense and egalitarian parenting only at the top of the educational distribution. It is associated with less and more gendered childcare at the lower end of the educational distribution. Thus, we would expect that if education homogamy increases a couple's chance of having children via the egalitarian family milieu, its effect is more likely to be found in the highly educated group. Moreover, over cohorts, as women attain higher education and socioeconomic status, they face increasing "opportunity costs" of childbearing. The family environment and parenting arrangement would weigh more in their childbearing decision-making. Thus, we would expect the family milieu effect of homogamy to become more important over time.

H1: Compared to heterogamous couples, the family milieu created by homogamous couples increases their likelihood of having children. The effect should be more salient among the highly educated group and should increase over cohorts.

Second, from the resource combination perspective, the influence of couples' education on their chance of having children would come from the combination of the independent effects of men's and women's education. As documented in the literature, educational attainment has a positive relationship with having children among men with the better-educated more likely to become fathers (Kravdal & Rindfuss, 2008; Nisén, Martikainen, Kaprio, & Silventoinen, 2013). Among women, the reverse is true. Women with higher levels of education are consistently found to remain childless than their less-educated counterparts (Nisén, Myrskylä, Silventoinen, & Martikainen, 2014; Wood, Neels, & Kil, 2014). At the couple level, we would

expect the combined impact of men's and women's education on having children to cancel out, resulting in no difference between homogamy and heterogamy. For instance, for highly educated homogamous couples, when compared to hypergamous couples, where only men have high education, homogamous couples should demonstrate a lower likelihood of childbearing due to the higher attainment of women in the unions. Compared to hypogamous couples where only women have high education, homogamous couples should demonstrate a higher likelihood of childbearing due to the higher attainment of men in the unions. Thus, when compared with the heterogamous group on average, the combined education of couples should lead to no difference in the chance of having children between homogamous and heterogamous couples.

H2: Compared to heterogamous couples, the combined education of couples should create no difference with homogamous couples in the chance of having the next generation.

As for the educational attainment of the children, from the family milieu perspective, we expect that the homogamous couples' family environment and atmosphere will be more beneficial for children's education than heterogamous couples. Compared to heterogamous couples, they are expected to create a more stable and beneficial family environment for their children, which should increase their children's educational achievement. Moreover, as this benefit of homogamy derives from its nature of similarity, we would expect that its influence should remain stable over time.

H3: Compared to heterogamous couples, the family milieu created by homogamous couples should benefit their children's education, and its influence should remain stable over time.

Second, from the resource combination perspective, we would expect heterogeneous scenarios across the educational distribution because the quantity and quality of the resources that the two sides bring into the family vary. Beneficial educational resources are concentrated in families with highly educated homogamous parents; thus, their children should have higher achievements than those from heterogamous families with only one highly educated parent. Resources detrimental to educational attainment are concentrated in families with two less educated parents; thus, their children would have lower achievements than those from heterogamous families with only one lower educated parent. In the middle of the educational distribution, for instance, at the high school level, the heterogamous group consists of couples where one with a high school degree and the other with a degree lower or higher than high school, whereas homogamous couples both have high school degrees. Assuming that there is no disproportional upward or downward tendency in forming heterogamous unions at this level, the average combined resources of the heterogamous group as a whole should be comparable to the homogamous group.

Over time, how the magnitude of educational gaps in children, created by the discrepancies in educational resources between homogamous and heterogamous groups, change will depend on how the intergenerational influence of parental education changes over time. If parental education becomes more important in shaping children's educational attainment, we would expect a growing educational gaps in the next generation. Empirical evidence on the intergenerational association of education over time in the U.S. has been inconclusive. Most studies have reported stability in intergenerational educational associations over most of the 20th century (Mare, 1993; Hout & Dohan, 1996; Pfeffer, 2008; Bloome & Western, 2011; Pfeffer & Hertel, 2015). However, evidence for temporal changes has also been recorded. For instance, Roksa, Grodsky, Arum, and Gamoran (2007) found an increasing influence of

parental education on college attainment in the late 20th century. Furthermore, Buchmann and DiPrete (2006) found it increased in particular for the father-son association. In contrast, Belley and Lochner (2007) reported a declining influence of maternal education on higher educational attainment. Therefore, we do not form a specific hypothesis regarding how the influence of the combined education of parents on children's attainment changes over time.

H4: Compared to children of heterogamous parents, children of homogamous parents at the top of the educational distribution achieve more education; children of homogamous parents at the bottom of the educational distribution achieve less education; and children of homogamous parents in the middle of the educational distribution achieve comparable education to the children of heterogamous parents.

Method

We estimate the consequences of assortative mating for a generation of potential parents for whether they have children and the educational achievement of those children. Our two outcomes of interest are C, whether the couple has a child, and Y, the educational attainment of the child. In this section, we illustrate our models using the outcome Y, though the same approach is applied to both C and Y. Though we use the word "effect" in the study, we do not make causal claims for our estimates. Our approach can be used for causal inference only if the assumption of no unmeasured confounders holds.

Following the "prospective approach," we treat the spouse's attainment as the reward for the potential parent's own education via assortative mating and estimate the difference between marrying a spouse with the same attainment and marrying a spouse with different attainment. By doing so, we capture both the effect of homogamy that stems from the combined

educational resources of the couples and the effect that stems from the family milieu created by the couple net of their educational resources.

We start with the separate effects for fathers and mothers. Let *i* indexes respondents, *j* father's educational category, and *k* mother's educational category. Define $h(f)_{j=J}$ as the homogamy effect for fathers with educational level J. We write this as,

$$h(f)_{j=J} = E\left(Y_{j=J,k=J}\right) - \frac{\sum_k E(Y_{j=J,k\neq J}) n_{j=J,k\neq J}}{\sum_k n_{j=J,k\neq J}} \quad (4.2)$$

where n_{jk} is the number of respondents with father's educational level *j* and mother's educational level *k*. The homogamy effect for fathers is captured as the difference between the average outcome for couples both with education j, and the average outcome for couples where only the father (but not the mother) has education at level *j*. The homogamy effect for fathers combines several ways in which homogamous fathers differ from heterogamous fathers. First, they differ in the education of their spouse. Second, they also differ in the resources that come from the spouse's family of origin. Both spouse's education and family background are the resources fathers matched via assortative mating. Third, they differ in the family milieu created by the couple.

We obtain the estimates of $h(f)_{j=J}$ with OLS regressions. By controlling different sets of covariates, we distinguish the homogamy effects stemming from different sources. As presented in Table 4.1, we first control the characteristics of the adult children (G3) including their age, gender, and the number of siblings. We also control the characteristics of parents (G2) including their year of birth, age at marriage, the order of marriage, and racial identity. Finally, we also control fathers(G2)' family background represented by the educational

attainment of both his parents (G1)[14]. This yields the estimate $h_1(f)_{j=J}$ (Homogamy Effect) that contains the above-mentioned three sources that generate the differences between homogamy and heterogamy. Second, we further control for the mother's education and her family background, which yields the estimate $h_2(f)_{j=J}$ capturing the effect of homogamy that stems only from the family milieu. The difference between $h_1(f)_{j=J}$ and $h_2(f)_{j=J}$ captures the effect of homogamy that stems from the pooling of resources via assortative mating.

Table 4.1 Details of the Fitted Models for the Homogamy Effect on Child's Education for Fathers

Model	Control Variables	Effect Estimated Includes
$\boldsymbol{h_1(f)_{j=J}}$ **Homogamy Effect**	Adult children's Characteristics[a] Father's Characteristics[b] Mother's Characteristics[b] Father's Family Background	• Mother's Education • Mother's Family Background • Family Milieu
$\boldsymbol{h_2(f)_{j=J}}$ **Family Milieu**	Adult children's Characteristics[a] Father's Characteristics[b] Mother's Characteristics[b] Father's Family Background Mother's Family Background Mother's Education	• Family Milieu
$\boldsymbol{h_1(f)_{j=J} - h_2(f)_{j=J}}$ **Resource Pooling**		• Mother's Education • Mother's Family Background

Note: a. Covariates measuring the characteristics of adult children including their age, gender, and the number of siblings; b. Covariates measuring the characteristics of the father and the mother (G2) including their years of birth, age at marriage, order of marriage, and racial identity.

[14] The information of grandparents (G1) is obtained following the practice in Song and Mare (2017). If the grandparents are also PSID sample members we use the information from their PSID individual files. If not, the information on grandparents is obtained via retrospective information from the family interview of household heads and their partners (G2). We also perform multiple imputation for grandparents' education to reduce the loss of cases due to missing data.

Similarly, we can write the expression for the mother, $h(m)_{k=J}$ as,

$$h(m)_{k=J} = E\left(Y_{j=J,k=J}\right) - \frac{\sum_k E(Y_{k=J,j\neq J})n_{k=J,j\neq J}}{\sum_k n_{k=J,j\neq J}} \quad (4.3)$$

The same set of control variables for the mother was used when estimating the homogamy effect for mothers. Estimating the homogamy effect for fathers and mothers separately allows us to control for the confounders of each. As illustrated in Figure 4.2, from the mother's perspective, the father's family background is the reward of her assortative mating for the attainment of the next generation, however, her own family background is a potential confounder. From the father's perspective, the mother's family background is the reward of assortative mating, however, his own family background is the potential confounder. Thus, by estimating the effect separately for fathers and mothers, we can tease out the corresponding confounders but retain the effect from the combined family resources.

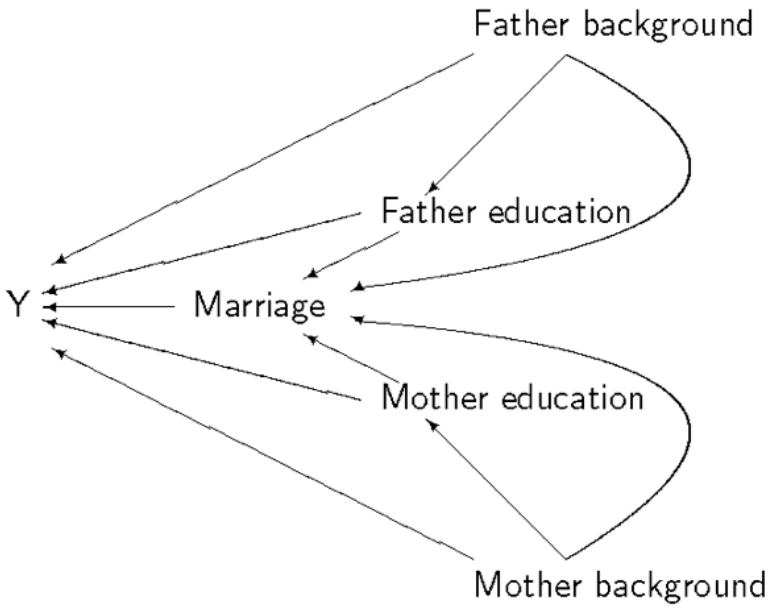


Figure 4.2 Graphical Illustration of the Homogamy Effect on Child's Education

Then taking the average of the father's effect, $h(f)_{j=J}$, and the mother's effect, $h(m)_{k=J}$, the overall homogamy effect for educational category j is,

$$h_{j=J} = \frac{h(f)_{j=J} + h(m)_{k=J}}{2} \quad (4.4)^{15}$$

We estimate the effect at each education level to capture the potential heterogeneity across the educational distribution. As suggested in Hypotheses 1 and 4, the associations between homogamy and the outcomes are likely to vary across educational levels. Nevertheless, we can calculate the overall homogamy effect by taking the weighted average across all levels of education:

$$h = \frac{\sum_j h_j n_{j=k}}{\sum_j n_{j=k}} \quad (4.5)$$

Data, Analytic Sample, and Measurements

We used the Panel Survey of Income Dynamics (PSID) data from 1968 to 2019. PSID provides representative longitudinal data on U.S. individuals and families. The longitudinal design allows us to follow sample individuals to ascertain whether they ever had a partner or a child. We can reconstruct their complete mating and fertility histories, allowing us to consider divorce, remarriage, and multiple childbearing. Furthermore, whereas many other household surveys only collect information on children living with their parents at the time of the interview, PSID is designed to follow all the sample members residing in the PSID families in 1968 and anyone subsequently born to or adopted by a sample member. Thus, PSID provides information on the

[15] Standard errors for $h_{j=J}$ are obtained with the delta method (Turner & Rockel, 1988).

complete education of the child generation, regardless of their residence status with their parents.

We follow the original sample members from the first 1968 wave of PSID to the latest available 2019 wave and construct a "Person-Partner-Child" panel to record every individual's mating and fertility history.[16] We retrieved mating and fertility histories from the PSID Marriage History File and Childbirth History File and used the PSID Family Identification Mapping System (FIMS) to identify biological parent-child relationships. Sample members could have multiple entries in the "Person-Partner-Child" panel if they had more than one partner or childbearing record, for example, one child with the first partner and two children with the second partner. In this case, the sample member would have three records in our "Person-Partner-Child" panel containing the information for each relationship. We also include the "Person-Child" relationship, where the partner's information is not observed, and the "Person-Partner" relationship, where no childbearing record is observed for the couple. Individuals who have no partnership or childbearing records can also be identified in the panel. The "Person-Partner-Child" panel considers the consequences of assortative mating following the prospective approach. We select two analytical samples from the "Person-Partner-Child" panel to examine whether assortative mating is associated with having any offspring and how it is associated with children's attainment.

Analytic Sample

Following the practice in Maralani (2013), we follow respondents aged 0–49 in 1968 and divide them into three birth cohorts: participants in cohort 1 are born in 1919–38, aged 30–49

[16] The original core sample of the 1968 wave was drawn from the Survey of Economic Opportunity (the SEO sample) and the nationally representative Social Research Center sample (SRC sample). We exclude the Latino and immigrant samples that entered the PSID survey only since the 1990s.

in 1968; participants in cohort 2 are born in 1939–53, aged 15–29 in 1968; and participants in cohort 3 are born in 1954–68, aged 0–14 in 1968. These are our second generation, G2; their parents are G1 and their children are G3. The individual weight from the 1968 wave is applied to all the analyses to reduce biases from differential sampling fractions and non-response rates.[17] We follow the G2 respondents over time and form two samples to answer different research questions. Table 2 provides the number of cases at each step of the sample selection process. Among the respondents in the initial 1968 wave (numbers are shown in the first column of the table), we first select those with partner records regardless of their childbearing conditions in the last three columns of Table 4.2. They constitute the "Homogamy-Fertility" sample for analyzing whether educational homogamy influences couples' chances of having a child. Second, we choose a "Homogamy-Education" sample, which includes those with partner record(s) and children aged 25 or above in 2019 (last column in Table 1). The threshold of 25 is set to ensure that the child generation has completed education. As depicted in Table 2, for the youngest cohort aged 0–14 in 1968, most of their offspring were under 25 in 2019. Considering that children born to members of this cohort, especially those with more education, are relatively young in 2019, the 25-year-old cut-off point may lead to some selection bias. Therefore, we focus on the first two cohorts when presenting the results. Results for Cohort 3 are provided in the Appendix. The sample for Cohort 1 contains 1,953 respondents with 7,066 "Person-Partner-Child" records, and the sample for Cohort 2 contains 2,077 respondents with 6,704 "Person-Partner-Child" records. Cohort 3 contains 1,788 respondents with 5,797 records. As both samples are in hierarchical formats, we obtain estimates from regressions with clustered standard errors to correct the correlations of observations from the same person.

[17] The core sample of the 1968 wave contains two parts. There is an over-sample of low-income families from the SEO sample and a nationally representative SRC sample. The individual 1968 weights are constructed based on the family-level weight, which, according to the 1968 file description (https://psidonline.isr.umich.edu/Data/Documentation/pdf_doc/psid68w1.pdf), "*was done taking both samples into consideration, so that all interviews can be analyzed as one representative national cross-section sample when weighted*."

Table 4.2 The Number of Respondents at Each Step of the Sample Selection Process

	PSID 1968 Wave	**Without the Info of the Partner**		**With the Info of the Partner**		
		No Child Info	With Child(ren)	No Child Info	With Child(ren)	
					<=25 in 2019	>25 in 2019
Cohort 1 (1919-1938)	3,828	175	438	466	1,041	1,953
Cohort 2 (1939-1953)	4,590	158	323	536	1,384	2,077
Cohort 3 (1954-1968)	6,978	227	546	710	4,143	1,788

Note: The sums of the last five columns does not necessarily equal the number of initial respondents in the 1968 wave in the second column, because one respondent may contribute multiple records in various scenarios. For instance, one may have one child under 25 and one older than 25 in 2019; and, one may have no child with one partner but have three children with the other partner.

Measurements

Parental educational attainment is measured as the *highest grade or year of school the individual has completed*. It is collected in every wave of the survey. We use the latest available value during the 1968–2019 survey period. Parental attainments are converted into five categories: less than ten years (no high school education), 10–11 years (some high school education), 12 years (high school completed), 13–15 years (some college or relevant), and more than 15 years (college completion and above).

For the first analysis, the outcome variable, *C* is whether the couple has any children (Yes = 1; No = 0). Control variables include parents' racial identity[18], year of birth, age at marriage, the order of marriages, and parental educational attainments (G1). In the second analysis, the outcome variable is *Y*, the educational attainment of the children (G3). Control variables are added in the manner illustrated in Table 1 to distinguish different sources of the homogamy effect. Descriptive statistics for variables in the "Homogamy-Education" sample are shown in Appendix Table A4.1. As shown, among respondents who became parents (G2), the average number of marriages increased over cohorts, while the average number of children per couple decreased. Over cohorts, the proportion of parents with the lowest educational attainment decreased, while the proportion of parents with the highest attainment increased.

Results

Homogamy and Parenthood

We first use the proposed approach and the "Homogamy-Fertility" sample to test whether education homogamy is associated with becoming parents. The results are reported in Table

[18] PSID has collected information on the ethnicity of the household head from 1968 but only from 1985 for the spouse. Those whose ethnicity is missing are assigned that of the household head. There are too few cases of interracial marriage in our sample (N = 57) to conduct a meaningful separate analysis.

4.3. Estimates are obtained with linear probability regressions with clustered standard errors to correct the correlations of multiple observations from the same respondent. We report the homogamy effects at each educational level, followed by the weighted average effects. At each education level, we report three quantities of interest. The "Homogamy Effect" refers to the total effect arising from 1) the combined resources of the couples and 2) the family environment they create. The "Family Milieu" refers to the effect of the family environment after controlling both parties' education and family backgrounds. The difference between these two estimates is that the effect of homogamy that stems from the pooling of educational resources.

For the 1919–1938 cohort (Cohort 1), homogamous couples at every educational level were more likely to become parents than heterogamous couples. The total homogamy effects are positive and statistically significant. Homogamous couples with less than 10 years of education are 2.8% ($p < 0.01$) more likely to become parents than heterogamous couples with only one parent having less than 10 years of education. Homogamous couples with a college education are 2.2% ($p < 0.05$) more likely to become parents than heterogamous couples with only one parent having a college education. On average, the probability of becoming parents for homogamous couples is 1.7% ($p < 0.01$) higher than for heterogamous couples. The total homogamy effects constitute the resource pooling and family milieu effects. After taking both parties' education into account, results indicate that their beneficial family milieu mainly drives the fertility advantage shared by homogamous couples. As predicted in *Hypothesis 1*, above and beyond couples' respective educations, the homogamy effect stemming from the family milieu on becoming parents is positive and statistically significant. The magnitudes of the family milieu effects are larger than the total effects, because the homogamy effects from the pooling of educational resources are negative, though these are all statistically insignificant except for homogamous couples with less than 10 years of education. At the bottom of the

distribution, the pooling of disadvantaged resources leads to a 2.3% ($p < 0.001$) lower chance of having a child. However, the negative influence of resource pooling is compensated by the beneficial family atmosphere and environment shared by couples with the same attainments. The family milieu of homogamous couples leads to a 5.1% ($p < 0.001$) higher chance of having any child. Taken together, the total homogamy effect at the bottom is positive. The family milieu effects on becoming parents dominate the total homogamy effects at other education levels. For instance, at the high school completion level (12 years of education), the combined resources of couples create a statistically insignificant difference between homogamous and heterogamous couples (Hypothesis 2). However, the positive family milieu shared by couples with the same educational attainments increases homogamous couples' chances of having children by 1.4% ($p < 0.05$).

Over cohorts, we found that the fertility advantage shared by homogamous couples was maintained at the bottom end of the educational distribution (i.e., high school completion and below). However, contrary to *Hypothesis 1*, the advantage disapperaed for the highly-educated homogamous couples. Among the 1939–1953 cohort (Cohort 2), the total homogamy effects are positive and statistically significant for high-school or lower attainments. Homogamous couples with less than 10 years of education are 1.6% ($p < 0.01$) more likely to become parents than heterogamous couples. Homogamous couples with some high-school education are 3.3% ($p < 0.01$) more likely to become parents than heterogamous couples. Homogamous couples with completed high-school education are 0.8% ($p < 0.05$) more likely to become parents than heterogamous couples. These fertility advantages shared by homogamous couples are mainly driven by the beneficial family milieu and the resource pooling effects are not statistically significant. At the higher end of the educational distribution, the probability of having a child does not differ between homogamous and heterogamous couples. Neither the family milieu nor

the resource pooling effect of homogamy is statistically significant. The attenuation of the fertility advantage of homogamous couples continued into the 1954–1968 cohort (Cohort 3). As shown in Appendix Table A4.2 (page 163), in Cohort 3, the previously observed high likelihood of becoming parents among homogamous couples disappeared at every educational level. Homogamous couples and heterogamous couples show no differences in their chances of becoming parents.

Table 4.3 Linear Probability Regression Estimates for Homogamy Effects on Selection into Parenthood by Cohorts

Dependent Variable	**Whether the Couple (G2) Has Any Child (1=Yes; 0 = No)**					
Education Levels (G2)	**<10**	**10-11**	**12**	**13-15**	**>15**	**Average**
Cohort 1 (1919–1938)						
Homogamy Effects	.028** (.009)	.033*** (.007)	.012* (.005)	.019* (.009)	.022* (.008)	.017** (.005)
Family Milieu	.051*** (.011)	.037** (.010)	.014* (.006)	.036** (.012)	.040** (.014)	.019** (.005)
Resource Pooling	-.023*** (.006)	-.004 (.007)	-.002 (.006)	-.017 (.008)	-.018 (.011)	-.002 (.005)
N (Homogamy vs. Heterogamy)	1,647/1,553	232/769	1,283/839	208/659	359/590	3,729/4,410
Cohort 2 (1939–1953)						
Homogamy Effects	.016** (.004)	.033** (.006)	.008* (.004)	.001 (.001)	.002 (.003)	.005 (.003)
Family Milieu	.027* (.013)	.039** (.012)	.018* (.007)	.008 (.004)	.004 (.006)	.007 (.003)
Resources Pooling	-.011 (.012)	-.006 (.010)	-.010 (.006)	-.007 (.004)	-.002 (.005)	-.002 (.003)
N (Homogamy vs. Heterogamy)	273/1,441	221/562	1,377/1,218	514/1,092	855/1,044	3,240/5,357

*Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; N refers to the number of observations; Clustered standard errors are in parentheses; Control variables include parents' racial identity, year of birth, age at marriage, the order of marriages, and parental educational attainments*

Homogamy and Child's Attainment

Next, we apply the same approach to the "Homogamy-Education" sample to examine how educational homogamy is associated with children's attainment. Table 4.4 reports the results.

For the 1919–1938 cohort (Cohort 1), educational homogamy is associated with statistically significant differences in children's attainment of homogamous parents compared to heterogamous parents at the extreme ends of educational distribution. At the bottom of the distribution, children of parents with less than 10 years of education have 0.711 years ($p < 0.001$) less education than children of couples where only one parent has less than 10 years of education. At the top, children of parents with a college education have 0.698 years ($p < 0.001$) more education than children of couples where only one parent has a college education. At other educational levels, children of homogamous parents and heterogamous parents do not demonstrate statistically significant differences in educational attainment. Furthermore, after controlling both parents' education, the family milieu does not contribute to the educational differences between homogamous and heterogamous parents in their children's attainment (contrary to the predictions of *Hypothesis 3*). Aligned with *Hypothesis 4*, the educational gaps at the extreme ends are generated by the resource pooling effects of homogamy. Homogamous parents at the lower end of educational distribution bring more disadvantaged resources into the family than heterogamous couples, which harms the attainment of their children. At the top of the distribution, parents combine advantageous attainments and family resources in homogamy and accumulate more beneficial properties than heterogamous parents, which leads to the high achievement of their children.

Over cohorts, we observe an increase in the negative effects of homogamy at the bottom of the educational distribution but a decrease in the positive effects of homogamy at the top. At the

lower end, first, the magnitude of the negative homogamy effects rises for those with less than 10 years of education. For the 1939–1953 cohort (Cohort 2), children of parents with less than 10 years of education have 1.457 years ($p < 0.001$) less education than children of couples where only one parent has less than 10 years of education. Second, the total effects for having some high-school education or high-school completion also turn negative. The resource pooling effects of homogamy mainly drive the growth of disadvantages at the bottom and, for the most disadvantaged group, over cohorts, the resource pooling effect becomes more negative, and the family milieu effect for this group also turns negative. After controlling both parents' attainments, the family environment created by two parents with less than 10 years of education reduces their children's attainment by 0.246 years ($p < 0.05$). At the top of the distribution, we found that the magnitudes of the total homogamy effects decline over cohorts. For Cohort 2, children of parents with a college education have 0.344 years ($p< 0.01$) more education than children of couples where only one parent has a college education. The attenuation of the advantages for such homogamous parents is driven by the negative family milieu effect. The resource pooling effect at the top is positive, and its magnitude increased compared to Cohort 1. However, the family milieu effect of highly-educated homogamous parents turns negative in Cohort 2, leading to a reduction in the total beneficial effect of homogamy at the top. The pattern observed for Cohort 2 was maintained for Cohort 3. As shown in Appendix Table A4.3 (page 163), the negative effects of homogamy at the bottom of the educational distribution grew further for Cohort 3, but the positive effects of homogamy at the top of the educational distribution evaporated with their negative family milieu effect offsetting the advantage of resource pooling at the top.

Table 4.4 Linear Regression Estimates for Homogamy Effects on Child's Education over Cohorts

Dependent Variable	**Year of Education of G3**					
Education Levels (G2)	**<10**	**10-11**	**12**	**13-15**	**>15**	**Average**
Cohort 1 (1919–1938)						
Homogamy Effects	-.711***	-.226	-.109	.327	.698***	-.111
	(.117)	(.187)	(.082)	(.172)	(.123)	(.064)
Family Milieu	.128	.012	-.261	.326	-.276	-.106
	(.173)	(.227)	(.138)	(.214)	(.207)	(.079)
Resource Pooling	-.839***	-.238	.152	.001	.974***	.005
	(.127)	(.129)	(.111)	(.127)	(.166)	(.046)
N (Homogamy vs. Heterogamy)	1,299/1,072	192/404	1,144/1,045	186/831	335/646	3,156/3,337
Cohort 2 (1939–1953)						
Homogamy Effects	-1.457***	-.753**	-.182*	.159	.344**	-.045
	(.170)	(.222)	(.091)	(.145)	(.097)	(.062)
Family Milieu	-.246*	-.314	.210	.099	-.826***	-.260***
	(.199)	(.268)	(.133)	(.178)	(.153)	(.070)
Resource Pooling	-1.211***	-.439**	-.392**	.060	1.170***	.215***
	(.103)	(.150)	(.097)	(.103)	(.118)	(.032)
N (Homogamy vs. Heterogamy)	207/1,089	174/442	1,134/1,061	348/725	661/880	2,524/4,180

*Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; N refers to the number of observations; Clustered standard errors are in parentheses; Control variables are added in the manner illustrated in Table 4.1.*

Conclusion and Discussion

This paper has examined how couples' mating patterns shape their intergenerational transmission process using a new analytical approach. We focused on the difference between homogamous and heterogamous couples in (a) their chances of having children, and (b) the educational attainment of their children.

We argued that differences between homogamous and heterogamous couples arise from two sources—resource combination and family milieu. These have been studied in separate strands of literature, and their relative contributions to an outcome have rarely, if ever, been considered

together. Our results show the value of doing this because, depending on the outcomes concerned, the resources combined through homogamy and the family milieu created by homogamy played different roles. For instance, results for the 1919–1938 cohort (Cohort 1) indicate that while the family milieu arising from homogamy is the driving force for their higher likelihood of having children than heterogamous couples, the resource combination is the driving force that shapes children's educational attainment. Identifying the two sources of the homogamy effect sets up a framework for analyzing the consequences of assortative mating that might be adopted in future studies.

Moreover, in the literature, the possibility that educational homogamy might increase inequality has received a lot of attention (Schwartz & Mare, 2005; Torche, 2010; Schwartz, 2010). This follows the resource combination perspective. The growing resemblance between couples leads to the concentration of (dis)advantages and more inequalities between households. According to our results, among the oldest cohort, educational homogamy does create significant gaps between homogamous and heterogamous families at the extreme ends of the distribution in the educational attainment of the next generation. Here, the combination of resources is the driving force. However, the situation gets more complex over cohorts. If only the overall homogamy effects were estimated, we would conclude that the educational gaps at the bottom enlarged while the gaps at the top diminished over time. However, by breaking down the effects, we see that, over cohorts, the resource combinations of parents exerted an increasing influence at both ends of parental educational distribution, so widening the gap between homogamous and heterogamous families. In addition, the family milieu effect at the extreme ends turns negative over cohorts. It further worsens the situation for the children of less educated homogamous families. Among the highly educated, the negative family milieu effect leads to the disappearance of the overall advantage of homogamy. The benefits of

combined parental resources are cancelled out by the family milieu effect, which has turned negative over time. Therefore, considering either source solely or only estimating the overall effect would give a distorted impression of how the trends developed.

Second, we consider the role of parental mating in the intergenerational reproduction process following the "prospective" approach. The pivotal contribution of previous "prospective" studies is showing the importance of fertility in intergenerational status transmission, especially for women. The "one-sided" model provides important insights that a woman's high educational attainment can enhance her children's chances of attaining a better education but may be partially offset by her low fertility rate (Maralani, 2013; Lawrence & Breen, 2016). In this study, we take a step further and examine the intergeneration transmission process at the couple level. For Cohort 1(1919-1938), compared to heterogamous couples, homogamous couples are more likely to have children, which means that any conditional (dis)advantages found for the homogamous couples in children's educational attainment would have a higher likelihood of transmission. In Cohort 2(1939-1953), the fertility advantage of homogamy at the top disappeared and so it is only disadvantages at the lower ends of the educational distribution that are more likely to be transmitted in Cohort 2. In addition, the fertility advantage of homogamy disappeared for all in Cohort 3 (1954-1968).

Future studies might address some limitations of ours. First, we argue that the egalitarian family milieu of homogamous couples would benefit their child-bearing decisions, and we do find for the oldest cohort that homogamous couples are more likely to have a child than heterogamous couples, which aligns with previous findings (Huber & Fieder, 2011). However, it is unclear why this disappeared first for the more educated group among the middle cohort (Cohort 2) and for all groups among the youngest cohort (Cohort 3). If, as we argued, the egalitarian family

milieu drives the fertility difference, then the waning of the fertility advantage of education homogamy could be due to the diffusion of the egalitarian ideologies that the cohorts experienced, which might mitigate the gap between the homogamous and heterogamous groups in this aspect (Wilkie, 1993; Bolzendahl & Myers, 2004; England, 2010; Shu & Meagher, 2018). Since the diffusion of ideologies tends to start with the educated groups (Mason and Lu, 1988; Ciabattari, 2001; Pampel, 2011), it could explain why the gap first disappeared among them. In particular, some evidence suggests that educationally hypogamous couples demonstrate more gender-egalitarian attitudes (Trimarchi, 2022) and practice a more egalitarian division of labor under certain conditions (Miller, 2020). Nevertheless, the link between assortative mating and egalitarian attitudes and fertility behaviors remains hypothetical.

Second, contrary to *Hypothesis 3*, we did not find a positive influence of family milieu on children's educational attainment among the homogamous groups. Moreover, at the top and bottom of the parental educational distributions, in the younger cohorts (Cohort 2 and Cohort 3), the effects of homogamy from the family milieu turn negative. Couples' employment status could be an explanation. Because of the tightening relationship between education attainment and employment status, less educated homogamous couples are more likely to face the challenge of being unemployed simultaneously (Mincer, 1991) and have a higher chance of remaining unemployed together (Farber, 2004; Riddell & Song, 2011) compared to heterogamous couples involving only one party with low educational attainment. The potential long-term economic struggles and related stress can harm the stability and quality of their relationship, thus leading to a negative family milieu for their children. On the other hand, for the highly educated homogamous couples, employment status could also be the reason for the negative family milieu that emerged among them. As women receive more education and

increase their labor force participation over time (Leibowitz & Klerman, 1995), highly educated homogamous couples are more likely to become dual-earner families. Studies have found that dual-earner couples, especially females, report a higher level of stress (Bianchi & Wight, 2010) and are more burdened by multitasking at work and home (Bianchi, Robinson, & Milke, 2006; Offer & Schneider, 2011). Both parties report lower life satisfaction (Stutzer & Frey, 2006; Keizer & Komter, 2015). In addition, the work-family conflicts faced by full-time working parents are found to increase over time (Nomaguchi, 2009), which could explain why the family milieu turns negative for the most educated groups. To address these issues, future studies should consider mating on multiple dimensions, including education, employment status, and others when examining the consequences of assortative mating.

Finally, single parenthood is not the focus of this study and so, when selecting the analytical sample, we omitted the observations where the spouse's information is not available. However, there is a growing proportion of children growing up in families with absent fathers or absent mothers in the U.S. (Bianchi, 1994; Powell & Downey, 1997; McLanahan & Sandefur, 2009). Understanding how they were affected by their family structure is important. Future studies can easily incorporate single-parenthood into the analysis using the proposed approach, most simply by considering the effect of homogamy or heterogamy compared to single-parenthood: this could advance our understanding of the consequences of education homogamy and the consequences of single-parenthood.

Chapter Five

Conclusion

This thesis explored the demographic pathways of intergenerational transmission by investigating the role of fertility and assortative mating in educational reproduction with four essays. Findings from these four essays demonstrate how fertility and assortative mating shape educational reproduction from different perspectives.

Chapter One brings the previous individual-level inquiries on the relationship between sibship size and educational attainment to the societal level. Using the case of China during its One-Child Policy (OCP) era, it first shows that fertility decline during the OCP era brought modest education dividends in terms of improvement in the average years of schooling. The contribution of fertility decline during the OCP era to improving the average educational attainment is only 9%. It reveals that, whether fertility decline at the societal level translates into improvements in human capital, depends on two factors: a) the magnitude of fertility changes; b) the magnitude of the effect of sibship size on educational attainment. In China, both factors are relatively modest during the OCP era. Second, it shows that the impact of sibship size differentials on the educational disparity between males and females is limited. However, the sibship size differentials have a marked impact on the rural-urban disparity in education. Differential fertility can explain up to 30% of the rural-urban education gap but does not play an important role in explaining the closing gender gap in education in China. These findings highlight a less mentioned perspective: the differential fertility between groups, in understanding educational inequality in contemporary China.

Chapter Two examined the role of fertility in the multigenerational setting. It proposed that the fertility rates of the grandparents should moderate the educational association between

grandparents and grandchildren. With three-generational data from Panel Studies of Income Dynamics (PSID) and mixed-effect models, results show that having multiple children (i.e. multiple members in the parental generation) amplifies grandparents' influence on grandchildren. The strength of the grandparents' effect increases as the extended family size increases. These findings should advance our understanding of how the grandparents' effect works. Grandparents can play an important role in grandchildren's development by maintaining extended family networks. By shaping the parental generation's education and marital sorting outcomes, grandparents can influence the life chances of the grandchildren by defining the family characteristics of both the immediate family and the extended family where the grandchildren grew up. Grandparents' characteristics define what kind of extended family network the grandchildren are exposed to. The larger the network, the stronger the influence of grandparents. This moderation effect of the extended family size on grandparents' effect demonstrates a resource accumulation process in the multigenerational setting. While the advantages accumulate in a large family with multiple better-educated members, disadvantages also accumulate in a large family with multiple less-educated members. When grandparents have educational advantages, their advantages are reproduced and amplified via extended family networks. When they have more offspring, their grandchildren, compared to those from smaller families, enjoy the benefits of having better-educated biological parents and multiple better-educated relatives. However, when grandparents have educational disadvantages, their disadvantages are also reproduced and amplified via extended family networks. Thus, when they have more offspring, their grandchildren's attainment is punished for having less-educated parents and multiple less-educated relatives.

Chapter Three examines the role of parents in adult children's marital sorting. It focuses on the extent to which parents' education is associated with the educational attainment of children-in-

law. Results demonstrated that parents can play a role in adult children's marital sorting through three pathways: a) intergenerational transmission, b) matching with the parents of children-in-law, and c) direct involvement either by providing opportunities and advice or attracting potential children-in-law. These results highlight a vital process in transmitting (dis)advantages over generations. The intensively studied parents–children association captures the extent to which parental educational attainment shapes the achievement of the next generation and represents a reproduction process of (dis)advantages. The parent–children-in-law association studied here captures an accumulation process of (dis)advantages over generations. Parents not only affect their children's educational attainment but also influence whom their children will marry and who their in-laws will be. Acquiring in-laws is a vital function of marriage, as it converts strangers into relatives and expands cooperative networks. By influencing their adult children's marital sorting, parents attract in-laws with specific traits and integrate their resources. The parents–children-in-law association demonstrates that one generation's (dis)advantages not only reproduces over generations but also amplifies because similarly (dis)advantaged people join in via marriages. Furthermore, it investigates how parental involvement in marital sorting changes over the life course. The results demonstrate divergent life course trends according to gender. Parents' influence in marital sorting becomes less important for males at older ages and in remarriages. For females, it becomes more vital over the life course as compensation for their disadvantages when marrying at older ages and in remarriages. This finding stresses the gender inequalities in marriage formation over the life course. In contrast to males, the marriage prospects of females are worsened by age and a retreat from a previous marriage. Instead of gaining autonomy over the life course in finding a better-educated spouse, like their male counterparts, females have to rely on parental attributes to compensate for their disadvantaged positions in marital sorting.

Chapter Four examined the role of education homogamy in intergenerational reproduction. Following the "prospective" approach, we use a "Person-Partner-Child" panel constructed from PSID and bring the previous one-sided analysis, which focused on one parent only, to the couple level. We propose an approach to study the differences between homogamous and heterogamous couples in their likelihood of having a child and their children's educational attainment. Our approach considers and distinguishes the two sources—resource combination and family milieu—that generate the difference between homogamy and heterogamy. Our results demonstrate that the homogamous family milieu is the driving force for their higher likelihood of having a child compared to heterogamous couples. However, this reproductive advantage among homogamous couples waned over cohorts. Second, the combination of parents' resources via homogamy is the driving force that shapes the child's educational attainment, and it is associated with disadvantages at the bottom of the educational distribution, albeit with advantages at the top. Over cohorts, the magnitudes of the penalties increased at the bottom, while the benefits declined at the top. For Cohort 1(1919-1938), the revealed pattern shows that compared to heterogamous couples, homogamous couples are more likely to have the next generation in the first place, which means that any conditional (dis)advantages found for the homogamous couples in children's educational attainment would have a higher likelihood of transmission. At the bottom, education homogamy results in lower attainment of the next generation than heterogamy. As homogamous couples are more likely to produce offspring in the first place, the disadvantages of having two less-educated parents have a higher chance of being transmitted to the next generation. At the top, compared to heterogamy, education homogamy results in higher attainment of the next generation. As homogamous couples are more likely to produce offspring, the advantages of having two highly-educated parents are passed on to the next generation. Over cohorts, for Cohort 2(1939-1953), the fertility advantage of homogamy at the top disappeared. Highly-educated homogamous

couples in Cohort 2 no longer share the advantage of having a next-generation to transmit their advantages. Only disadvantages at the lower ends of the educational distribution are more likely to be transmitted in Cohort 2. In addition, the fertility advantage of homogamy disappeared for all when it came to Cohort 3 (1954-1968). These results demonstrate how (dis)advantages are reproduced over generations at the couple level.

Taken together, findings from this thesis should advance our understanding of how educational attainment is being reproduced and transmitted across generations via demographic pathways of fertility and assortative mating. The educational attainment of one generation determines not only the next generation's attainment but also who will marry into the family via marital sorting (Chapter Three). The pattern of assortative mating defines the composition of the family formed and affects the probability of becoming parents and the attainment of the couples' children (Chapter Four). Couples' fertility rates not only impact their children's educational attainment within the household but may affect the educational attainment and inequality at the societal level (Chapter One). Moreover, fertility rates can moderate the influence of one generation's achievement on the inconsecutive generation's achievement and facilitate the accumulation and transmission of (dis)advantages across multiple generations (Chapter Two).

Appendix

Chapter One

I. Tables

Table A1.1. Descriptive Statistics for Cohorts

Cohort	Sample Size	Sibling Size	Average Schooling
1950	290	3.63	7.33
1951	263	3.64	7.30
1952	354	3.72	7.22
1953	367	3.69	7.47
1954	445	3.69	7.50
1955	437	3.58	7.89
1956	515	3.64	8.00
1957	570	3.61	8.22
1958	509	3.60	8.31
1959	435	3.47	8.63
1960	515	3.49	8.88
1961	509	3.48	8.72
1962	963	3.41	8.51
1963	1,111	3.36	8.34
1964	1,080	3.32	8.19
1965	1,105	3.26	7.98
1966	1,215	3.21	7.80
1967	1,146	3.07	7.87
1968	1,617	2.99	8.00
1969	1,455	2.85	8.10
1970	1,795	2.73	8.17
1971	1,704	2.62	8.15
1972	1,759	2.51	8.29
1973	1,785	2.42	8.31
1974	1,643	2.30	8.50
1965	1,574	2.17	8.67
1976	1,694	2.03	8.88
1977	1,579	1.90	9.09
1978	1,746	1.77	9.28
1979	1,703	1.67	9.53
1980	1,705	1.57	9.67
1981	1,778	1.47	9.89
1982	1,948	1.41	9.99
1983	1,687	1.40	10.18

1984	1,571	1.42	10.22
1985	1,715	1.44	10.33
1986	390	1.37	10.46
1987	463	1.22	11.06
1988	353	1.21	11.17
1989	373	1.18	11.73
1990	307	1.17	12.22
1991	294	1.10	12.92
1992	255	1.06	13.03
1993	205	1.02	13.12

Table A1.2. Descriptive Statistics by Groups

	Male		**Female**		**Urban**		**Rural**	
Cohort	Sibling Size	AYS	Sibling Size	AYS	Sibling Size	AYS	Sibling Size	AYS
1950	3.65	7.81	3.61	6.83	3.34	9.53	3.82	5.91
1951	3.63	7.87	3.66	6.68	3.26	9.52	3.87	5.96
1952	3.65	7.70	3.79	6.70	3.33	9.44	3.94	5.95
1953	3.59	8.03	3.80	6.88	3.28	9.48	3.94	6.25
1954	3.52	8.08	3.87	6.83	3.29	9.66	3.93	6.17
1955	3.48	8.48	3.68	7.27	3.12	10.10	3.89	6.41
1956	3.54	8.86	3.74	7.17	3.13	10.35	3.98	6.42
1957	3.52	8.99	3.68	7.54	3.08	10.32	3.97	6.76
1958	3.44	9.13	3.76	7.52	3.09	10.29	3.96	6.94
1959	3.30	9.20	3.65	8.06	2.95	10.34	3.87	7.35
1960	3.30	9.59	3.67	8.19	2.87	10.65	3.94	7.59
1961	3.32	9.36	3.64	8.08	2.88	10.57	3.85	7.58
1962	3.30	9.04	3.53	7.97	2.84	10.50	3.70	7.50
1963	3.30	8.74	3.43	7.92	2.83	10.46	3.61	7.35
1964	3.22	8.57	3.42	7.80	2.76	10.34	3.55	7.27
1965	3.15	8.36	3.37	7.57	2.70	10.52	3.47	7.00
1966	3.06	8.17	3.37	7.41	2.64	10.52	3.42	6.80
1967	2.94	8.20	3.21	7.52	2.50	10.81	3.29	6.74
1968	2.83	8.35	3.16	7.63	2.39	10.71	3.24	6.88
1969	2.68	8.52	3.03	7.64	2.28	10.79	3.07	7.02
1970	2.55	8.62	2.91	7.69	2.18	10.93	2.93	7.14
1971	2.45	8.51	2.82	7.77	2.13	11.05	2.80	7.12
1972	2.32	8.58	2.72	7.98	2.00	11.26	2.69	7.26
1973	2.26	8.56	2.60	8.05	1.89	11.29	2.60	7.32
1974	2.16	8.79	2.44	8.20	1.75	11.51	2.48	7.53

1975	2.07	8.91	2.28	8.43	1.63	11.66	2.34	7.75
1976	1.89	9.08	2.17	8.68	1.49	11.92	2.20	7.91
1977	1.75	9.32	2.07	8.85	1.31	12.13	2.09	8.15
1978	1.59	9.55	1.98	8.97	1.18	12.35	1.96	8.33
1979	1.53	9.78	1.84	9.23	0.99	12.52	1.88	8.62
1980	1.43	9.84	1.72	9.49	0.86	12.67	1.79	8.74
1981	1.35	10.02	1.60	9.76	0.70	12.86	1.73	8.90
1982	1.25	10.11	1.57	9.86	0.65	13.08	1.66	8.94
1983	1.26	10.26	1.55	10.08	0.62	13.33	1.66	9.13
1984	1.30	10.29	1.56	10.13	0.65	13.53	1.65	9.23
1985	1.33	10.41	1.56	10.23	0.62	13.72	1.66	9.41
1986	1.26	10.57	1.50	10.32	0.58	13.92	1.56	9.60
1987	1.07	11.25	1.38	10.86	0.40	14.51	1.41	10.28
1988	1.07	11.16	1.34	11.18	0.46	14.52	1.37	10.47
1989	1.07	11.72	1.28	11.74	0.52	14.86	1.32	11.06
1990	1.04	12.22	1.30	12.22	0.47	15.10	1.34	11.53
1991	0.96	13.03	1.24	12.80	0.43	15.28	1.28	12.29
1992	0.93	13.03	1.21	13.03	0.35	15.20	1.25	12.44
1993	0.91	13.06	1.14	13.19	0.33	15.00	1.20	12.65

Note: AYS=Average Years of Schooling

II. Figures

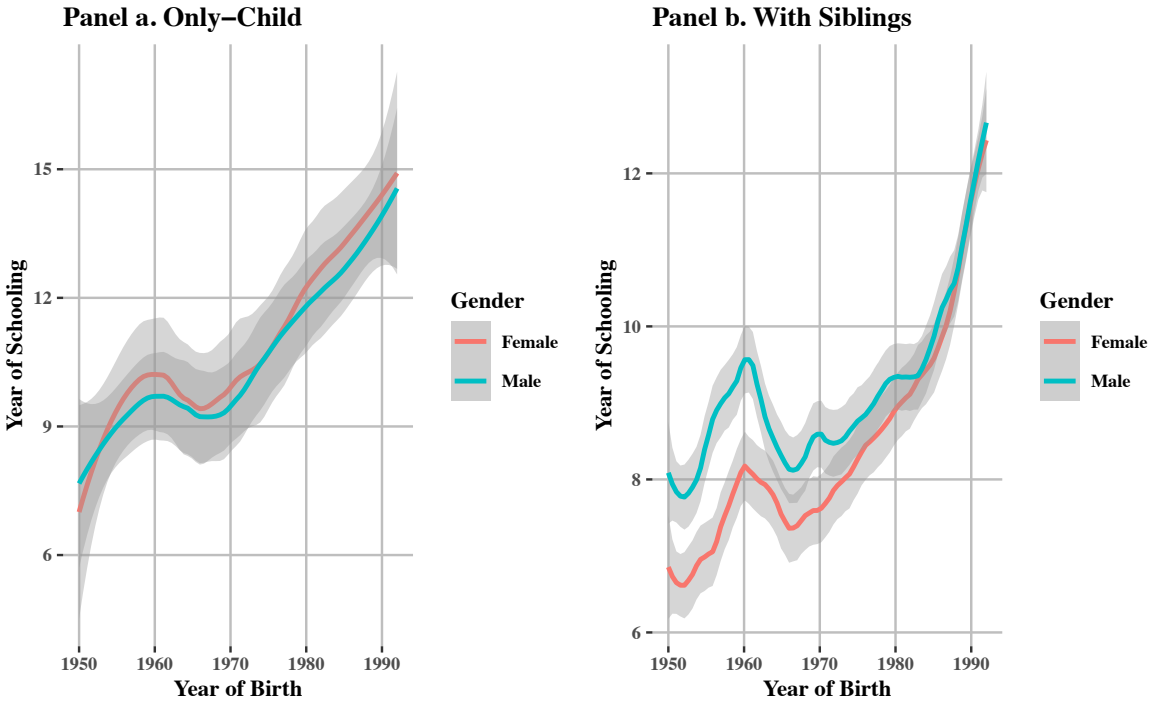


Figure A1.1 Cohort Trends of Educational Attainment by Genders for those without sibling (Panel a) and with siblings (Panel b)

III. Details of Causal Analysis with Instrumental Variables

Data and Sample

To employ the local variations in fertility policy in rural areas as instrumental variables, I used the CFPS 2010 Data. It suits the research agenda for two reasons. First, information on the specific regulations of fertility policy is available at the community level. Compared with previous studies, it provides more refined policy variations. Second, it collected information on all children of the adult respondents, including those who did not reside in the same household. Thus, it is possible to examine the effect of sibling size on complete educational attainment at older ages.

Among those born after 1949 and older than 25 in 2010, a sub-sample is selected for the causal inference with the following criteria. 1) Mothers who are living in the same places as where their *hukou* is registered.; 2) Mothers who have the rural type of *hukou*. The first two criteria are set to exclude internal migrants. It responses to the concern mentioned earlier that people may migrant for fertility purpose to places where the local policy is more relaxed. Then, I restricted the sample to mothers whose 3) first child is older than 25 years old and 4) first birth is not twin birth. Next, following the practice in previous study (Liu, 2014), I further restricted the sample to 5) mothers who gave their first birth after 1976, four-year prior to the implementation of the "one-child" policy to make sure their fertility decisions were subjected to the policy restriction. The four-year interval is used as it was the recommended birth interval before the "one-child" policy.[19] 6) I exclude ethnic minority from the sample as they are exempted from the restriction. The final analytic sample contains 1,461 mothers, residing in

[19]I tested the robustness of the results against the sample selection criteria. First, I selected mothers who were born after 1945, so they were younger than 35 in 1980 when the one-child policy is implemented. It is to make sure that mothers were at their prime fertility age at the time when one-child policy was implemented. Thus, their fertility behaviors were subjected to the variances of the policy. For the same purpose, I also conducted the analysis on a sample where mothers were younger than 30 years old in 1980 (N=2043). The results confirm the conclusions presented in the paper.

338 communities in 23 different provinces with complete information on the variables used in the analysis[20].

Measurements

Instrumental Variable

Two instrumental variables are employed as the exogenous variation in sibling size. They reflect the local fertility regulation. The information is collected from the officials in the community governments. The regulation is applied to all residences whose hukou is registered to the community.

The first instrument (IVa) is a binary variable indicating whether the family is allowed to have more than one child. It is generated according to the local fertility regulation and the sex composition of the children in the family. Among communities that have valid information on fertility regulations, 10% has strict one-child policy. 57% allows for a second birth if there is no boy in the household. Another 33% allows for two or more births. Families living in the same community, they may subject to different regulations according to the sex composition of the children in the family. I generated a variable indicating how many births the family is allowed to have according to the local policy regulation and the sex composition of the children. In the sample, 46.11% of the cases is subjected to the one-child policy, 52.98% is allowed to have two births, and 0.91% is allowed to have three births. I further recoded it into a binary variable indicating whether one-child limit is rule (Yes=1; No= 0). It is expected to be negatively associated with the sibling size.

[20] Variables that suffer most from the missing values are the instrumental variables. 14.2% of missingness in IVa and 15.7% of missingness in IVb.

The second instrument (IVb) is a continuous variable measuring the minimum amount of fine charged for excess births. It ranges from 0 to 10,000 RMB. Two pieces of information can help understand the severity of punishment. First, the medium annual household income for families in the sample is 23,961 RMB. Second, I also computed the share of fine of the annual household income. It ranges from 0 to 20 times the annual household income with a mean of .83 and a standard deviation of 2.08.[21] It is expected to be negatively associated with the sibling size.

Other Variables

Education attainment is measured as the year of education completed. The main explanatory variable is the sibling size of the family. It equals to the number of children born to the mother minus one. Throughout the analysis, I controlled for four sets of variables when assessing the relationship between sibling size and educational attainments: 1) the demographic features of the child: gender and age gap between the oldest and youngest children in the family; 2) the characteristics of the mother: her age at first birth and year of schooling; 3) father's year of schooling and the logarithm of annual net family income; 4) local educational resources measured by annual educational expenditure of the government and number of schools in the communities.

Exclusion Restriction Assumption

First, as mentioned, the exclusion restriction assumption can be tested statistically when the instrumental variable is not precisely identified. I perform the Sargan-Hansen test (1988) for

[21] The share of fine of family income is not used as the instrument for the following reasons. The household income is measured in 2009. It is less clear to what extent it can reflect the level of family resources when the child grown up. Furthermore, if the adult children were in co-residency with the parents, they also contribute to the household income, which may result in reverse causation. I also conducted analysis with the proportion as the instrument, the results suggest the same conclusion as presented.

over-identification, and results show that there lacks sufficient evidence to reject the null hypothesis that the IVs are exogenous (p=.982).

Second, I utilize the fact that the ethnic minorities are exempted from the fertility control to conduct a placebo test. The idea is that since the ethnic minorities are exempted from the fertility regulation, the instruments should not be correlated with the fertility outcomes of this group. Therefore, it provides a chance to test whether the instruments are correlated with the education outcomes after controlling for the sibling size. Among families where the first child aged 25 to 35, there are 189 cases where the mothers belong to the ethnic minority groups, and they resided in 54 different communities. First, I regressed their fertility outcomes on the instruments. The results show that fertility regulations and punishments are not associated with sibling size for ethnic minorities. Then, I regressed the educational attainment on the instruments controlling for the sibling size. The parameters for the instruments are not statistically significant (p=.655 for IVa and p=.525 for IVb). Therefore, the placebo test suggests that the instruments are not correlated with the education outcome. It can be perceived as evidence supporting the validity of the instruments.

Third, measurement errors in the instrumental variable could bias the estimates if the errors are generated systematically. A potential source of bias comes from the fact that local fertility policy may change over time. The regulations that the families faced when making fertility decisions may not be the same as they were measured in 2010. Thus, if the temporal changes in the regulations are associated with the outcome, for instance, places where the investment in education increased over time, are more likely to increase punishment on excess fertility, the measurement errors in the instruments can lead to the violation of the exclusion restriction and bias the results. To assess the robustness of the IV results, I computed the temporal variations

in the fine level between 2010 and the child's birth year. The data on historical changes in the fine level comes from Ebenstein (2010). It is a provincial-level measurement of the monetary punishments for excess fertility in China from 1979-2000. The fine level is measured as the share of the fine of the average household annual income, ranging from 0.3 to 5. The fine rate at the year the child was born is compared with the fine rate in 2010. The error is computed as the difference between them as,

$$IV_{error} = \frac{Community\ Fine\ Rate\ (2010)}{Household\ Annual\ Income\ (2010)} - \frac{Provincial\ Fine\ Rate\ (Year\ of\ Birth)}{Average\ Household\ Income\ (Year\ of\ Birth)}$$

Then, I regressed the education outcome on the computed variable. The results show that they are not correlated, which suggests that the IV estimator is robust against the potential measurement errors.

Chapter Three

Figure.A3.1 Unconditional Correlations Between Couples' Education Based on Different Educational Measurements

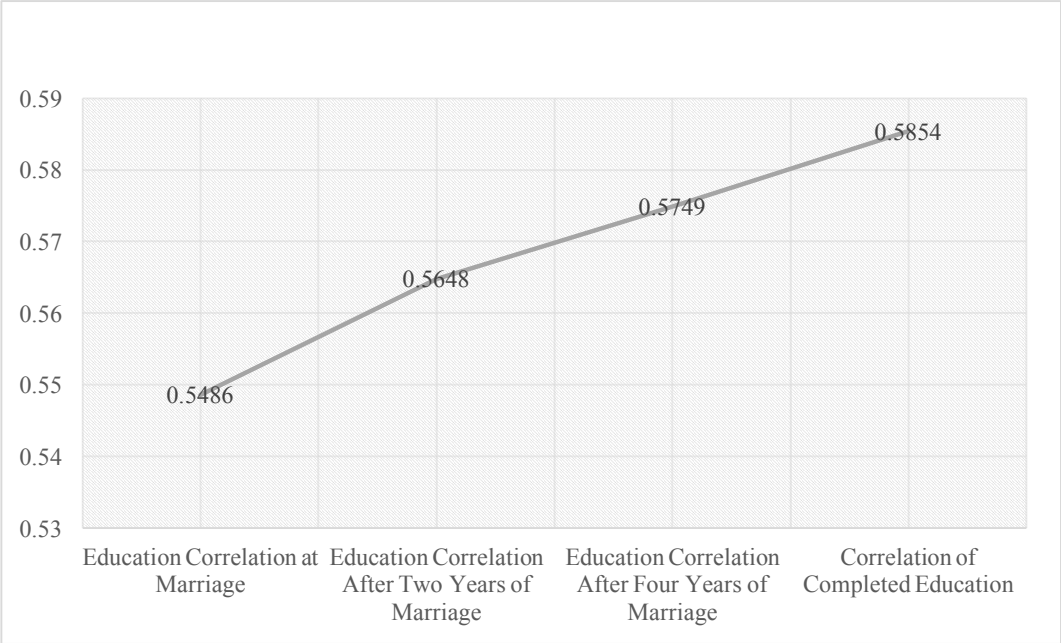


Table.A3.1 Descriptive Statistics

	Mean	S.D.	Min	Max
Generation 1 (G1)				
Average Education of Focal Person(G2)'s Parents	11.69	2.82	1	17
Average Education of Spouse (G2)'s Parents	11.70	2.93	1	17
Generation 2 (G2)				
Focal Person				
Gender				
Male	47.00%			
Female	53.03%			
Race				
White	70.00%			
African American	26.27%			
Other	3.74%			
Year of birth	1964.08	9.84	1950	1989
Age at marriage	26.07	6.28	15	64
Number of marriage	1.16	.43	1	6
Logarithm of income at marriage	5.65	4.48	0	12.51
Year of Education at Marriage	13.18	2.11	1	17
Year of Education after two-years of marriage	13.29	2.09	2	17
Year of Education after four-years of marriage	13.33	2.08	2	17
Completed Education	13.68	2.12	3	17
Spouse				
Race				
White	70.00%			
African American	26.27%			
Other	3.74%			
Year of birth	1963.46	10.60	1920	1995
Age at marriage	26.68	6.95	15	67
Year of Education at Marriage	13.28	2.11	1	17
Year of Education after two-years of marriage	13.34	2.11	1	17
Year of Education after four-years of marriage	13.36	2.11	1	17
Completed Education	13.66	2.15	1	17
N of Observation		13,489		
N of Focal Person (G2)		6,635		

Table.A3.2 Estimates from Mixed-effect Models for Parents-Spouse Associations with Different Measurements for Couples' Education

Dependent Variable	**Spouse's Education at Marriage**			**Spouse's Education after Two-Years of Marriage**			**Spouse's Education After Four-years of Marriage**			**Spouse's Completed Education**		
	Model 1	Model 2	Model 4	Model 1	Model 2	Model 4	Model 1	Model 2	Model 4	Model 1	Model 2	Model 4
Parents' Average Education	.282*** (.010)	.139*** (.009)	.065*** (.011)	.281*** (.009)	.146*** (.009)	.066*** (.011)	.280*** (.010)	.146*** (.006)	.067*** (.011)	.290*** (.010)	.145*** (.010)	.063*** (.012)
Own Education at Marriage		.428*** (.010)	.409*** (.010)									
Own Education After Two Years of Marriage					.403*** (.010)	.385*** (.010)						
Own Education After Four Years of Marriage							.	.401*** (.010)	.384*** (.010)			
Own Completed Education											.427*** (.012)	.405*** (.012)
Spouse parents' average education			.119*** (.010)			.126*** (.009)			.127*** (.009)			.134*** (.010)
Number of Persons	6,635											
Number of Observations	13,489											

Note: Parameter estimates for other control variables including the focal person's race, region of birth, year of birth, logarithm of income at marriage, and spouse's race, region of birth, and age at marriage, are omitted.
*p<0.05; ** p<0.01; ***p<0.001

Chapter Four

Table.A4.1 Descriptive Statistics for the "Homogamy-Education" Sample by Races and Cohorts

	Cohort 1 (1919-1938)		**Cohort 2 (1939-1953)**		**Cohort 3 (1954-1968)**	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Generation 1						
Paternal Grandfather's Education	8.68	3.21	9.94	3.90	11.27	3.95
Paternal Grandmother's Education	9.12	3.12	10.92	3.26	11.91	2.82
Maternal Grandfather's Education	8.70	3.20	9.83	3.83	10.95	4.20
Maternal Grandmother's Education	8.99	3.02	10.93	3.10	11.81	2.79
Generation 2						
Father's Education						
<10	23.3%		18.2%		21.7%	
10-11	11.3%		5.3%		6.5%	
12	32.0%		28.1%		31.0%	
13-15	14.6%		18.7%		16.7%	
>15	18.8%		29.7%		24.1%	
Mother's Education						
<10	15.6%		13.8%		15.2%	
10-11	11.2%		6.1%		5.0%	
12	47.2%		37.1%		31.9%	
13-15	14.9%		21.1%		23.0%	
>15	11.1%		21.9%		25.0%	
Number of Marriages	1.25	.68	1.45	.61	1.41	.77
Number of Children per Couple	4.50	2.40	2.87	3.42	2.77	1.16
Generation 3						
Gender						
Female	48.5%		51.9%		49.1%	
Male	51.5%		48.1%		50.9%	
Age	61.23	6.30	44.73	6.51	32.40	6.06
Region of Birth						
Northeast	23.0%		20.2%		23.7%	
North Central	30.0%		31.1%		31.4%	
South	30.0%		30.4%		27.9%	
West	17.2%		18.2%		17.0%	
Number of Persons	1,953		2,077		1,788	
Number of Observations	7,066		6,704		5,797	

Table A4.2 Linear Probability Regression Estimates for Homogamy Effects on Selection into Parenthood for Cohort 3

Dependent Variable	**Whether the Couple (G2) Has Any Child (1=Yes; 0 = No)**					
Education Levels (G2)	**<10**	**10-11**	**12**	**13-15**	**>15**	**Average**
Cohort 3 (1954-1968)						
Homogamy Effects	.024 (.015)	.032 (.017)	.001 (.001)	.004 (.003)	.002 (.002)	.002 (.002)
Family Milieu	.025 (.013)	.029 (.017)	.000 (.002)	.005 (.003)	.002 (.002)	.002 (.002)
Resources Pooling	-.001 (.007)	.003 (.017)	.001 (.001)	-.001 (.003)	.000 (.002)	.000 (.002)
N (Homogamy v.s. Heterogamy)	181/1,131	264/614	1,685/1,992	810/857	1,012/1,053	3,952/5647

Note: $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$; N refers to number of observations; Clustered standard errors in parentheses; Control variables include parents' racial identity, year of birth, age at marriage, the order of marriages and parental educational attainments

Table A4.3. Linear Regression Estimates for Homogamy Effects on Child's Education for Cohort 3

Dependent Variable	**Year of Education of G3**					
Education Levels (G2)	**<10**	**10-11**	**12**	**13-15**	**>15**	**Average**
Cohort 3 (1954-1968)						
Homogamy Effects	-1.851*** (.233)	-.515* (.219)	-.354** (.102)	.124 (.131)	.084 (.135)	-.247** (.070)
Family Milieu	-.381** (.260)	.027 (.272)	.229 (.141)	-.056 (.173)	-.976*** (.018)	-.221* (.078)
Resource Pooling	-1.47*** (.115)	-.542** (.103)	-.583*** (.097)	0.180 (.113)	1.060*** (.134)	.026 (.034)
N (Homogamy v.s. Heterogamy)	79/692	121/402	854/1,234	409/853	300/827	1,763/4,034

Note: $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$; N refers to number of observations; Clustered standard errors in parentheses; Control variables are added in the manner illustrated in Table 4.1.

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Chapter Three

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