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CAUSES AND CONSEQUENCES OF HORIZONTAL STRATIFICATION IN HIGHER EDUCATION

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CAUSES AND CONSEQUENCES OF HORIZONTAL STRATIFICATION
IN HIGHER EDUCATION

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ABSTRACT

This dissertation examines the role of horizontal stratification (qualitative differences within the same education level) in higher education for social stratification and inequality. Sociological studies, that have long debated the role of educational expansion for social mobility, have often assumed that increased access to higher education occurs uniformly. However, the limited focus on the quantitative increase in the number of highly educated individuals may obscure another important mechanism, that is, the growth of institutional heterogeneity through the proliferation of lower-tier institutions. This study examines the case of social mobility, and two critically related outcomes – assortative mating and gender stratification.

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I was supposed to spend another 4 or 5 years there while working with Jim remotely since he decided to move to Princeton. However, the plan had to change when I received an email from Jim on August 19th, 2019 (a few weeks before the fall semester started). In the email, titled “Important question for you,” he said, “Are you interested in moving to Princeton too?.” I needed to make a decision within three days, and if I decided to move, I had to do so within two weeks. He again changed my life.

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I slowly (very slowly because of the pandemic) started diving into the Princeton sociology and OPR. I particularly enjoyed and learned a lot from my collaboration with Noreen Goldman. I took her epidemiology class in the spring semester of 2019-20. The first half of the class was normal epidemiology, while the second half became so practically oriented to

understand the ongoing pandemic. I was fortunate to work with her (and publish a paper) and take her POP 503. Starting in 2021, I started talking with Yu Xie, my academic grandfather. His stratification workshop was my favorite time at Princeton, where I learned a lot from student's presentations as well as his way of critique. Once I presented my research idea, he suggested that I should apply this idea to Asian Americans. It was a funny moment since I did not work on the Asian American population at all. But his suggestion was right, and I am now working on multiple projects looking at family demography of Asian Americans. As such, his influence on my scholarship is equally important to the influence of Jim, so in that sense, this may be clear evidence for causal grandparent effects.

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Predictably, I would like to thank my family. I started to think about the role of family in the creation of inequality when I entered the University of Tokyo, one of the most selective universities in Japan. On one hand, it did not take long for me to realize that my classmates mostly came from advantaged families, and it was difficult to find friends who were first-generation college students who had also experienced parental divorce, as I had growing up. On the other hand, however, it was also the case that I grew up in a household with a mother who got divorced in her late twenties, but who had instrumental and emotional support, provided by my grandmother and other relatives who lived near our home. So my special thanks are given to my mother Aita Kaori and my grandmother Igarashi Kyoko.

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INTRODUCTION

This dissertation examines three questions regarding the role of horizontal stratification (qualitative differences within the same education level) in higher education for mobility and demographic outcomes. Social stratification scholars have long debated the role of educational expansion for a range of outcomes, including social mobility (Brand and Xie 2010; Breen 2010; Hout 1988; Rauscher 2016; Torche 2011), assortative mating (Rauscher 2015; Smits 2003), or female labor force participation (Goldin 2006; Hannum and Buchmann 2003).

While the theoretical expectations of prior studies are varied, these studies have often assumed that increased access to higher education occurs uniformly. Meanwhile, as access to higher education has expanded in many countries, there has been increased attention to horizontal stratification – qualitative differences within the same education level – with respect to questions about inequality and social mobility (see, e.g., Gerber and Cheung 2008). Specifically, college expansion is often accompanied by institutional diversification in terms of selectivity (Arum et al. 2007; Hoxby 2009) and curricular programs (Charles and Bradley 2009).

While sociological studies have long debated the role of educational expansion for social mobility, most studies have focused on the quantitative increase in the number of highly educated individuals. This specific focus may obscure another important mechanism, that is, the growth of institutional heterogeneity. Some studies suggest that this structural change in higher education may or may not contribute to maintaining existing socioeconomic inequality, but empirical evidence is still limited. This study contributes to the literature on horizontal stratification in higher education by examining the case of social mobility, and two critically related outcomes – assortative mating and gender stratification.

Chapter 1 examines the role of horizontal stratification for social mobility with a genetic lens.¹ Scholars have paid increasing attention to qualitative differences within the same education level as they are impacted by upstream factors such as parental investment and family resources, and, in turn, as they affect later outcomes such as earnings. In this vein, studies have investigated whether such differences in “quality” across similar quantities of education serve as a primary mechanism through which high-SES families transmit advantage dynastically. For instance, Chetty et al. (2020) claim that college attendance, especially at selective colleges, eliminates almost all family background effects on earnings—though it remains possible that this is not a treatment effect of college per se but rather results from a dynamic process whereby the ability selection gradient for college admissions is steeper for lower-SES students. In this research tradition, however, few studies have examined the role of genetic inheritance of ability; here we argue that the recent addition of genetic data to social scientific surveys provides an important tool with which one can examine how ability inherited through biological mechanisms is correlated with social origins, on the one hand, and contributes to the creation of horizontal educational stratification, on the other. Additionally, we examine the role of differences in college quality as a mediator of genetic effects on labor market outcomes. Results from analysis of the National Longitudinal Study of Adolescent to Adult Health show the following: First, the

¹ An earlier version of this paper was presented at the RC28 summer meeting held at University of Turku on June 2, 2021, American Sociological Association annual meeting (virtual), on August 10, 2021, The Integrating Genetics and the Social Sciences annual meeting, October 28, 2021, Japanese Association of Mathematical Sociology spring meeting (virtual), March 12, 2022, and Population Association of America Annual Meeting, April 4, 2022. We thank Chi Qi for technical assistance on this paper. We also thank participants at the Princeton biosociology lab for their helpful feedback. This research uses data from Add Health, a program project directed by Kathleen Mullan Harris and designed by J. Richard Udry, Peter S. Bearman, and Kathleen Mullan Harris at the University of North Carolina at Chapel Hill, and funded by grant P01-HD31921 from the Eunice Kennedy Shriver National Institute of Child Health and Human Development, with cooperative funding from 23 other federal agencies and foundations. Information on how to obtain the Add Health data files is available on the Add Health website (<https://addhealth.cpc.unc.edu/>). No direct support was received from grant P01-HD31921 for this analysis.

genetic potential for educational attainment is positively associated with college degree attainment, the quality of colleges respondents graduate, and individual earnings in middle age (overall and net of college degree and college selectivity). Second, we find that lower SES students evince a higher correlation between the genetic potential and college selectivity, thus raising questions about the leveling effect of elite college attendance. Third, we find supportive evidence for the thesis of college completion serving as a great equalizer even after considering genetic potential, but not for the equalizing role of college selectivity. Last, we do not find evidence for an interaction between parents' SES and the genetic measures associated with individual earnings net of college degree and college selectivity.

Chapter 2 examines the role of horizontal stratification in explaining educational assortative mating trends.² Research on educational assortative mating has devoted much attention to educational expansion but has been less focused on a concurrent trend of importance – growing differentiation among higher education institutions. In this study, I examine whether the bifurcation between high- and low-tier institutions in the context of high participation in tertiary education may help us understand the mixed evidence on educational homogamy trends across countries. Applying log-linear and log-multiplicative models to analyze trends in educational assortative mating in Japan, characterized by a clear and widely acknowledged hierarchy of institutional selectivity, I find that; (1) the odds of homogamy are higher among graduates of selective universities than among graduates of nonselective universities; (2)

² An early version of this paper was presented at the RC28 summer meeting held at Princeton University on August 15–19, 2019. The Japanese Panel Survey of Consumers and the Keio Household Panel Study were provided by the Panel Data Research Center at Keio University. I thank several anonymous reviewers, Jim Raymo, Christine Schwartz, Eric Grodsky, Leafia Zi Ye, Kelsey Wright, Noah Hirschl, Sawako Shirahase, Sho Fujihara, Ryota Mugiyama, Kohei Toyonaga, Akira Igarashi, and seminar participants at the National Institute of Population and Social Security Research for their helpful comments and suggestions. This research is supported by the Nakajima Foundation and the Eunice Kennedy Shriver National Institute of Child Health and Human Development of the National Institutes of Health under grant P2CHD047879. All errors are my own. Note that this chapter is based on the final proof before publication in *Demography* (Vol. 59, Issue 6).

homogamy trends among graduates of selective and nonselective universities have diverged in recent years; (3) possibly reflecting the more rapid increase in the share of female students enrolled in less-selective institutions, the opportunity for them to “marry up” has decreased. Results suggest that close attention should be paid to the important and growing heterogeneity of institutional characteristics that has been obscured in earlier studies to understand the impact of educational assortative mating on economic inequality.

Chapter 3 examines the underrepresentation of women in selective colleges in Japan.³ The intersection of gender and higher education is an important source of social change. This is most compellingly seen in the concurrent trends of women outnumbering men in higher education attendance and the progress toward gender equality. Meanwhile, women’s underrepresentation in selective colleges remains in countries characterized by relatively stronger institutional differentiation in terms of selectivity. Recent studies suggest that high-stakes exams and the associated risk of exam failure play a critical role in shaping women’s underrepresentation in selective college attendance. Taking advantage of the unique combination of college application and outcome available in a longitudinal dataset in Japan, where higher

³ This study was supported by the Japan Society for the Promotion of Science KAKENHI (Grant Number JP23H05402, JP22H00069, JP19H01637, and JP15H05397), Institute of Social Science at the University of Tokyo, the Nakajima Foundation and the Friends of University of Tokyo, Inc. Permission to use the panel data was obtained from the Management Committee of the Japanese Life Course Panel Surveys. An earlier version of this paper was presented at the Japanese Association for Mathematical Sociology biannual meeting (September 4, 2021), Tokyo Center for Contemporary Japanese Studies, the University of Tokyo (September 7, 2021), the Japan Society of Educational Sociology annual meeting (September 11, 2021), 21st Century Japan Politics and Society Initiative (21JPSI), Indiana University (September 16, 2021), and Princeton University Stratification Workshop (October 15, 2021). The data for this secondary analysis, “Japanese Longitudinal Study of Children and Parents” (Benesse Educational Research and Development Institute), were provided by the Social Science Japan Data Archive, Center for Social Research and Data Archives, Institute of Social Science, The University of Tokyo. I thank Mika Akasaka, Ha-Joon Chung, Sho Fujihara, Rama Hagos, Yuko Hara, Hilary Holbrow, Natsumi Isa, Mei Kagawa, Takuma Kamada, Tate Kihara, Jordan Klein, Kaori Mitsushima Maruno, Ryota Mugiyama, Eunmi Mun, Yoko Okuyama, Hiroshi Ono, Tamkinat Rauf, Jim Raymo, Risa Saiki, Ziyao Tian, Kohei Toyonaga, Zoey Wang, and Yu Xie for their helpful comments and suggestions.

education is characterized by an extremely low proportion of female students in selective institutions, the analysis reveals that women are significantly less likely to retake the exam than men. Further analysis finds that significantly more women than men tend not to retake the exam when they fail and the gender gap remains even after accounting for likely correlates. These results suggest that a properly designed admission system that reduces the risk of exam retaking or the avoidance of these exams may have implications for the gender gap in selective college attendance in high-stakes exam contexts.

CHAPTER 1 Horizontal Educational Stratification through a Genetic Lens: Effects of Social Background and Genetic Endowment on College Selectivity and Earnings

1. Introduction

As access to higher education has expanded in many countries, there has been increased attention to horizontal stratification – qualitative differences within the same education level – with respect to questions about inequality and social mobility (see, e.g., Gerber and Cheung 2008). For instance, stratification research has argued that educational expansion is typically accompanied by differentiation or, in other words, a growth of institutional heterogeneity through the proliferation of less-selective institutions (Arum et al. 2007; Hoxby 2009). In this context, two theoretical perspectives provide important insights into the role of selective colleges in stratification processes. One perspective, the Effectively Maintained Inequality (EMI) hypothesis, suggests that selective colleges may play a key role in the dynastic perpetuation of socioeconomic differences (Lucas 2001). In the expanded higher education context, this hypothesis implies that parents of high socio-economic status intensively invest in their children's human capital to help them to attain advantaged positions within the same levels of education as their less advantaged peers (Haveman and Smeeding 2006; Jerrim et al. 2015; Karabel and Astin 1975; Lovenheim and Smith 2022; Roksa et al. 2007). If so, the SES gradient in admission to selective colleges represents an important pathway through which social reproduction is maintained in meritocratic societies (Alon 2009; Carnevale and Rose 2003; Davies and Guppy 1997; Karen 2002; Michelman et al. 2021; Torche 2011; Turley et al. 2007; Witteveen and Attewell 2020). Another perspective, college as a great equalizer or negative selection hypothesis, suggests that these highly selective schools can serve as levelers of family background effects (Brand and Xie 2010; Breen and Jonsson 2007; Breen and Luijkx 2007; Fiel

2020; Karlson 2019; Hauser and Logan 1992; Hout 1984; 1988; Karlson 2019; Pfeffer and Hertel 2015; Torche 2011; Vallet 2004). For instance, one recent study that examined over eight million college-goers born 1980-1982 in the United States (Chetty et al. 2020) claimed that completing a 4-year college degree substantially eliminated family-of-origin SES effects on income. They also found that the income correlation between children and parents is even flatter for students at selective colleges. Similar arguments have been provided by several other observational (Giani 2016; Klein 2021) as well as natural experiment studies (Black et al. 2020; Bleemer 2021).

However, such a claim does not fully take into consideration the possibility that the selection gradient in the admissions process differs for low- and high-SES students. Namely, it may not be a treatment effect of college degree or highly selective colleges per se that eliminates any effect of parental SES on later earnings; rather, it may be that lower-SES students who gain admission to and attend colleges, especially selective colleges, display more positive underlying characteristics that are rewarded in the labor market than do their higher-SES peers (Dale and Krueger 2002, 2014; Zhou 2019). The greater level of “ability” to graduate from a (selective) college from a lower-SES background may, in turn, cancel out the direct, positive effect of coming from a high-SES family, thus producing the leveling effect observed by Chetty et al. (2017, 2020) without any actual treatment effect from the colleges themselves. When examining whether (selective) college attendance contributes to the reproduction of inequality or serves as a great equalizer, it is thus critical to distinguish between two fundamental sources of origins, namely, students’ academic potential and parental social class. However, one of the core empirical challenges is the fact that they are correlated with each other; earlier work in this domain of scholarship has not addressed the extent to which the influence of parents’

socioeconomic position represents the social distribution of resources as opposed to the biological endowments that helped parents achieve such a position and which, in turn, they pass on genetically to offspring. Therefore, the role of innate endowments in generating those class differences in vertical as well as horizontal educational outcomes remains unclear.

To this debate about the causes and consequences of (selective) college attendance in stratification processes, we propose that the deployment of genetic data helps us to measure at least part of the ability endowment inherited through biological mechanisms from parents so that we can evaluate how such biological endowments may be associated with social origins, on the one hand, and contribute to the creation of downstream educational and labor market outcomes, on the other hand. Results from such analysis will provide intuition as to the degree to which biological inheritance, differential selectivity, and social inheritance play distinct or interacting roles in the transmission of educational and labor market advantage.

To this end, we ask two questions. First, we examine whether the relationship between genetic endowment and educational attainment, including college selectivity, varies by family background. Specifically, we test the proposition that the findings of Chetty et al. (2017, 2020) result from differential selection gradients for high and low SES students in college degree, especially among more selective ones. If the correlations between genetic signatures of educational (and labor market) success and college selectivity are equal to or higher for lower SES students than for their higher SES counterparts, it suggests that genetic potential does not play a major role among higher parental SES groups, consistent with the EMI hypothesis and that there may indeed be a treatment effect of elite college attendance that mutes the effect of family background that is observed among non-college graduates. (Those who attend non-elite colleges show a steeper earnings gradient, but this slope is also muted as compared to non-four-

year-college graduates.)⁴ Second, we compare the contribution of family SES, college degree, and college selectivity to later socioeconomic attainment with and without accounting for genetic potential for educational attainment. Our focus is to test whether a 4-year college degree, especially from a selective college, levels the field or not. If this hypothesis is correct, the positive effect of selective college attendance would be stronger for those from lower parental SES groups than higher SES groups, even after controlling for academic potential measured as genetic endowments for educational attainment. If the EMI hypothesis is correct, we expect to see the genetic gradients in college attendance and selectivity to be much steeper (or flatter) for those from lower (or higher) parental SES groups, which suggests that the positive effect of (selective) college attendance on later socioeconomic attainment goes away when controlling for genetic endowments.

Additionally, this study contributes to updating the general implications of the genetic perspective for stratification research. Specifically, this study illustrates how the use of genetic data helps us to address theoretically important but empirically challenging questions, in this case complicated relationships between social and biological origins, education, and class destination, by allowing us to partly quantify underlying traits which are prone to higher or lower educational attainment but difficult to measure (e.g., motivation) in a causally prior manner. This study also provides important insights into the potential role of horizontal stratification in contemporary societies (Gerber and Cheung 2008), wherein an increasing number of individuals enter higher education in many countries, so simply looking at the vertical aspects of educational attainment obscures a potentially important source of inequality.

⁴ That leveling effect could be due to any number of factors—sheepskin effect (i.e. a signaling effect of the degree), skill acquisition, social capital, or even self-confidence.

2. Background

2.1 Horizontal stratification in U.S. higher education

Higher education expansion in the United States has been characterized by the growth of institutional heterogeneity thanks to the proliferation of lower-tier schools and increasing selectivity of elite institutions (Hoxby 2009; Roksa et al. 2007). At the lower end of the distribution, expansion has been driven by an increase in the number of for-profit universities from the early 1990s until around 2010 (National Center for Education Statistics 2019)—as one out of seven U.S. college students was enrolled at these for-profit institutions during this period (Deming et al. 2016). Studies have argued that these colleges target poor and minority students (Deming et al. 2013) who then end up with heavy student loan debt (Deming et al. 2012) and almost no economic benefits from their education (Cellini and Turner 2019). Also, since most of these institutions have open admission policies, it is not surprising that students with lower test scores are more likely to enter these lower-tier institutions, which, in turn, contributes to the growing heterogeneity of college students' skills. Meanwhile, studies have also reported that the top ten percent most selective colleges (measured by SAT scores of students enrolled) have increased their selectivity over the half century from 1960s (Bound et al. 2009; Hoxby 2009).

Reflecting this observation of growing heterogeneity in college selectivity, scholars have paid increased attention to how qualitative aspects of higher education play a role in the human capital generation processes (see, e.g., Gerber and Cheung 2008; Hout 2012; Hoxby 2009 for reviews). Prior work has focused on selective colleges to examine heterogeneity within higher education in terms of both access (Chetty et al. 2017, 2020; Haveman and Smeeding 2006; Jerrim et al. 2015; Karabel and Astin 1975; Roksa et al. 2007) and returns to higher education (Astin and Oseguera 2004; Brand and Halaby 2006; Brewer et al. 1999; Chetty et al. 2017, 2020;

Haveman and Smeeding 2006; James et al. 1989; Karen 2002; Lovenheim and Smith 2022; Sekhri 2020; Thomas 2003; Thomas and Zhang 2005), whereas a handful of studies has directly examined the implication of the proliferation of lower-tier institutions (Deming et al. 2013; Deming et al. 2016).

Not surprisingly, according to these studies, selective institutions tend to enroll a disproportionately larger share of students with advantaged backgrounds (Chetty et al. 2017, 2020; Haveman and Smeeding 2006; Jerrim et al. 2015), while lower-tier institutions are characterized by a greater share of disadvantaged and minority students (Deming et al. 2013). For example, students from the top 1% of the family income distribution are 77 times more likely to attend the most selective colleges (Ivy league Plus) in the U.S. than children from the bottom 20% are (Chetty et al. 2017). As such, studies have argued that meritocratic competition in the U.S. higher education system often reinforces, rather than attenuates, parents' social, economic, and cultural advantages in the process of selection (Armstrong and Hamilton 2013; Collier and Morgan 2008; Jack 2016; Michelman et al. 2021). Indeed, the EMI hypothesis argued that intergenerational inequality in education is maintained even when access to higher education becomes universal because privileged groups seek qualitative advantages within the same levels of education as their less advantaged peers (Lucas 2001).

Whether there are any returns to attending a selective college, and whether the effect differs by population subgroups, is another separate, but deeply related, question. First, evidence on the labor market returns to attending these institutions is less clear. Earlier work has argued that elite college graduates enjoy higher earnings, and it appears the advantage has increased in recent cohorts (Astin and Oseguera 2004; Karen 2002; Long 2010). However, Dale and Krueger (2002, 2014) have argued that the observed returns to attending these selective colleges are

largely due to selection effects: Namely, students with certain characteristics, such as higher motivation, better cognitive skills, or advantageous parental backgrounds are more likely to attend these institutions and succeed in the labor market because of these traits rather than a treatment effect of the particular college attended. One recent study by Zhou (2019) partly supports this claim, arguing that the observed equalizing effect of college education, especially that of nonselective colleges,⁵ is mainly due to the selection of “high-ability, high-motivation students from low-and moderate-income families into this group” (Zhou 2019: 475). In contrast to Zhou (2019)’s approach, we explicitly consider the role of selection by adding genetic correlations of educational attainment to models.

Second, evidence on the heterogeneous returns to selective college attendance is also mixed. On the one hand, many studies have claimed that elite colleges are a social leveler (Chetty et al. 2020; Giani 2016; Klein 2021). For instance, several natural experiment studies took advantage of “top percent” policies, a test-based meritocracy which increased opportunities for talented students from low SES backgrounds, implemented by some U.S. public universities to estimate the effects of attending flagship state universities for labor market outcomes. According to these studies, attending competitive public universities (e.g., the University of California and the University of Texas systems) helps upward mobility among low SES students, supporting claims about college as a great equalizer. Dale and Krueger (2002) also argued that earnings return to selective college attendance are slightly higher (8%) for children from low SES parents than high SES ones. On the other hand, Zhou (2019) reported that attending selective colleges does catalyze upward mobility among low SES students, although the effect is

⁵ A few experimental studies have also examined the benefits of attending lower-tier institutions—measured by the callback rates from employers—and have found that those who graduated from for-profit universities experience worse outcomes than non-selective public university graduates (Deming et al. 2016).

not statistically significant due to the small sample size of low SES students making it to selective colleges. A few other studies have reported a non-linear relationship between social class and returns to college selectivity (Manzoni and Streib 2019; Thompson 2019). Overall, there is no consensus on the role of college selectivity in reinforcing or mitigating the effect of family background on long term economic outcomes.

2.2. The role of cognitive ability in the context of horizontal educational stratification

As discussed above, unequal access to higher education, especially among selective institutions, is a likely factor that contributes to the reproduction of inequality in the United States, while it is equally important to ask how individual traits are rewarded in the meritocratic selection, particularly cognitive ability, since it likely plays an important role in the selection process into prestigious colleges (Dale and Krueger 2002, 2014; Davies and Guppy 1997; Zhou 2019). Indeed, myriad studies have shown that the impact of student ability on educational attainment is comparable to or larger than that of social origins (Jencks 1979; Marks 2013, 2014). Still, difficulties in comparing the impacts of nature and nurture remain by the fact that these abilities are endogenous to family resources. For instance, prior studies have distinguished children's ability from social origins by using some proxies, such as test scores, academic achievement, or intelligence (Baker and Vélez 1996; Bowen et al. 2005; Grodsky 2007; Hearn 1991; Jencks 1979; Karabel and Astin 1975; Sewell and Shar 1967), but other scholars have noted that parents' SES already influences these scores (Farkas 2003; Guo 1998; Heckman 2006; Turkheimer 1991; Tucker-Drob and Bates 2016).

Here we argue that distinguishing between nature and nurture is crucial; otherwise, the estimated effects of parental background or children's abilities are biased. The identification of

biological contributions to educational attainment also provides important insight into the debate on the returns to attending selective colleges. As reviewed above, inconsistencies remain in the literature, with some studies providing evidence of economic returns to college selectivity (Astin and Oseguera 2004; Black and Smith 2006; Brand and Halaby 2006; Brewer et al. 1999; Chetty et al. 2017, 2020; Haveman and Smeeding 2006; James et al. 1989; Karen 2002; Monks 2000; Thomas 2003; Thomas and Zhang 2005) and others questioning this (Dale and Krueger 2002, 2014). Such differences may stem from the extent to which we can adjust for unobserved characteristics that affect both selective college attendance and higher earnings (Gerber and Cheung 2008; Hout 2012), namely, student ability. Indeed, earlier work has not paid enough attention to the role of ability. We, thus, fill this gap in prior work by integrating recent developments in sociogenomics studies that allow us to partially capture the genetic architecture that predicts educational attainment.

2.3 Genetic data and social stratification

The recent integration of Genome-Wide Association Studies (GWAS) into the social and behavioral sciences (see, e.g., Lee et al. 2018; Okbay et al. 2022) helps us to identify (a part of) genetic endowment. Using sites of common genetic variation across the genome called single nucleotide polymorphisms (or SNPs), recent studies have constructed polygenic indices (PGIs), summarizing genetic propensities for given phenotypic traits, which we discuss in more detail below. These studies have argued that the contribution of genes to years of education is non-negligible; a meta-analysis twin studies, for instance, estimate the heritability of educational attainment to be around 40 percent (Branigan and Freese 2014). Meanwhile, the heritability of education estimated using common SNPs is around 20-30 percent (Krapohl and Plomin 2016;

Rietveld et al. 2013; Savage et al. 2018). PGIs for years of education, for example, currently explain approximately 12-16% of the variance in educational attainment (Okbay et al. 2022), although controlling for parental PGIs reduces the magnitude roughly by half. Thus, PGIs represent imperfect estimates of genetic propensity and provide lower bound estimate on both the genetic effects as well as the bias due to genetic confounding in social background variables. Importantly, they also demonstrate that an individual's genetic potential for educational attainment is associated with one's later socioeconomic outcomes even after adjusting for one's realized education (Belsky et al. 2016; Belsky et al. 2018; Conley and Domingue 2016; Conley et al. 2016; Liu 2018; Lin 2020; Papageorge and Thom 2020).

This suggests that there are at least three potential interpretations regarding the role of genetics in realizing socioeconomic outcomes. One is that genetic endowments may have a direct effect on these outcomes net of all measures of schooling even if they were perfectly measured. This is likely since previous studies have found that a sizable number of talented students missed opportunities for selective colleges due to limited socioeconomic resources (Hoxby and Avery 2013; Hoxby and Turner 2013, 2015).⁶ Such an undermatch between education potential and achieved education allows us to hypothesize that this educationally-unrealized part of skill endowment may partly explain variation in later socioeconomic outcomes that is not accounted for by either measured quantity or quality of schooling. A second possibility is that genetic traits are correlated with other education relevant traits that also predict socioeconomic outcomes, even within the same level of schooling. If the second possibility is the case, we expect to see that the variation in relevant outcomes, i.e. college selectivity, within the same educational level

⁶ Meanwhile, Chetty et al. (2020: 1572) provide a skeptical view towards Hoxby's and colleagues' claims, arguing that there are much fewer low-income children whose academic achievement gain them entry into selective colleges.

might be partly explained by one's genetic endowment. By contrast, the third possibility casts a doubt on the causal effect of genetic traits by arguing that the association is produced through processes of social transmission. Specifically, by the fact that children share their alleles with their parents (and/or siblings), the observed genetic effect is partly due to the environment that parents (and/or siblings) provide that, in turn, stems from the genetic signature they share with the proband. As such, this genetic measure, when used in cross-family analysis, captures what are called "genetic nurture" effects (Kong et al. 2018; Wertz et al. 2019). Another problem is population stratification, wherein the alleles may be correlated with unmeasured environmental aspects of family background (Mills and Tropf 2020). To the extent that these are pre-treatment, that is, that they occur causally prior to college, then any genetic nurture or other environmental confounds of the PGI are still useful in helping to determine the effect of college on earnings. However, where we are concerned with the effect of family background on college/earnings, these confounds may bias the parental SES effect. The ideal method is to use family-based data to capture only the direct effects of genes, net of population structure and genetic nurture. We show in supplementary analyses using a sibling subsample that results using this within-family approach largely mirror what we find in the larger sample.

2.4 Gene-environment interaction for socioeconomic attainment

So far, we have treated both parental background and genetic endowments independently, but there is good reason to believe that they would jointly influence socioeconomic attainment in a process that is often called a gene-environment interaction (Conley and Fletcher 2017, ch.7; Plomin 2018, ch.9). In the context of the genetic gradient of educational attainment, for instance, earlier work by Papageorge and Thom (2020) found evidence of a positive gene-environment

interaction for educational attainment, meaning that those individuals coming from wealthier families evince greater returns to genetic endowment than their counterparts from poorer families. This finding supports the Scarr-Rowe hypothesis, which posits that the heritability of ability is stronger for children from higher status backgrounds (Baier and Lang 2019; Gottschling et al. 2019; Rowe et al. 1999; Scarr-Salapatek 1971; Tucker-Drob and Bates 2016; Turkheimer 1991; Turkheimer et al. 2003). This hypothesis suggests a socio-genetic reinforcement mechanism, whereby high SES parents invest more in high endowment children due to the greater availability of educationally relevant resources in these households. As a result, the more advantaged the families from which children come, the higher chances they enjoy in realizing their genetic potential by leveraging socioeconomic resources (Turkheimer et al. 2003). Other research, however, has not necessarily found this effect to hold up (see, e.g., Baier et al. 2022; Belsky et al. 2018; Conley et al. 2015).

Although Papageorge and Thom (2020) did not examine whether the positive gene-environment interaction is observed for horizontal stratification in higher education and labor market outcomes, we can extend this finding to the selection into selective college attendance. By directly investigating this question, we provide further evidence on the nature of gene-environment interaction with respect to socioeconomic attainment. In turn, this study contributes to the prior literature on the role of college selectivity for intergenerational mobility, by examining the counter-hypothesis that selection on genetics is different for low and high SES students, which may explain the apparent leveling effect.

3. Research questions and hypotheses

In this study, we ask: do children from lower SES families “undermatch” in the likelihood of attaining a college degree and on college selectivity conditional on college degree attainment? If so, is college – and selective college in particular – the great equalizer in terms of muting the association between class background and labor market outcomes? Is this a treatment effect of college or is it a selection effect based on a steeper genetic gradient for lower SES offspring to graduate college and in terms of the quality of colleges graduated? Lastly, are the returns to genetic potential for educational attainment different by class background? To provide empirical evidence on these questions, the current study draws on data from the National Longitudinal Study of Adolescent to Adult Health (Add Health) to test the role of genotype on horizontal stratification and the nature of gene-environment interaction with respect to parental SES effects on college degree and college selectivity.

Specifically, we test the following hypotheses. First, we hypothesize the positive correlation between the genetic potential for educational attainment (education PGI) and realized education (college degree and college selectivity) and individual earnings (Hypothesis 1a-1c).

Hypothesis 1a: genetic potential for educational attainment is positively correlated with college degree attainment.

Hypothesis 1b: genetic potential for educational attainment is positively correlated with the quality of college respondents graduated from, conditional on degree attainment.

Hypothesis 1c: genetic potential for educational attainment is positively correlated with individual earnings, net of measures of education.

Second, we test the two hypotheses regarding the role of college education in intergenerational mobility. On the one hand, the college as a great equalizer hypothesis posits that the intergenerational transmission of socioeconomic status is weaker among (selective) college graduates (Hypothesis 2a), which implicitly assumes that genetic selection into (selective) college degree should not influence this process since college education has an independent effect on intergenerational mobility. On the other hand, the EMI hypothesis suggests that the observed equalizing effect of a college degree is driven by the steeper (or flatter) genetic gradients in (selective) college attendance among lower (or higher) parental SES groups (Hypothesis 2b). This hypothesis thus posits that the equalizing effect goes away when we account for the genetic potential for educational attainment (Hypothesis 2c).

Hypothesis 2a: The correlation between parental SES and individual earnings is weaker among college graduates, especially selective college graduates.

Hypothesis 2b: The correlation between the genetic potential for educational attainment and realized education (college degree and college selectivity) is higher for those from lower parental SES groups than those from higher parental SES groups.

Hypothesis 2c: The muting effect of a (selective) college degree on the correlation between parental SES and individual earnings is reduced when we control for genetic potential for educational attainment.

Last, we examine the gene-environment interaction hypothesis for individual earnings. Specifically, we test the Scarr-Rowe hypothesis, which expects to see the positive interaction between the genetic potential for educational attainment and parental SES for status attainment.

Hypothesis 3: the positive association between the genetic potential for educational attainment and status attainment (college degree, better college selectivity, and individual earnings) is stronger for those from higher parental SES groups than those from lower parental SES groups.

4. Data and methods

4.1 Data

The present study uses the National Longitudinal Study of Adolescent to Adult Health (Add Health), a nationally representative survey of over 20,000 students drawn from a sample of 80 U.S. high schools and 52 U.S. middle schools. This survey provides a unique set of longitudinal information on social and biological characteristics among U.S. adolescents in grades 7-12 in 1994-95. We first focus on respondents who have reached ages 18-26 at Wave 3, which collected detailed education information, including the ranking of colleges respondents have attended, tuition, or the racial composition of students, surveyed by the Adolescent Health and Academic Achievement study (AHAA). In the analysis on respondents' college degree attainment and individual earnings, we focus on Wave 5 when they are aged 32-42.

4.2 Variables

As a genetic measure, this study uses a polygenic index (PGI) for years of education (EA4) (Okbay et al. 2022) to characterize respondents' DNA, which was collected at Wave 4 through saliva samples.⁷ A PGI is a standardized composite index calculated by using genetic associations uncovered by a genome-wide association study (GWAS). This measure is estimated

⁷ We calculated education PGI by using GWAS summary statistics provided by the Social Science Genetic Association Consortium (SSGAC) (Becker et al. 2021)

based on multiple genetic variants associated with an individual's phenotypic trait (years of education in this case) in training sample. Conceptually, we can interpret this variable as a noisy measure of one's genetic potential for an outcome of interest (see a full explanation in Conley and Domingue 2016). Unlike Mendelian diseases that are influenced by a single gene, most traits in which social scientists are interested are complex by nature, implying that many genetic variants are associated with the outcome, each with a very small effect size (Mills and Tropf 2020), so a PGI is more suitable for these complex traits to detect the additive influences of multiple genetic variants. This variable is standardized with a mean of 0 and a standard deviation of 1. Another independent variable of interest is parents' SES. Specifically, we use parental socioeconomic status at Wave 1; this measure is based on the first principal component loadings of four social origin measures (parental education, parental occupation, household income, and household receipt of public assistance at Wave 1) constructed by Belsky et al. (2020).

We examine three outcomes – college graduation measured at Wave 5, college selectivity measured at Wave 3, and logged annual individual earnings during middle age measured at Wave 5. First, college graduation is coded as a dummy variable indicating whether the respondent had received a bachelor's degree by Wave 5 when respondents are aged from 32 to 42. Second, we use the academic selectivity of the postsecondary educational institution students attend (conditional on attendance of any postsecondary schooling). This ranking was scored by AHAA based on the median SAT score of entering students. The percentile rank is collapsed to the scores ranging from 1 to 20 by the Wave 3 survey, with lower values indicating higher ranking. For ease of understanding, we invert and standardized the values so that a higher score means the institution is more selective. If respondents did not attend a college at Wave 3, we supplement the Wave 4 measures collected by AHAA. To make the results comparable to the

analysis on college completion, we only focus on those who completed college by Wave 5.⁸ Our third outcome of interest is logged annual individual earnings. This is a single year measure collected at Wave 5. In analysis, we use the logged form of earnings.

To minimize confounding of genetic measures with environmental conditions, we follow the norm in the literature and restrict our analysis to non-Hispanic whites. This is also done because the weights that go into the PGI are based on discovery analysis that is restricted to this particular ancestral population as well. Of the 5,758 self-reported non-Hispanic whites with the polygenic index in the original dataset, we omit those without information about relevant variables, such as parental socioeconomic status or college selectivity. Other control variables include age, sex, and self-reported health measured at Wave 1.⁹ The total sample size is 3,464 for the estimation of college degree, 677 for the estimation of college selectivity, and 3,435 for the estimation of logged annual individual earnings. We use Add Health Wave 5 cross-sectional weights to account for differential sample selection and panel attrition. Note that the analysis on college selectivity limits the sample to those who graduated the post-secondary institutions with the constructed college selectivity score (public and non-profit private universities), while we include those who did not graduate these institutions in our estimation of college degree and individual earnings. Descriptive statistics are shown in Table 1, below.

Simply pruning the sample along these lines is not sufficient to control for environmental differences that may still be correlated with allele frequencies in the non-Hispanic, white population. Thus, as controls, we add respondents' first 20 genetic principal components.

⁸ This means that our sample excludes those who dropped out of college. The inclusion of those who did not complete college, including college dropouts, in the sample to estimate college selectivity does not change results substantially; see [Table X](#) in Appendix B that deploys Heckman selection weights.

⁹ Self-reported health is included based on the previous studies showing the robust relationship between child health status and later socioeconomic attainment (Currie 2009). The same variable was used in earlier studies that examine genetic gradients in socioeconomic attainment (e.g., Papageorge and Thom 2020).

Principal components of the genetic data are typically added to control for ancestry-related systematic differences in allele frequencies for different subpopulations that could be detected in GWAS but may function as a confounder between independent variables and outcome of interest (Price et al. 2006). Principal components are generally considered inadequate as controls for population stratification, so in sensitivity analyses (Appendix A) we also deploy the within-family models described earlier that completely purge any confounding with genetic nurture or population structure.

[Table 1 about here]

4.3 Methods

To estimate the impact of genetic potential and parents' SES on a college degree, college selectivity, and labor market outcomes, we estimate the following OLS regressions. First, we estimate models where the outcome is college degree attainment or college selectivity score. In the case of the latter outcome, Models 1 and 2 are specified as follows.

$$EdRank_i = \beta_0 + \beta_1 \times SES_i + \sum_{k=1}^K \beta_k X_i + u_i \quad (\text{Model 1})$$

$$EdRank_i = \beta_0 + \beta_1 \times SES_i + \beta_2 \times PGI_i + \sum_{k=1}^K \beta_k X_i + u_i \quad (\text{Model 2})$$

Where SES_i represents parental socioeconomic status at Wave 1 while PGI_i represents one's genetic risk associated with years of education.

In addition to estimating the independent effects of the parental SES and PGI, we also examine a potential interaction between them. Specifically, we add an interaction variable to the Models above.

$$EdRank_i = \beta_0 + \beta_1 \times SES_i + \beta_2 \times PGI_i + \beta_3 \times SES_i \times PGI_i + \sum_{k=1}^K \beta_k X_i + u_i \text{ (Model 3)}$$

Next, we estimate correlates of logged individual earnings as follows. We first estimate Model 1 as a baseline. In the case where we limit the sample to those who graduated college, the model is expressed as follows.

$$LogEarnings_i = \beta_0 + \beta_1 \times EdRank_i + \beta_2 \times SES_i + \sum_{k=1}^K \beta_k X_i + u_i \quad \text{(Model 1)}$$

We then add the education PGI and the interaction with college selectivity. By comparing the two models, we provide estimates of to what extent the genetic contribution to individual earnings differs by the college selectivity.

$$LogEarnings_i = \beta_0 + \beta_1 \times EdRank_i + \beta_2 \times SES_i + \beta_3 \times PGI_i + \beta_4 \times EdRank_i \times PGI_i + \sum_{k=1}^K \beta_k X_i + u_i \quad \text{(Model 2)}$$

For Models 3, 4, and 5, we are interested in the role of college degree or college selectivity as a great equalizer. First, Model 3 estimates the interaction between educational attainment (college degree or college selectivity) and parental SES, while Model 4 adds education PGI to examine whether the observed relationship between educational attainment and parental SES holds even accounting for genetic factors. In the case of college graduates, these models are expressed as follows.

$$LogEarnings_i = \beta_0 + \beta_1 \times EdRank_i + \beta_2 \times SES_i + \beta_3 \times EdRank_i \times SES_i + \sum_{k=1}^K \beta_k X_i + u_i \quad \text{(Model 3)}$$

$$\begin{aligned} \text{LogEarnings}_i = & \beta_0 + \beta_1 \times \text{EdRank}_i + \beta_2 \times \text{SES}_i + \\ & \beta_3 \times \text{EdRank}_i \times \text{SES}_i + \beta_4 \times \text{PGI}_i + \sum_{k=1}^K \beta_k X_i + u_i \end{aligned} \quad (\text{Model 4})$$

Lastly, we examine the gene-environment interaction for individual earnings by focusing on the PGI interaction with educational attainment and parental SES.

$$\begin{aligned} \text{LogEarnings}_i = & \beta_0 + \beta_1 \times \text{EdRank}_i + \beta_2 \times \text{SES}_i + \beta_3 \times \text{EdRank}_i \times \text{SES}_i + \\ & \beta_4 \times \text{PGI}_i + \beta_5 \times \text{PGI}_i \times \text{EdRank}_i + \beta_6 \times \text{PGI}_i \times \text{SES}_i + \sum_{k=1}^K \beta_k X_i + u_i \end{aligned} \quad (\text{Model 5})$$

Following a suggestion discussed by Domingue et al. (2020) which was originally pointed out by Keller (2014), we avoid model misspecifications by adding covariate-gene interactions and covariate-environment interactions to the analysis.

We also perform two sensitivity analyses to test whether our results are robust. Specifically, we examine (1) models considering selection into college degree attainment and (2) Mendelian imputation models that impute the missing parental genotypes (Young et al. 2022) in order to get a causally identified estimate of direct effects of the EA4 PGI on college completion/quality and earnings.

5. Results

5.1 Descriptive results

We first present descriptive figures to examine whether the association observed above differs by SES at Wave 1 when respondents were young adolescents. Figure 1 presents fitted lines describing the relationship of PGI with college degree, college selectivity, and individual earnings, for children of different parental SES. As we expected, Figure 1 shows that the education PGI is positively correlated with all three outcomes, but the slope is much steeper for

low SES children in college selectivity (the correlation coefficient is 0.30 for the 1st tercile and 0.20 for the 3rd tercile, both of which are statistically significant, though the difference between these two point estimates is not, itself, significant at conventional alpha levels). This result seems to call into question Chetty et al. (2020)’s claim that selective colleges are an important pathway for intergenerational upward mobility in the sense that there is a dynamic process that low SES students are more selective in terms of their genetic endowments than the high SES students. That said, the correlation of PGI with college degree among low SES children (0.31) is almost identical to that of high SES children (0.33), while the correlation of PGI with individual earnings among low SES children (0.18) is higher than that of high SES children (0.13).¹⁰

[Figure 1 about here]

5.2 Regression results: college degree and college selectivity

Descriptive results presented above suggest that the association between respondents’ education PGI, one measure that quantifies some part of “innate” ability inherited (mostly) through biological mechanisms from parents and later socioeconomic outcomes differ by parents’ socioeconomic status. We examine whether these results are supported even if we control likely confounders using OLS regressions. We also examine whether the contribution of education PGI to individual earnings is partly mediated by including college degree or college selectivity, which is also correlated with education PGI.

Table 2 presents the regression estimates on college degree (Panel A) and college selectivity (Panel B), respectively. Since the descriptive results suggest that higher correlation

¹⁰ Note that both differences are not statistically significant at the 5% level according to the Fisher’s z transformation.

between the PGI and college selectivity is observed for those from the lower SES quartile, we examined the non-linear relationship by estimating models where we add an interaction between the education PGI and squared parental SES to examine the non-linear relationship.

First, comparing results from Model 1 and Model 2 in Panel A, we can see that parental SES is a strong predictor of college degree attainment, but this effect is mitigated by considering education PGI. As expected, results from Model 2 show that education PGI is positively associated with one's college degree attainment. The magnitude of the coefficients (0.13) is comparable to that of parental SES (0.13). Looking at Model 3, the interaction term for education PGI and parental SES is not positive and is statistically insignificant, in contrast to results reported by Papageorge and Thom (2020) or Belsky et al. (2018). However, while the one-way interaction is not statistically significant, the two-way interaction (PGI and SES squared) is statistically significant at the 10% level.

Panel B of Table 2 presents the regression estimates on college selectivity. First, similar to results predicting college degree attainment, results from Model 1 suggest that parental SES is positively correlated with college selectivity, but the magnitude decreased from 0.26 in Model 1 to 0.22 in Model 2 where we considered education PGI. Looking at Model 2, we can see that the education PGI is a strong predictor of academic selectivity of colleges from which respondents graduate. Specifically, a one standard deviation increase in education PGI is associated with about a 0.17 standard deviation increase in college selectivity. We also examine the possibility of gene-environment interaction by adding an interaction variable between education PGI and parental SES. We see evidence for a gene-environment interaction. According to Model 3, we can see that the two-way interaction (education PGI and parental SES squared) is positively correlated with college selectivity and statistically significant at the 5% level.

Figure 2 presents the predicted college degree and college selectivity (both based on Model 3) by education PGI and parental SES. For illustration, the figure shows predicted probabilities if parental SES is either -1 or +1 standard deviation. As presented in Table 2, the statistically significant interaction between parental SES and education PGI for college selectivity suggests that the chance of those with higher education PGIs may depend on parental resources. For example, among those with a -1SD education PGI, their college selectivity is significantly lower for children of low SES parents than those with high SES parents, while the gap is smaller for children with a high education PGI. By contrast, we do not observe the same gradient for college degree. Rather, there is a weak positive interaction between education PGI and parental SES for this outcome.

[Table 2 about here]

[Figure 2 about here]

5.3 Regression results: the intersection of equalizing effects of college degree and genetics

Next, we examine how the genetic potential for educational attainment, realized educational attainment (either college degree or college selectivity), and parental SES combine to influence individual earnings in middle age (age 32-42). Results are shown in Table 3. We prepared for the two sets of samples, one including all respondents and the other limiting the sample to college graduates to examine the role of college selectivity. Model 1 is a baseline, where we can see that educational attainment is positively correlated with individual earnings for both of the samples. Specifically, a college degree is associated with a 58% increase in individual earnings, while a one standard deviation increase in the academic quality of college

respondents graduated is associated with a 18% increase in individual earnings. In Model 2, we add education PGI and its interaction with educational attainment. Results indicate that education PGI is positively correlated with individual earnings for both samples, but the statistical significance is only found for the sample that includes both non-college and college graduates. For both samples, the inclusion of education PGI reduces the magnitude of college degree or college selectivity. We also do not find evidence that the effect of educational attainment differs by genetic potential.

Models 3 to 5 test the thesis on the college as a great equalizer and the gene-environment interaction for labor market outcomes. First, Model 3 for the entire sample suggests that the effect of parental SES on individual earnings is muted among those who graduate college by 16%, which is consistent with the equalizer thesis, while we do not find evidence for the equalizer thesis for college selectivity. Rather, we see a positive interaction between college selectivity and parental SES, indicating that the parental SES effect on individual earnings is intensified among those who went to colleges with better quality. In Model 4, we add education PGI to see if this changes the interaction coefficient size. Results generally do not change when we include Education PGI in Model 4, although the relationship between college completion and parental SES is muted as the interaction term coefficients reduced from -0.16 to -0.14.¹¹ Lastly, Model 5 examines whether the relationship holds even after considering the potential gene-environment interactions. Looking at the relationship between a college degree and parental SES,

¹¹ Coefficients in Model 2 and Model 4 suggest that a one standard deviation increase in education PGI is associated with about a 9-11% increase in individual earnings for the entire sample. Using the Health and Retirement Study sample, one earlier study showed that men's education PGI is associated with an increase with a log earnings of 0.05 conditional on one's amount of schooling and parental SES (Papageorge and Thom 2020). Our estimates are higher than the previous study possibly because we used education PGI based on the EA4, which is estimated by a genome-wide association study (GWAS) of educational attainment in a sample of more than 3 million genotyped individuals, whereas Papageorge and Thom (2020) used EA3, which is based on the same GWAS of educational attainment with fewer genotyped individuals, which reduces the predictive power of the education PGI.

the magnitude is reduced from -0.14 to -0.10, but it is still statistically significant at a 10% level. Looking at the interaction between college selectivity and parental SES, the magnitude increases when we consider the gene-environment interactions (from 0.08 to 0.11), where one standard deviation increase in parental SES is associated with a 0.11 standard deviation increase in the size of college selectivity.

Similar to results on college degrees and college selectivity, we visualized the predicted individual earnings by the two types of educational attainment and parental SES. For illustration, we show results from Model 5. For college degree attainment, we can see that the flatter correlation between parental SES and individual earnings among college graduates does not change even after accounting for genetic correlation with educational attainment. For college selectivity, the figure shows the correlation between parental SES and individual earnings is reversed between those who graduated from a college with better quality and those who did not graduate from such colleges. Specifically, the correlation is positive for those who went to selective colleges, while it is negative for those who did not—the reverse of what we expected based on the results from Chetty et al. (2020).

[Table 3 about here]

[Figure 3 about here]

5.4 Supplementary Analysis

To summarize, these results suggest that genetic endowments play an important role in shaping vertical and horizontal educational stratification and later socioeconomic outcomes. However, the fact that these results are based on cross-family analysis raises the possibility that

the observed effect of genetic traits may reflect genetic nurture, as we discussed above (Kong et al. 2018; Wertz et al. 2019). For example, the parents' education PGI that is transmitted to children may also influence children's educational attainment through parenting, although such an effect would appear to be small in this context. Estimating sibling fixed effects models eliminate such indirect genetic effects (Howe et al. 2021; Young et al. 2019), but this method often suffers from being extremely underpowered due to the small sample size.

In the supplementary analysis, therefore, we provide additional analysis that uses Mendelian imputation to impute the missing parental genotypes (Young et al. 2022). This method allows us to address the concern that child's genotype may be reflecting unmeasured parental characteristics mentioned above. In order to eliminate the influence caused by the environment that parents provide, we examine the Mendelian imputation method using SNIPar (Young et al. 2022). This method can be applied when genotypes are observed for the child and their sibling. If the observed sibling's genotype is homozygote (e.g., AA) and the child's genotype is heterozygote (e.g., AT), we can infer one-half of the missing parental genotype exactly, while we can give the expectation of the other half based on the population allele frequency. The same is the case when the observed sibling's genotype is heterozygote, and the child's genotype is homozygote. In cases where both the child's and sibling's genotype are heterozygote, we can calculate the expectation of the missing parental genotype as the average over the two inheritance patterns (Young et al. 2022). Results are shown in Appendix Table 1. Among 3,114 sibling pairs including dizygotic twins in the dataset, the number of individuals who remained after limiting the sample to non-Hispanic Whites with no missing values is 555 for the analysis of college degree, 134 for the analysis of college selectivity, and 550 for the analysis of individual earnings. To deal with the limited sample size, we only examined the

effects of the PGI on a college degree and earnings including non-college graduates. There are three findings worth reporting. Model 1 for a college degree is identical to Model 3 in Panel A of Table 2, while Model 1 for earnings is identical to Model 4 in Panel A of Table 3. Results from the imputation sample without parental PGI is shown in Model 2 and ones with parental PGI are shown in Model 3. First, similar to the results presented earlier, comparing Model 1 and Model 2 suggests that the education PGI is positively correlated with college completion. Second, for individual earnings, the effect of education PGI is weaker in Model 2 than in Model 1 and not statistically significant. Third, the relationship holds even after controlling for the parental genome. To summarize, we see generally similar results for the imputation analysis, while the smaller sample size limits our ability to evaluate the association between the education PGI and college selectivity.

Also, the sample for results predicting college selectivity is limited to those who completed college, so this excludes someone who did not attend college or dropped out of school. To examine whether our results are robust when we consider selection into college completion, Appendix Table 2 compares the estimated results with one using Heckman correction. Overall, we see similar results between the one that does not include non-college graduates and the one that considers differential selection, although the size of the coefficients varies.

Lastly, we also estimated logged annual household income at Wave 5. Results are shown in Appendix Table 3. Similar to results on annual earnings, both education PGI and college selectivity are positively associated with higher household income (Models 1 and 2), except for a null association between education PGI and household income among those who completed college. We also find some evidence for the equalizer thesis for college completion (Model 3),

which is muted by considering education PGI (Model 4) and the interaction between education PGI and parental SES (Model 5).

6. Discussion

Taking advantage of the unique combination of genetic and college selectivity data available in Add Health, this study is the first attempt to examine the role of genetic endowments associated with educational attainment on horizontal stratification in higher education. Results generally support a role for genetics in horizontal educational stratification. Specifically, one's genetic risk score for years of education is positively associated not only with college degree attainment but also with college selectivity, supporting Hypotheses 1a and 1b. We also considered whether the genetic traits are associated with later labor market outcomes measure by analyzing individual earnings net of realized education including college selectivity. Results indicate the impact of education PGI remains even if we consider later life-course outcomes while controlling for its influence on college degree, supporting Hypothesis 1c. However, that the effect of the education PGI on individual earnings is not statistically significant when we limit the sample to those graduate college to examine the role of college selectivity. We should note here that the analysis including college selectivity is limited to college graduates, so we cannot directly compare the result with models predicting individual earnings for the entire sample including non-college goers.

We also tested college as a great equalizer hypothesis. Results from the entire sample provides supportive evidence for the thesis. As observed by previous studies, we found that the association between class background and labor market outcomes is weaker among college graduates. Interestingly, we also find that this equalizing effect remains even accounting for

genetic potential for educational attainment, thus supporting Hypothesis 2a while rejecting Hypothesis 2c. This result can be contrasted with a recent study by Zhou (2019), which argued that the observed equalizing effect of a college degree is mainly driven by differential selection into college education by “high-ability, high-motivation” (ibid: 475), especially for children from low and middle socioeconomic backgrounds. Although we did not find differential genetic selection into college degree attainment by parental socioeconomic status, the evidence for the equalizing effect of college education net of genetic propensities for educational attainment suggests that the observed equalizing effect may not be driven by potential ability variation predicted by genes. Interestingly, in contrast to the effect of college degree attainment, we found the opposite interaction effect on individual earnings for college selectivity. Specifically, the correlation between parental SES and individual earnings is positive for those who went to selective colleges while the correlation is negative for those who went to non-selective colleges—the reverse of what Chetty et al (2022) found. Meanwhile, we found there is a sizable association between education PGI and college selectivity. This is especially the case for lower SES students, consistent with Hypothesis 2b, which thus raise questions about the leveling effect of elite college attendance observed by Chetty et al. (2017, 2020).

Lastly, we also tested the gene-environment interaction hypothesis with molecular data and for horizontal educational outcomes. Specifically, we examined the Scarr-Rowe hypothesis, which posits a higher heritability of ability among advantaged families. Results on college degree attainment found weak support for the hypothesis. By contrast, our results do not provide support for a gene-environment interaction for college selectivity and labor market outcomes, as children from advantageous families do not necessarily enjoy additional benefits with respect to college selectivity or labor market outcomes when they enjoy higher genetic endowments.

Rather, the result is the opposite for college selectivity, as we found that the genetic selection into better quality colleges is much steeper for children from lower SES backgrounds. Therefore, these results provide limited support for the Scarr-Rowe hypothesis.

It would be worth discussing the implication of the findings that the GxE interaction is found for selective college selection but not for the labor market outcomes. At the stage of college admission, there are two equally important selection mechanisms, genetic endowments and parental SES. As the descriptive results shown in Figure 1 suggest the ability selection gradient for highly selective colleges is steeper for lower-SES students, which evinces a skeptical view towards the argument made by many studies (e.g. Chetty et al. 2020) that access to selective colleges is an important mechanism for upward social mobility, regression results indicate that these two sources of selection mechanisms are likely to interactively influence opportunities for college selectivity.

However, the very selection may not induce an interaction of the education PGI and parental SES for the labor market outcomes despite the differential genetic selection into attending selective colleges by parental SES. Rather, results on the effect of college selectivity on earnings found that economic returns to college selectivity are higher for those from high SES parents than low SES parents regardless of their genetic potential. This result suggests that the persistent importance of social origins in shaping children's socioeconomic success. For example, one recent qualitative research studying the hiring process of high-paying firms in the United States argues that when recruiters approach students at elite universities, they do emphasize students' social skills or involvements in extracurricular activities, which are correlated with parental SES (Rivera 2015). Similar findings have been reported by a study using a historical archive of Harvard graduates during the early 20th century (Michelman et al. 2021),

arguing that high SES students are more likely to join an exclusive campus club than low SES students, which raises labor market outcomes during middle age. This suggests that, regardless of whether students are talented or not, parental SES may enhance the chance for the job market success by improving the returns to college selectivity.¹² As such, genetic endowments may not play an important role in reducing preexisting inequality, especially at prestigious colleges (Karabel 2006; Lucas 2001).

This study has made three contributions to the literature on horizontal stratification in higher education and one contribution to the sociogenomics literature. First, this is the first study to provide an estimate of the impact of one's "innate" ability on college selectivity. To quantify the contribution of parental background to unequal access to selective institutions, earlier work has measured students' abilities by using test scores or intelligence test results; however, these scores are already influenced by parental social backgrounds. By using the genetic measure presented here that is presumably less influenced by parental backgrounds than those measures, we believe our results provide less endogenous estimates of both parental social background and children's genetic endowments. Second, our results provide new evidence that college selectivity matters for one's earnings even if we control for their genetic endowments (as noisily measured by the EA4 PGI). Earlier work that cast doubt on the "college selectivity effect" has argued that the positive association between college selectivity and labor market outcomes is spurious by matching college admission results with earnings data to eliminate selection bias due to unobserved student abilities (Dale and Krueger 2002; 2014). While such an approach was considerably different from ours, we also considered conditioning on one's abilities by using a genetic measure. Last, to the sociogenomics literature, our analysis contributes by providing the

¹² In a similar vein, one study reported a positive interaction between one's academic achievement and parental SES for college selectivity (Davies and Guppy 1997).

first estimate supporting the gene-environment interaction for college selectivity, an important aspect of educational stratification.

We are aware of this study's limitations, such as a small sample size, which constrains our ability to estimate precise results, especially for within-family models, and the limitation of analysis to non-Hispanic whites, which prohibits the generalization of the results to a wider population. Another limitation is that our study did not control for indirect genetic effects, or "genetic nurture." (Kong et al. 2018; Wertz et al. 2019) except in supplementary analyses. Still, we believe this study provides an important contribution to human capital and social stratification literatures by examining the process through which genetic variants contribute to variation in educational and economic outcomes.

Table 1 Descriptive Statistics

	Mean	SD	Min	Max	N
Female	0.57	0.50	0.00	1.00	3464
Age at Wave 5	22.09	1.78	18.00	28.00	3464
Child health at Wave 1	3.91	0.88	1.00	5.00	3464
Constructed SES (std.)	0.00	1.00	-4.11	2.71	3464
EA4 SSGAC residualized (std.)	0.00	1.00	-3.36	3.70	3464
College completion	0.43	0.50	0.00	1.00	3464
College selectivity (std.)	0.00	1.00	-2.43	1.55	677
Logged individual earnings at Wave 5	10.49	1.19	7.82	12.45	3435

Table 2 OLS Regressions Estimating College Degree and College Selectivity

A. College degree						
	Model 1		Model 2		Model 3	
Female	0.11***	(0.02)	0.10***	(0.02)	0.10***	(0.02)
Age at Wave 5	-0.00	(0.01)	-0.00	(0.01)	0.00	(0.01)
Child health at Wave 1	0.07***	(0.01)	0.06***	(0.01)	0.06***	(0.01)
Constructed SES (Std.)	0.18***	(0.01)	0.13***	(0.01)	0.17***	(0.01)
Education PGI (Std.)			0.13***	(0.01)	0.14***	(0.01)
PGI * SES					0.01	(0.01)
SES (squared)					0.03***	(0.01)
PGI * SES (squared)					-0.01#	(0.00)
Constant	0.10	(0.14)	0.12	(0.13)	0.08	(0.12)
Observations			3464			
R2	0.19		0.28		0.31	
B. College selectivity						
	Model 1		Model 2		Model 3	
Female	-0.06	(0.10)	-0.02	(0.10)	-0.04	(0.10)
Age at Wave 5	-0.05#	(0.03)	-0.05#	(0.03)	-0.04#	(0.03)
Child health at Wave 1	0.12#	(0.07)	0.12	(0.07)	0.12#	(0.06)
Constructed SES (Std.)	0.26***	(0.06)	0.22***	(0.05)	0.25***	(0.07)
Education PGI (Std.)			0.17**	(0.06)	0.23**	(0.08)
PGI * SES					-0.10#	(0.06)
SES (squared)					0.00	(0.05)
PGI * SES (squared)					0.11*	(0.05)
Constant	0.37	(0.73)	0.23	(0.66)	0.17	(0.62)
Observations			677			
R2	0.06		0.15		0.27	

Standard errors in parentheses

p<0.1 * p<0.05 ** p<0.01 *** p<0.001

Table 3 OLS Regressions Estimating Logged Annual Individual Earnings

A. All samples	Model 1		Model 2		Model 3		Model 4		Model 5	
Female	-0.58***	(0.05)	-0.58***	(0.05)	-0.59***	(0.05)	-0.58***	(0.05)	-0.57***	(0.05)
Age at Wave 5	0.04***	(0.01)	0.04***	(0.01)	0.04***	(0.01)	0.04***	(0.01)	0.04***	(0.01)
Child health at Wave 1	0.08*	(0.03)	0.06#	(0.03)	0.08*	(0.03)	0.07*	(0.03)	0.07#	(0.03)
College degree	0.58***	(0.05)	0.51***	(0.05)	0.60***	(0.05)	0.53***	(0.06)	0.52***	(0.06)
Constructed SES (Std.)	0.17***	(0.03)	0.14***	(0.02)	0.22***	(0.04)	0.19***	(0.03)	0.17***	(0.03)
Education PGI (Std.)			0.10**	(0.04)			0.08**	(0.03)	0.09*	(0.04)
College degree * Education PGI			-0.04	(0.05)					-0.00	(0.06)
College degree * SES					-0.16**	(0.05)	-0.14**	(0.05)	-0.10#	(0.06)
SES * Education PGI									-0.02	(0.03)
Constant	9.30***	(0.31)	9.41***	(0.32)	9.33***	(0.30)	9.38***	(0.31)	9.44***	(0.32)
Observations	3435									
R2	0.17		0.21		0.18		0.19		0.21	
B. Limited to college completion	Model 1		Model 2		Model 3		Model 4		Model 5	
Female	-0.66***	(0.10)	-0.61***	(0.09)	-0.66***	(0.10)	-0.63***	(0.10)	-0.60***	(0.10)
Age at Wave 5	0.06*	(0.03)	0.07*	(0.03)	0.06*	(0.03)	0.07*	(0.03)	0.07*	(0.03)
Child health at Wave 1	-0.03	(0.06)	-0.01	(0.06)	-0.03	(0.06)	-0.00	(0.06)	-0.02	(0.07)
College selectivity (Std.)	0.18***	(0.05)	0.14*	(0.06)	0.15**	(0.05)	0.14**	(0.05)	0.11	(0.07)
Constructed SES (Std.)	-0.01	(0.05)	-0.01	(0.05)	0.00	(0.05)	0.01	(0.05)	0.10	(0.08)
Education PGI (Std.)			0.05	(0.06)			0.03	(0.05)	0.03	(0.07)
College selectivity * Education PGI			-0.00	(0.04)					-0.03	(0.05)
College selectivity * SES					0.06	(0.04)	0.08#	(0.04)	0.11*	(0.05)
SES * Education PGI									-0.01	(0.08)
Constant	10.17***	(0.69)	9.78***	(0.70)	10.14***	(0.69)	9.80***	(0.70)	9.84***	(0.69)
Observations	676									
R2	0.14		0.25		0.14		0.19		0.29	

Standard errors in parentheses

p<0.1 * p<0.05 ** p<0.01 *** p<0.001

Note: 20 PCs to account for population stratification, interactions between (1) parental SES and PCs and (2) PGI and PCs included.

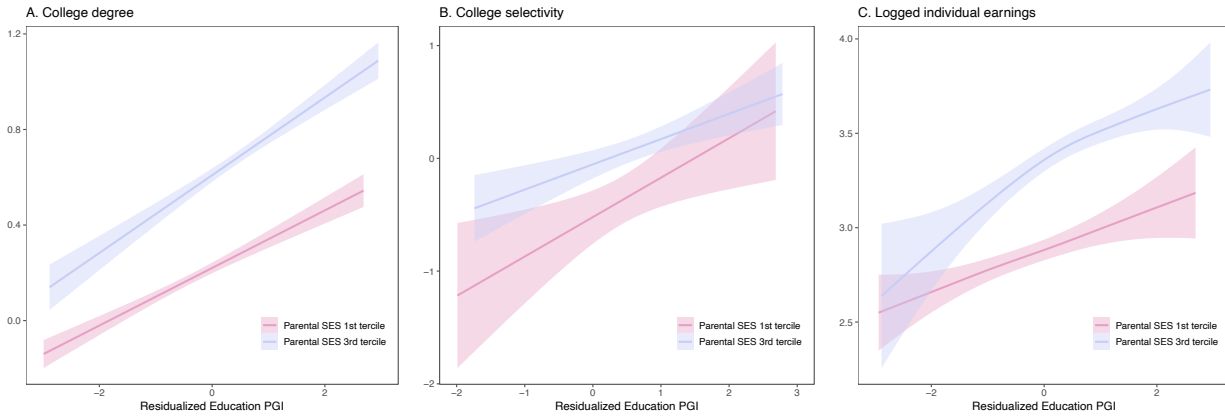


Figure 1 Correlation of Education PGI with College Degree, College Selectivity and Individual Earnings by Parental SES Tercile at Wave 1 with 95% Confidence Intervals

Note: Education PGIs are residualized by subtracting the observed PGI from the PGI predicted by a linear regression using 20 PCs.

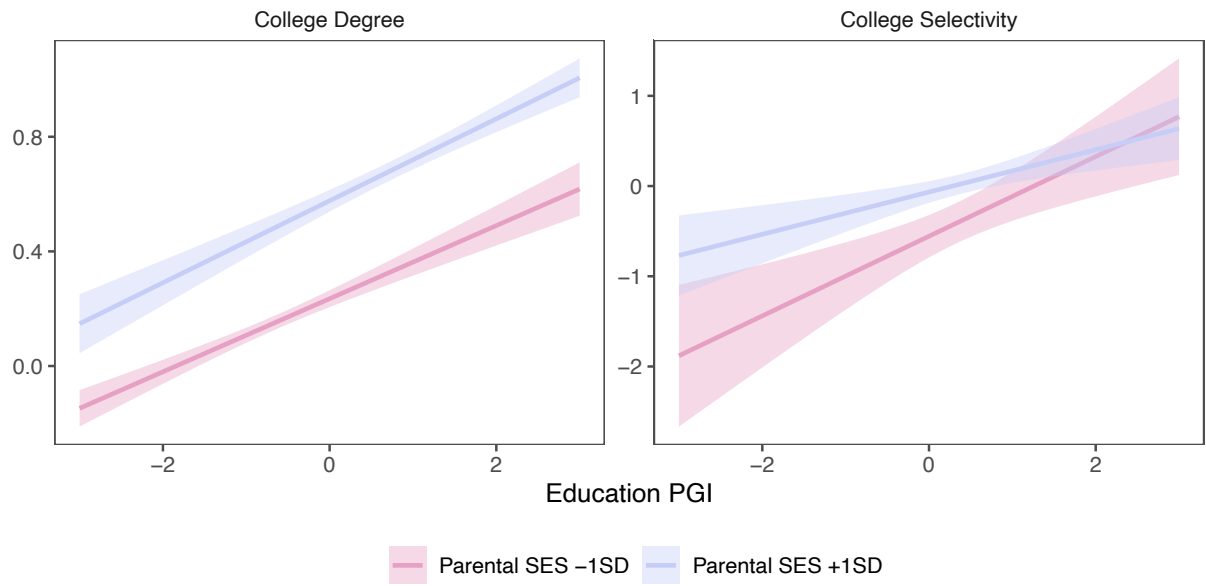


Figure 2 Predicted College Degree and College Selectivity by Education PGI and Parental SES with 95% Confidence Intervals

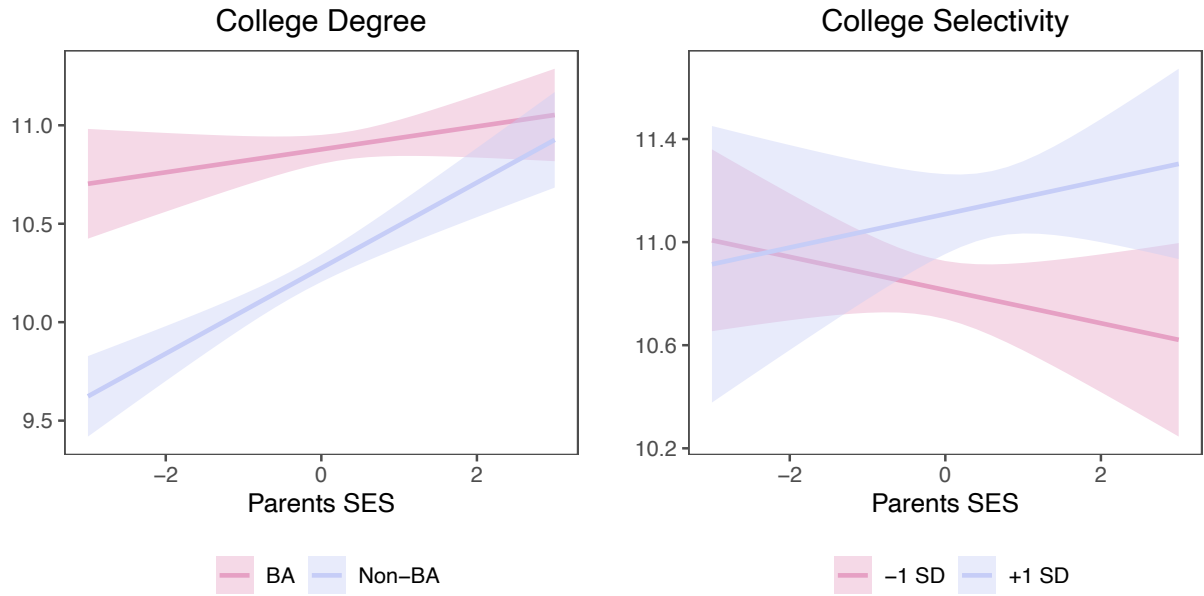


Figure 3 Predicted Logged Annual Earnings by Educational Attainment and Parental SES with 95% Confidence Intervals

Appendix for Chapter 1

Table A1 The Comparison between Models with and without Parental Genotype Imputation

A. College degree	Model 1		Model 2		Model 3	
Female	0.10***	(0.02)	0.04	(0.04)	0.04	(0.04)
Age at Wave 5	0.00	(0.01)	-0.00	(0.01)	-0.00	(0.01)
Child health at Wave 1	0.06***	(0.01)	0.05*	(0.02)	0.05*	(0.02)
Constructed SES (Std.)	0.17***	(0.01)	0.26***	(0.03)	0.26***	(0.03)
Education PGI	0.14***	(0.01)	0.17***	(0.03)	0.17***	(0.03)
PGI * SES	0.01	(0.01)	0.02	(0.03)	0.02	(0.03)
SES (squared)	0.03***	(0.01)	0.02	(0.03)	0.02	(0.03)
PGI * SES (squared)	-0.01#	(0.00)	-0.02	(0.01)	-0.02	(0.01)
Parental PGI					0.10	(0.27)
Constant	0.08	(0.12)	0.19	(0.32)	0.20	(0.31)
Observations	3464		555		555	
R2	0.31		0.46		0.46	
B. Logged individual earnings	Model 1		Model 2		Model 3	
Female	-0.58***	(0.05)	-0.62***	(0.11)	-0.62***	(0.11)
Age at Wave 5	0.04***	(0.01)	0.08*	(0.03)	0.08*	(0.04)
Child health at Wave 1	0.07*	(0.03)	-0.02	(0.06)	-0.02	(0.06)
College completion	0.53***	(0.06)	0.34*	(0.14)	0.34*	(0.14)
Constructed SES (Std.)	0.19***	(0.03)	0.19*	(0.08)	0.20*	(0.08)
College degree * SES	-0.14**	(0.05)	-0.10	(0.20)	-0.10	(0.20)
Education PGI	0.08**	(0.03)	0.05	(0.09)	0.05	(0.08)
Parental PGI					0.24	(0.84)
Constant	9.38***	(0.31)	9.00***	(0.77)	9.02***	(0.78)
Observations	3435		550		550	
R2	0.19		0.26		0.26	

Standard errors in parentheses

p<0.1 * p<0.05 ** p<0.01 *** p<0.001

Note: 20 PCs to account for population stratification, interactions between (1) parental SES and PCs and (2) PGI and PCs included.

Table A2 OLS Regressions Estimating College Selectivity with and without Heckman Correction

	Limited to college degree holders		With Heckman correction	
Female	-0.04	(0.10)	0.08	(0.25)
Age at Wave 5	-0.04#	(0.03)	-0.07	(0.19)
Child health at Wave 1	0.12#	(0.06)	0.09#	(0.05)
Constructed SES (Std.)	0.25***	(0.07)	0.33	(0.53)
Education PGI	0.23**	(0.08)	0.25	(0.41)
PGI * SES	-0.10#	(0.06)	-0.07	(0.06)
SES (squared)	0.00	(0.05)	-0.04	(0.04)
PGI * SES (squared)	0.11*	(0.05)	0.06#	(0.04)
Constant	0.17	(0.62)	0.54	(1.41)
Observations	677		3,470	

Standard errors in parentheses

$p < 0.1$ * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Note: 20 PCs to account for population stratification, interactions between (1) parental SES and PCs and (2) PGI and PCs included. For Heckman selection, college attendance is estimated by female, age, education PGI, constructed SES, and 20PCs.

Table A3 OLS Regressions Estimating Logged Annual Household Income

A. All samples	Model 1		Model 2		Model 3		Model 4		Model 5	
Female	-0.16***	(0.04)	-0.17***	(0.04)	-0.17***	(0.04)	-0.17***	(0.04)	-0.17***	(0.04)
Age at Wave 5	0.03**	(0.01)	0.02*	(0.01)	0.03*	(0.01)	0.03*	(0.01)	0.02*	(0.01)
Child health at Wave 1	0.12***	(0.03)	0.11***	(0.03)	0.12***	(0.03)	0.11***	(0.03)	0.11***	(0.03)
College degree	0.51***	(0.05)	0.45***	(0.05)	0.52***	(0.05)	0.47***	(0.05)	0.45***	(0.05)
Constructed SES (Std.)	0.22***	(0.03)	0.19***	(0.02)	0.25***	(0.04)	0.22***	(0.03)	0.20***	(0.03)
Education PGI (Std.)			0.08*	(0.03)			0.06*	(0.02)	0.08*	(0.03)
College degree * Education PGI			-0.04	(0.05)					-0.03	(0.05)
College degree * SES					-0.09#	(0.05)	-0.07	(0.05)	-0.04	(0.05)
SES * Education PGI									-0.01	(0.02)
Constant	10.06***	(0.27)	10.26***	(0.26)	10.08***	(0.27)	10.17***	(0.26)	10.27***	(0.26)
Observations	2,985									
R2	0.22		0.25		0.22		0.24		0.27	
B. Limited to college completion	Model 1		Model 2		Model 3		Model 4		Model 5	
Female	-0.06	(0.06)	-0.03	(0.06)	-0.07	(0.06)	-0.05	(0.06)	-0.03	(0.06)
Age at Wave 5	0.06***	(0.02)	0.05**	(0.02)	0.06***	(0.02)	0.06**	(0.02)	0.06**	(0.02)
Child health at Wave 1	0.04	(0.05)	0.08#	(0.04)	0.05	(0.05)	0.05	(0.05)	0.07#	(0.04)
College selectivity (Std.)	0.14***	(0.04)	0.07	(0.04)	0.10**	(0.03)	0.08*	(0.04)	0.01	(0.04)
Constructed SES (Std.)	0.11**	(0.04)	0.12**	(0.04)	0.11**	(0.03)	0.12**	(0.04)	0.16**	(0.05)
Education PGI (Std.)			-0.01	(0.05)			0.00	(0.04)	-0.00	(0.05)
College selectivity * Education PGI			0.09*	(0.03)					0.08*	(0.04)
College selectivity * SES					0.07*	(0.03)	0.08*	(0.03)	0.10**	(0.03)
SES * Education PGI									-0.00	(0.04)
Constant	10.19***	(0.43)	10.25***	(0.45)	10.16***	(0.43)	10.29***	(0.44)	10.09***	(0.49)
Observations	591									
R2	0.10		0.20		0.11		0.16		0.27	

Standard errors in parentheses

p<0.1 * p<0.05 ** p<0.01 *** p<0.001

Note: 20 PCs to account for population stratification, interactions between (1) parental SES and PCs and (2) PGI and PCs included.

CHAPTER 2: Explaining Declining Educational Homogamy: The Role of Institutional Changes in Higher Education in Japan

1. Introduction

The question of who marries whom is of great interest to demographers and stratification researchers. Research on assortative mating suggests that an increase in educational homogamy at the top of educational distribution may affect economic inequality (Burtless 1999; Schwartz 2010) and the intergenerational transmission of advantages (Breen and Andersen 2012; Breen and Salazar 2010; Esping-Andersen 2007; Torche 2010). Of particular theoretical interest to researchers has been how educational expansion affects educational homogamy trends (Blossfeld 2009; Kalmijn 1998; Schwartz 2013). Explanations vary, with some hypotheses predicting a positive influence of educational expansion (Blossfeld 2009; Blossfeld and Timm 2003; Kalmijn 1998; Mare 1991; Rauscher 2015) and others predicting the contrary (Smits 2003; Smits and Park 2009).

Empirical evidence on educational expansion's effects on educational homogamy is also inconsistent (Blossfeld 2009; Hout and DiPrete 2006). In absolute terms, with educational expansion and therefore a greater number of women than men in higher education, educational hypergamy (women marrying up) is decreasing, whereas both homogamy and hypogamy (women marrying down) are increasing in many countries (Esteve et al. 2012, 2016; van Bavel et al. 2018).¹³ However, after controlling for compositional differences in educational attainment

¹³ Research on educational assortative mating typically views higher education as a single category for all types of four-year (and higher) tertiary education.

across time, research has found that relative trends in educational homogamy vary across countries (Hout and DiPrete 2006).¹⁴

I argue that those studies have overlooked an important mechanism: the growth in institutional heterogeneity. Prior studies have argued that the *quantitative* change in higher education has transformed the *qualitative* aspects of higher education. Specifically, education expansion is accompanied by a growth of institutional heterogeneity through the proliferation of lower tier institutions (Arum et al. 2007; Hoxby 2009). The impacts of the growth of institutional heterogeneity could be driven by two mechanisms. First, it could be driven by a *compositional* process: the baseline odds of homogamy for graduates of lower tier institutions may differ from those of higher tier institution graduates, whereas the relative distribution of these graduates has changed over time. Specifically, the former may be more likely to marry non-college graduates than are members of the most selective group, who are more likely to marry graduates of equally selective educational institutions (Arum et al. 2008). If so, the increase in the number of graduates of lower tier institutions may decrease the odds of homogamy among college graduates if no compositional adjustment is made. Second, it could be driven by a *diverging* process: the odds of homogamy for lower tier and higher tier graduates have changed over time, net of the compositional changes. If the boundary between selective and less selective groups has intensified with the increase in the number of lower tier institutions, then recent cohorts of these graduates of selective universities may be increasingly more likely to marry selective college graduates.¹⁵ If correct, this contributes to mitigating the decline in educational homogamy.

¹⁴ Using simple categorical measures of education, prior studies have measured educational assortative mating in two ways: (1) the overall prevalence of different types of pairings; or (2) the relative likelihood of different pairings, net of marginal distributions. The current study focuses on the second type of measure.

¹⁵ Arum and Roksa (2014) defined U.S. college selectivity based on the SAT percentile scores of college entrants. The university hierarchy in Japan reflects the difficulty of entrance examinations (Ishida 2007), but

This study is motivated by the concern that ignoring the growth of within-group variation in higher education may prevent the accurate evaluation of educational assortative mating trends. Although previous studies mentioned this growth as a likely explanation of current educational homogamy trends (Arum et al. 2008; Hersch 2013; Schwartz and Mare 2005), they did not evaluate this possibility by explicitly modeling the implications of the growing differentiation in higher education for assortative mating trends. A focus on the growing heterogeneity among university graduates in terms of their institutional selectivity could help decipher the mixed evidence on the trends in educational homogamy across countries and provide new insights into the potential role of educational assortative mating in stratification and inequality.

Another focus of this study is the relative gender difference in the expansion rate. Previous studies have assumed that the odds of educational homogamy net of compositional changes are less affected by the different expansion rates by gender. However, the odds of marrying homogamously are a function of not only one's educational group size but also the relative proportions of males and females within one's educational level. Thus, examining both the expansion of higher education and gender differences in rates of expansion is critical for understanding the putative role of educational expansion in generating trends in educational homogamy. With this consideration in mind, the current study explicitly examines female hypergamy patterns in university education.

I focus on Japan, which provides an interesting case of potentially broader relevance to other societies because of its clear and widely acknowledged selectivity-based hierarchy of higher education institutions. Educational homogamy in Japan has declined continuously since

institutions that require higher entrance examination scores are often historically prestigious. Therefore, selectivity measures based on entrance examinations and institutional prestige are highly correlated, and I use selectivity.

the 1950s (Fujihara and Uchikoshi 2019; Fukuda et al. 2021; Miwa 2007). Increased postsecondary educational attainment in Japan has been promoted through the growth of private institutions, including upgrades of private junior colleges, which are seen as lower in the selectivity hierarchy (Ishida 2007). If this increasing share of private universities has reduced the relative value of tertiary education in the marriage market in Japan, graduates of these institutions may be increasingly likely to marry nongraduates, as one recent study speculated (Fukuda et al. 2020).¹⁶

The current study addresses three questions. First, I ask whether the strength of homogamy among university graduates varies by the selectivity of the institution they attended. I hypothesize that educational homogamy is stronger for graduates of the most selective universities and less pronounced for graduates of less selective universities. Second, after confirming the previously documented decline in homogamy among university graduates, I examine the extent to which the declining trend reflects a combination of the compositional shift, especially among graduates of lower tier institutions, and an increasing likelihood of homogamy among selective college graduates. Third, I evaluate the potential role of relative gender differences in the rate of higher education by examining the persistence of female educational hypergamy in university education.

This study contributes by updating the general implications of educational assortative mating for stratification research. Specifically, the results of this study imply that the mechanism behind educational assortative mating trends in Japan may also operate in other contexts where educational expansion is characterized by stratification in higher education through the growth of

¹⁶ Of course, younger cohorts in Japan are marrying later and less, and these shifts could influence patterns of educational assortative mating. Although interesting and important, these aspects are not directly relevant to the analyses of educational pairing *conditional* on marriage.

lower tier institutions (Hoxby 2009; Roksa et al. 2007). This study also provides important insights into the potential role of horizontal stratification in contemporary societies (Gerber and Cheung 2008). As an increasing number of individuals enter higher education in many countries, looking only at the vertical aspects of educational attainment obscures a potentially important source of inequality.

2. Background

Expansion and Differentiation in Higher Education Institutions

Changes in educational assortative mating depend on how institutional contexts influence preferences and the opportunity structure in the marriage market (e.g., Blossfeld and Timm 2003; Rauscher 2015), two components influencing *who marries whom* (Kalmijn 1998). Among the possible institutional mechanisms, educational expansion is particularly relevant. Although prior studies posited varied theoretical expectations, they all assumed that increased access to higher education occurs uniformly. The limited focus on the quantitative increase in the number of highly educated individuals (which I call *expansion*) may obscure another important mechanism that influences the pattern of educational assortative mating: the growth of variation within higher education (which I call institutional *differentiation*) (Arum et al. 2007).

Both opportunity structure and preference perspectives have hypothesized that educational expansion can increase educational homogamy. On the one hand, structural theory (Blau and Schwartz 1984), which focuses on the role of opportunity structure, explicitly posits that educational expansion increases homogamy, especially among the highly educated, because such expansion increases the possibility of meeting equally educated spouses at the ages when marriage is most likely to occur (Blossfeld 2009; Mare 1991). On the other hand, preference-

based hypotheses also predict that educational expansion leads to increased homogamy. Schwartz and Mare (2005), for example, posited that potential spouses' preferences for partners have become more symmetric over time as a result of women's increasing education and earning potential (Oppenheimer 1988). Both hypotheses have been supported with data from many contexts (Han 2010; Hu and Qian 2015; Ravazzini et al. 2017; Wong 2003).

Smits (2003) and Smits and Park (2009), however, predicted an opposite consequence of educational expansion. Their *exclusivity hypothesis* suggests that educational homogamy among college graduates is stronger when their group size is smaller. Their rationale comes from the theory of status closure or status-group credentialism (Collins 1979), which posits that small, elite groups are aware of their advantages. This awareness may increase these groups' motivation to maintain their social boundaries and exclude out-groups (Parkin 1971). If group size increases, however, the relative value of higher education decreases, and barriers to mating with members of elite groups should also decrease. Therefore, this hypothesis predicts that educational expansion promotes intermarriage between educational elites and others. In line with this theoretical expectation, educational assortative mating has declined in several countries, including Japan (Fujihara and Uchikoshi 2019; Fukuda et al. 2021; Miwa 2007), France (Bouchet-Valat 2014), Denmark (Andrade and Thomsen 2019), Eastern Europe (Katrňák and Manea 2020), and East Asia (Smits and Park 2009).

The exclusivity hypothesis better aligns with this study's perspective on the co-occurrence of expansion and differentiation than other hypotheses stated above because this hypothesis predicts that a *quantitative* increase in group size is accompanied by *qualitative* changes in the value of higher education in the marriage market. However, even this hypothesis does not consider the likely heterogeneity among university graduates. The distinction between

expansion and *differentiation* provides important insights, especially when the growth of less selective institutions promotes an increase in the number of people with higher education (Arum et al. 2007:5). Although they only indirectly addressed the topic, a few studies have found that college selectivity is associated with marrying spouses from postsecondary institutions with similar academic selectivity (Arum et al. 2008; Feng 2022; Uchikoshi and Raymo 2021). These results suggest that graduates of selective institutions are more likely to seek marriage partners who are college graduates of similarly ranked institutions to maintain social boundaries, which is consistent with the exclusivity hypothesis.

Arguably, the distinction between educational expansion and differentiation within higher education is not new in social stratification research. Lucas' (2001) *effectively maintained inequality* (EMI) hypothesis provides relevant insights into my research question. This hypothesis posits that educational inequality is maintained even when vertical inequality in educational attainment decreases through improved access to higher education because privileged groups seek qualitative advantages within a given level of education to maintain their positions.¹⁷ Applying this perspective, I expect that to the extent that the importance of selectivity within higher education is constant or increases in tandem with the increase in the number of lower tier private institutions in Japan, the strength of homogamy among graduates of selective universities will increase.

Importantly, these theories have not adequately addressed the potential role of relative gender differences in higher education expansion. Indeed, trends in access to higher education often differ for men and women (DiPrete and Buchmann 2013; Esteve et al. 2012). The gender

¹⁷ Attempts to link the EMI hypothesis to educational assortative mating are not new, as Andrade and Thomsen (2019) mentioned an impact of differentiation in higher education on assortative mating, but their focus was more on diversification of fields of study.

gap in educational expansion has a direct influence on the absolute rate of educational assortative mating, such as the increasing prevalence of educational hypogamy (Esteve et al. 2012; van Bavel et al. 2018), and the gender gap also critically influences the relative odds of educational homogamy. For example, 100 men and 100 women have a university education. If the total number of university graduates increases by 100 men and 0 women, fewer women per man would have a university degree. Therefore, it is impossible for homogamy to increase under such circumstances because no more than one half of the men with a university degree can marry similarly educated women. This simple example demonstrates the importance of considering both higher education expansion and the relative gender differences in expansion rates. This perspective is critical for understanding educational assortative mating in Japan, which is characterized by a strong preference for female hypergamy (Brinton et al. 2021; Raymo and Iwasawa 2005).

The Japanese Context

Trends in Educational Assortative Mating

Much evidence suggests that educational homogamy has declined in Japan (Fujihara and Uchikoshi 2019; Fukuda et al. 2021; Miwa 2007). The overall odds of homogamy, for example, decreased by approximately 25% between the 1950–1954 and 1975–1979 birth cohorts (Fujihara and Uchikoshi 2019). Unfortunately, these studies also treated university degrees and their granting institutions as homogeneous, which limits our understanding of the plausible impacts of the growing heterogeneity in higher education on assortative mating. Importantly, however, a few studies suggested that a closer look at the growth in heterogeneity within higher education provides important insights into the decline in educational assortative mating in Japan. Japan has

been characterized by the social norm that encourages women to prefer “marrying up” (female hypergamy) (Brinton et al. 2021; Raymo and Iwasawa 2005). This hypergamy norm was rooted in gender-inegalitarian social regimes in which socioeconomic status was systematically lower among women than among men. In contrast to well-established knowledge, Fukuda et al. (2020) found an increase in educational hypogamy among university-educated women who married between 1990 and 2013. They interpreted this finding as suggesting that “the social and economic boundaries between lower-ranked universities and technical colleges may be declining among younger cohorts” (Fukuda et al. 2020:1393).

An Overview of Japan’s Higher Education System

Japanese universities are characterized by their position within a clear and widely acknowledged hierarchy of institutional selectivity (Yonezawa et al. 2002).¹⁸ National/public universities are often perceived to be more selective and of better quality, whereas private universities (with a few notable, widely recognized exceptions) are generally thought to be in a lower tier (Ishida 1998; Ono 2008). Importantly, an increase in the number of private institutions has led to a larger share of graduates of these less selective universities in the pool of college graduates.

Figure 1 illustrates two stages of educational expansion and upgrades of junior colleges to four-year universities, which contributed to the growing institutional selectivity. This figure presents trends in (1) male and female entrance rates into national, public, and private four-year

¹⁸ According to Times Higher Education’s Japan University Rankings 2022 (<https://japanuniversityrankings.jp/rankings/>), 10 of the top 10, 36 of the top 50, and 70 of the top 100 universities are national or public institutions. Because national or public universities account for less than 25% of all four-year universities, the overrepresentation of these universities in the ranking supports the claim that national or public universities are perceived to be more selective.

universities (calculated by the total number of enrolled students out of high school graduates) and (2) the proportion of students enrolled in private universities by gender. During the first stage of private university expansion, from the late 1950s to the late 1970s, the proportion of men and women enrolled in private universities continuously increased. This expansion was driven by newly established private institutions, which are mostly located in the lower ranks of the hierarchy of selectivity (Ishida 2007). The absolute and relative increases in the representation of students from these lower tier private universities thus drove the growth in heterogeneity among university students. This trend continued during the second stage of expansion, from early 1990s onwards, also prompted by the establishment of new private universities. As Figure 1 shows, although the proportion of students enrolled in private institutions slightly decreased during this period for men, it has been stable since 1995, while the proportion increased for women. As in the first stage of expansion, the private universities that contributed to the second stage of higher education expansion are still considered less selective (Ishida 2007).

[Figure 1 about here]

The upgrade of junior colleges to private universities is another mechanism through which heterogeneity across universities in Japan has grown. According to government statistics (Ministry of Education, Culture Sports, Science and Technology (MEXT) 2022), most junior colleges are established by private institutions (84% as of 1995), and they frequently have a high concentration of female students (almost 90% of the students enrolled in junior colleges from the 1980s). As women's opportunities to enter occupational careers increased, female students began to aim for a four-year university (Edwards and Pasquale 2003). Suffering from a shortage of

applicants, many private junior colleges decided to upgrade to four-year universities. Between 1995 and 2017, the number of junior colleges thus decreased from 596 to 337, whereas the number of private four-year universities increased from 415 to 604 (MEXT 2019). Importantly, these upgraded institutions have been less selective in recruiting students, suggesting that private institutions have become increasingly heterogeneous in terms of school selectivity.

To summarize, men and women in Japan can be expected to have experienced educational expansion differently in terms of both the timing of expansion and the selectivity of colleges they attended. This education context points to the value of explicitly examining potential gender differences in spouse pairing patterns within university education to clarify the role of educational expansion in assortative mating trends. The more rapid increase in the proportion of women enrolled in private institutions than men suggests that the relative value of higher education has become more heterogeneous for women. If the growing heterogeneity is accompanied by an increase in lower tier private university graduates, women who graduated from private universities would be increasingly less likely to marry up by partnering with men who graduated from national/public universities in recent years.

3. Research Questions and Hypotheses

Although the social stratification literature has emphasized the importance of horizontal stratification in higher education, consideration of how this factor impacts educational assortative mating has been limited. By linking the growing institutional heterogeneity at the top of educational distribution to the core of the stratification analytical framework, this study updates our understanding of the educational assortative mating trend.

A focus on institutional differentiation in higher education provides several testable hypotheses to explain declining educational homogamy in Japan. Specifically, I test five hypotheses—the first two related to *patterns* of assortative mating, and the last three examining temporal *trends* of assortative mating. All five hypothesis tests are based on estimates conditional on the composition of relevant characteristics (educational attainment and cohorts for Hypotheses 1 and 2, and educational attainment for Hypotheses 3a, 3b, and 4).

First, drawing on the exclusivity hypothesis, Hypothesis 1 expects that the strength of homogamy among university graduates differs by the selectivity of their institutions. I hypothesize that educational homogamy is stronger for the most selective group (national and public university graduates) and less pronounced among less selective groups (private university graduates). If supported, this hypothesis would suggest that educational homogamy among university graduates has declined partly because of the increase in the number of graduates of less selective universities in recent years.

Hypothesis 1: The odds of homogamy are strongest for national and public university graduates and lower for those attending a private university.

Second, the preference for female hypergamy (Brinton et al. 2021; Raymo and Iwasawa 2005) suggests that a similar hypergamy pattern may occur within university education. Hypothesis 2 expects that women's relative likelihood of marrying up (hypergamy) in terms of college selectivity is higher than that of marrying down (hypogamy).

Hypothesis 2: The odds of female hypergamy are stronger than female hypogamy within university education.

Next, I test whether distinguishing university graduates on the basis of their institutional selectivity explains the decline in educational assortative mating in Japan. Specifically, I test whether the direction of change in assortative mating differs by university selectivity.

Hypothesis 3a: Spouses' educational attainment will be more strongly associated for national/public university graduates than for private university graduates.

Hypothesis 3b: The likelihood that private university graduates will marry national/public university graduates will decrease over cohorts.

Finally, I test whether the female hypergamy pattern within university education—especially female private university graduates marrying national/public university graduates—has declined. This decline could happen because of the compositional mechanism: the proportion of students enrolled in private universities has increased more rapidly for women than men. Alternatively, as the exclusivity hypothesis expects, selective college graduates may respond to the numerical increase in less selective college graduates by maintaining their advantaged status via marriage. In either case, women who are graduates of less selective colleges are increasingly less likely to marry up.

Hypothesis 4: The likelihood of educational hypergamy between women graduating from private universities and men graduating from national/public universities will decrease.

4. Data and Methods

Data

For this study, I use all the available years of data from two comparable panel surveys: the Japanese Panel Survey of Consumers (JPSC) and the Keio Household Panel Study (KHPS). One reason for the previous literature's lack of consideration of institutional differentiation is data limitations. Most surveys do not ask about the characteristics of the spouse's college (Arum et al. 2008:110; but see Andrade and Thomsen 2019 for a recent exception). By contrast, the JPSC and KHPS collect information about the types of schools from which respondents and their spouses graduated. I combine these two data sets to increase the sample size.

JPSC and KHPS are highly comparative from design to implementation. In terms of sampling strategy, they employed the same sampling technique: a standard stratified two-stage sampling in which the first stage is based on census areas and the second stage involves randomly sampling approximately 10 individuals in each census area. Central Research Services (*Chuo Chosasya*) conducted the fieldwork for both surveys. Moreover, the initial response rate for the two surveys is almost equal, at 41.4% for JPSC and 41.1% for KHPS (Ishii and Nozaki 2014; Sakaguchi 2014); the retention rates are slightly higher for JPSC (94.4–98.3% vs. 82.7–94.2%). Therefore, in this study, I pool the two samples to form a single data file by extracting information on gender, year of marriage, and respondent's and spouse's education.¹⁹ To make

¹⁹ I estimated log-linear models separately for the JPSC and KHPS samples. The results are shown in Figures A1 and A2 (see appendix), which replicate Figure 4 in the main text. Substantively, these estimates are comparable.

the sample representative of the national population, I construct cross-sectional and longitudinal weights. Estimated results are based on the weighted sample (see the appendix for details on constructing the weights).

The 1993 JPSC was the first nationally representative longitudinal survey in Japan to target young women (aged 24–34), and the survey is conducted annually. Later waves (1997, 2003, 2008, and 2013) incorporated additional cohorts of women in their mid to late 20s. The first wave of the KHPS was conducted in 2004 with respondents from a nationally representative sample of 4,000 households. A total of 1,400 households were added in 2007 and 2012. Reflecting growing privacy concerns in recent years, the KHPS retention rate is lower than that of the JPSC but is comparable to that of other well-recognized panel studies, such as the Panel Study of Income Dynamics and the Survey of Income and Program Participation (Naoi 2006).²⁰

Variables

I use five categories for the husband's and wife's educational attainment: high school or less, including junior high school; junior college, college of technology, or professional training college; private university; and national or public university.

Given my focus on exclusivity and institutional differentiation, I do not consider educational attainment beyond an undergraduate university degree. In my sample of university graduates, 1.5% of respondents also obtained a master's degree or Ph.D.; I use only their undergraduate degree in my analysis. I assess respondents' education provided at the first interview. To measure spouses' education, I use the information provided in the first interview if

²⁰ The retention rate could be problematic in my study if there is any selective attrition by education characteristics, given that I used spouse's education information that respondents provided after they married if they were not married at the time of the first interview. I discuss these points in the appendix.

respondents were already married. Otherwise, I use the information provided at a later wave, after they married.

After I omit cases with missing educational information, 7,434 couples remain (2,685 cases for the JPSC and 4,749 cases for the KHPS). The year of marriage ranges from 1954 to 2015 in this sample. To minimize the possibility that respondents and their spouses graduated before the post–World War II education system reform, I limit the sample to respondents who married between 1970 and 2015, resulting in the removal of 12% of the observations.²¹ I then divide the sample into 15-year marriage cohorts (1970–1984, 1985–1999, and 2000–2015). The division between the late 1990s and early 2000s is critical to this study because of the upgrading of many junior colleges to four-year private universities in this period, which likely contributed to the growth in heterogeneity among four-year universities.

Methods

Assortative mating is formed through at least two mechanisms: preference and opportunity (Kalmijn 1998). Because the observed marriage patterns include the contribution of each mechanism, an appropriate method is needed to identify which factor contributes to the decline in a given marriage pattern, such as educational homogamy. The current study examines educational homogamy net of marginal distributions of men's and women's educational attainment. Thus, I control for compositional changes in educational attainment between men and women. I then examine changes in the odds ratio of homogamy conditional on educational attainment distributions.

²¹ Unfortunately, these surveys do not distinguish first from later marriages. Because the prevalence of remarried couples has increased in Japan, the inability to distinguish them from the first-married population may induce biased results.

To capture these odds ratios and their changes, which are assumed to capture preference,²² I apply log-linear and log-multiplicative models. These models have been the gold standard for describing assortative mating patterns and trends (for a methodological review, see Lichter and Qian 2019). Suppose we apply this method to three-way tables of the husband's educational attainment, $H(i = 1, \dots, 4)$; the wife's educational attainment, $W(j = 1, \dots, 4)$; and the respondent's marriage cohort, $C(k = 1, \dots, 3)$. The baseline model is the conditional independence model, which assumes the independence of wives' and husbands' education:

$$\ln F_{ijk} = \lambda + \lambda_i^H + \lambda_j^W + \lambda_k^C + \lambda_{ik}^{HC} + \lambda_{jk}^{WC}, \quad (0)$$

where F_{ijk} is the expected frequency of the (i, j, k) cell, consisting of husbands with education i and wives with education j who married in cohort k .²³ I set this model as the baseline and expand on it by adding other parameters. Each value for education and cohort corresponds to the categories that I defined previously. For example, F_{433} indicates the frequency of couples in which the husbands are national/public university graduates, the wives are private university graduates, and the marriage occurred in a year during 2000–2015.

I examine various extensions to the baseline model to test my hypotheses. First, Model 1a represents the quasi-independence model of homogamy:

$$\ln F_{ijk} = \lambda + \lambda_i^H + \lambda_j^W + \lambda_k^C + \lambda_{ik}^{HC} + \lambda_{jk}^{WC} + \delta_{ij}^{HW}, \quad (1a)$$

where δ_{ij}^{HW} follows Matrix 1. This model estimates the likelihood that homogamy is consistent across education levels.²⁴ The model also treats marriage between all university graduates

²² For a critique of this interpretation, see Logan (1996).

²³ All the models include category l (not shown in the equations), where the cell is distinguished by whether it comes from JPSC or KHPS.

²⁴ These parameters do not capture homogamy among junior college graduates, given that prior work argued that trends in homogamy among junior college graduates are stable (Fujihara and Uchikoshi 2019). Because this study aims to explain the declining trends in educational homogamy, I do not consider homogamy among junior college graduates in my analysis.

equally regardless of the selectivity of their institutions. To fit a different parameter for each cell, I use design matrices (shown in Appendix Table A1). The design matrix for Model 1a, for example, corresponds to Matrix 1, where homogamy among individuals with a high school education or less is 1, and university homogamy is expressed as 2; the reference category (=0) is other types of assortative mating.

Next, to capture a gradient in the odds of homogamy based on institutional selectivity, I estimate four models (1b–1d) to test Hypothesis 1. Model 1b assumes distinct diagonal parameters among university graduates but treats off-diagonal cells among graduates equally (see Matrix 2 in Appendix Table A1), and Model 1c captures the strength of the association for each cell on the main diagonal in comparison to that for the off-diagonal cells (see Matrix 3 in Table A1).

Although Models 1a–1c examine homogamy *within* educational groups, Model 1d reflects the permeability of barriers to marriage *across* educational types between spouses. The equation is defined as follows:

$$\ln F_{ijk} = \lambda + \lambda_i^H + \lambda_j^W + \lambda_k^C + \lambda_{ik}^{HC} + \lambda_{jk}^{WC} + \gamma_{ij}^{HW}, \quad (1d)$$

where $\gamma_{ij}^{HW} = \sum_{q=j}^{i-1} \gamma_q$ for $i > j$, $\gamma_{ij}^{HW} = \sum_{q=i}^{j-1} \gamma_q$ for $i < j$, and $\gamma_{ij}^{HW} = 0$ for $i = j$. This parameter is additive. Thus, for example, the odds ratio for husbands with a national/public university education crossing barriers and marrying wives with a junior college education is $\gamma_{42}^{HW} = \gamma_2 + \gamma_3$.

When I discuss the model fit for these models, I also reference the saturated model. This model provides us with a reference for selecting the best-fitting models. Models with better fit statistics relative to the saturated model can more parsimoniously capture the association. The equation for the saturated model is as follows:

$$\ln F_{ijk} = \lambda + \lambda_i^H + \lambda_j^W + \lambda_k^C + \lambda_{ik}^{HC} + \lambda_{jk}^{WC} + \psi_{ij}^{HW}.$$

Model 2 is used to test Hypothesis 2 (the persistence of female hypergamy), which relaxes the quasi-symmetry assumption that characterizes the off-diagonal parameters in Model 1b (see Matrix 4 in Table A1).

Next, I examine whether the degree of educational assortative mating varies by marriage cohort. To investigate the trends in educational assortative mating, I use the same model as Schwartz and Mare (2005) did (Model 3a):

$$\ln F_{ijk} = \lambda + \lambda_i^H + \lambda_j^W + \lambda_k^C + \lambda_{ik}^{HC} + \lambda_{jk}^{WC} + \lambda_{ij}^{HW} + \delta_{ijk}^{HWC}, \quad (3a)$$

where δ_{ijk}^{HWC} follows Matrix 1. I also apply the log-multiplicative layer effects models (Xie 1992) to estimate changes in the strength of the associations over time while assuming that the overall patterns are constant:

$$\ln F_{ijk} = \lambda + \lambda_i^H + \lambda_j^W + \lambda_k^C + \lambda_{ik}^{HC} + \lambda_{jk}^{WC} + \beta_k^C \delta_{ij}^{HW}, \quad (3b)$$

where δ_{ij}^{HW} follows Matrix 1.

Here, δ_{ij}^{HW} indicates the homogamous association between wives' and husbands' educational achievement, and β_k^C is the log-multiplicative parameter. This model produces a parsimonious estimation of changes in the strength of the association with flexibility in specifying the association (Xie 1992). The β parameter is set to 1, with the oldest cohort as the reference. I evaluate changes in the association as the percentage change in this parameter relative to the value for the reference cohort.

To test Hypothesis 3 (increasing odds of homogamy among selective college graduates and decreasing likelihood of less-selective college graduates marrying selective college graduates), I apply Models 3c–3e. These models are changing homogamy or crossing models based on the models used to test Hypothesis 1. For example, Model 3c is expressed as follows:

$$\ln F_{ijk} = \lambda + \lambda_i^H + \lambda_j^W + \lambda_k^C + \lambda_{ik}^{HC} + \lambda_{jk}^{WC} + \lambda_{ij}^{HW} + \delta_{ijk}^{HWC}, \quad (3c)$$

where δ_{ijk}^{HWC} follows Matrix 2.

Finally, to test Hypothesis 4 (changes in the strength of female educational hypergamy), I apply Model 4. This model uses the same design matrices examined in Model 2 and is expressed as follows:

$$\ln F_{ijk} = \lambda + \lambda_i^H + \lambda_j^W + \lambda_k^C + \lambda_{ik}^{HC} + \lambda_{jk}^{WC} + \lambda_{ij}^{HW} + \delta_{ijk}^{HWC}, \quad (4)$$

where δ_{ijk}^{HWC} follows Matrix 4.

5. Results

Descriptive Results

Figure 2 shows the distributions of educational attainment for married men and women separately using the JPSC and KHPS. Men and women in recent marriage cohorts are more likely to graduate from four-year universities than those in previous marriage cohorts. Despite the general rise in educational attainment among women, gender differences in educational attainment persist among recent cohorts. In terms of heterogeneity by university selectivity, the proportion of national/public university graduates remains largely the same across cohorts, but the proportion graduating from private institutions increases. This finding is consistent with the promotion of women's access to higher education through an increase in the number of private institutions, including schools upgraded from junior colleges.

[Figure 2 about here]

In Figure 3, changes in the observed proportions of educational homogamy, female hypergamy, and female hypogamy are presented on the left; the expected proportions, calculated under the assumption that the husband's and wife's education levels are independent of each other, are shown on the right. The observed data reveal that 48% of marriages in the 1970–1984 cohort are homogamous, and homogamy still characterizes more than 37% of the latest cohort. In contrast, both educational hypergamy and educational hypogamy increase from the oldest cohort to the latest cohort. Trends for the expected proportions (on the right) are similar to those for the observed proportions. The proportion of homogamy decreases across cohorts, and the proportions of hypergamy and hypogamy increase. This result suggests that the observed trends are largely due to changes in the marginal distributions of men's and women's educational attainment. One interesting finding is that expected educational homogamy is lower than the observed rate. Intuitively, it is plausible that educational expansion could lead to an increase in educational homogamy as the distributions of men's and women's education become more similar. However, the figure shows that this is not the case in Japan, which is not surprising given the studies cited earlier.

[Figure 3 about here]

Log-Linear and Log-Multiplicative Models

To investigate the relative association between wives' and husbands' educational attainment, I estimate log-linear and log-multiplicative layer effects models. Table 1 provides the goodness-of-fit statistics for the models: the log-likelihood ratio chi-square statistic (G^2), the degrees of freedom (df), the index of dissimilarity (ID), and the Bayesian information criterion

(BIC).²⁵ The ID is the proportion of misclassified cases in a given model: the smaller the ID, the better the model fit. The BIC adds a penalty for the number of parameters related to G^2 in a given model: the more negative the BIC, the better the model fit. One advantage of referring to the BIC is that for a fully saturated model, this criterion should be 0 (Raftery 1995). Thus, models with a BIC lower than 0 are preferred over models with a positive BIC. Throughout the analysis, I prioritize the BIC.

[Table 1 about here]

Assortative Mating Patterns Within University Education

In the baseline model, Model 0 (for conditional independence), 19% of cases are misclassified. Model 1a adds homogamy parameters, which improve the model fit relative to Model 0. I estimate Models 1b–1d to test Hypothesis 1. In Model 1b, which uses Matrix 2, I define homogamous marriages as the association in each cell on the main diagonal above college education (3 and 5) and treat the off-diagonal associations among university graduates as a separate group (4). This model is the best-fitting homogamy model in terms of the BIC. However, it is slightly worse fitting than the saturated model, which allows for a saturated association between wives' and husbands' educational achievement (ψ_{ij}^{HW}) (−126.4; results not shown). This result suggests that the association between husbands' and wives' education among university graduates is heterogeneous in terms of their institutions' selectivity levels, and heterogamy based on their selectivity is distinguishable from those on the main diagonals. Model 1d, which adds crossing parameters, also displays an improved fit, suggesting that the crossing

²⁵ The ID is defined as $\sum |F_{ijk} - f_{ijk}| / 2n$, where f_{ijk} denotes the observed frequencies of the (i, j, k) cell. The BIC is defined as $G^2 - \log n \times \text{df}$.

model is also sufficient to capture patterns of assortative mating parsimoniously, although the BIC for this model is slightly worse than that for the saturated model.

To test Hypothesis 1 and for descriptive purposes, I present in panel a of Figure 4 the Model 1b parameter estimates shown in Table 1. The parameters of the diagonal cells that represent university education types (private university and national/public university) tend to be larger (1.65, 3.06) than those representing individuals who did not graduate from a university (i.e., high school graduates; 1.28). Substantively, for example, the odds ratio for homogamy among national/public university graduates is 21.3 ($= \exp(3.07)$), implying that these university graduates are 21 times more likely than others to marry spouses with the same type of education. Additionally, if this parameter is interpreted as homogamy strength, homogamy is strongest among national/public university graduates (the 95% confidence interval ranges from 2.74 to 3.40) and is weaker among graduates of private universities (from 1.48 to 1.81). Thus, homogamy strength among university graduates differs based on their institution's selectivity under the assumption that the parameters are the same across cohorts, which supports the exclusivity hypothesis (Hypothesis 1).

The Model 1d crossing parameter estimates shown in panel b of Figure 4 show that marrying across educational attainment statuses is less likely to occur than marrying within the same educational level, as expected. Understandably, the crossing parameter is more negative for marriages between junior college and private university graduates than for marriages between high school and junior college graduates. Meanwhile, the magnitude of the crossing parameter for marriages between private university and national/public university graduates is comparable to that between junior college and private university graduates. This result suggests that the difficulty of crossing the education boundary is mainly found between educational levels.

Next, I estimate Model 2a to test Hypothesis 2. These estimates, shown in panel c of Figure 4, indicate that the relative likelihood of female hypergamy and hypogamy is positive. However, hypergamy is more likely to occur than hypogamy, net of compositional changes. Specifically, the odds ratio of hypergamy among university graduates is 4.9 ($= \exp(1.70)$, 95% confidence interval = 1.43 to 1.96), while that of hypogamy is 3.3 ($= \exp(1.18)$, 95% confidence interval = 0.85 to 1.50).

[Figure 4 about here]

Changing Assortative Mating Patterns Within University Education

To describe assortative mating trends by education, I estimate Model 3a, which adds parameters to estimate changes in each of the educational assortative mating types articulated in Model 1a. The BIC for this model is lower than that for Model 1a, indicating that the degree of educational homogamy changes over time.

Panel a of Figure 5 presents changes in homogamy for Model 3a and shows that homogamy is less likely to occur over time across cohorts relative to the reference cohort. This result is consistent with those of previous studies suggesting a continuous decline in educational homogamy in Japan (Fujihara and Uchikoshi 2019; Fukuda et al. 2021; Miwa 2007). To examine the trend in educational assortative mating using a more parsimonious model, I also apply a log-multiplicative model (Model 3b). For this model, the BIC is higher than that of the changing homogamy model. Although the model fit is worse, the log-multiplicative parameters (β_k^C) estimated in Model 3b suggest that the association between the husband's and wife's educational attainment, measured in terms of log-odds ratios, declines by 26% over the three cohorts (results not shown).

To test Hypothesis 3, I examine Models 3c–3e, which add parameters to estimate changes in assortative mating among graduates of each educational type. The BIC is lower than 0 across the models but indicates a poorer fit than the BIC for the reference models (except for the comparison between Model 1c and Model 3d), suggesting that there is no evidence for cohort change in assortative mating. Thus, the results should be considered descriptive, although the chi-square tests of the G^2 statistic between the hierarchical models (between Models 1b and 3c, and between Models 1d and 3e) reveal that the null hypothesis that these models are the same is rejected at the 1% level of statistical significance. These results, similar to results from Model 3a, suggest that educational homogamy has declined overall but that distinguishing between university graduates by institutional selectivity provides a more nuanced picture of these trends.

Panel b of Figure 5 presents changes in crossing parameters (Model 3e), the BIC of which is relatively lower than in other competing models (Models 3c and 3d). Positive coefficients on the cohort interaction mean more intermarriage in recent cohorts, whereas negative coefficients indicate less intermarriage. The results show that the difficulty of crossing educational attainment boundaries between private and national/public university graduates increases by 32.0% across the three cohorts, consistent with Hypothesis 3b. In contrast, crossing boundaries between junior college and private university graduates declines by 12.1%. In terms of the odds of homogamy, homogamy among national/public university graduates increased, consistent with Hypothesis 3a and 3b.

Finally, I estimate Model 4 to test Hypothesis 4, which posits that educational hypergamy among university graduates declines more rapidly than those hypogamy marriages. Because the model fit statistics for Model 5a are worse than those of the reference model (Model 2a), I present results for descriptive purposes rather than to detect the best-fitting model. Again,

though, the chi-square tests of the G^2 statistic between the hierarchical models indicate that I can reject the null hypothesis that these models are the same at a 1% level of statistical significance. Panel c of Figure 5 shows that the cohort interaction with hypergamy is negative but that hypogamy trends are stable, consistent with Hypothesis 4. Specifically, educational hypergamy decreases by 90% over three marriage cohorts, but educational hypogamy declines modestly (by 26%).

[Figure 5 about here]

A Consideration of Other Potential Explanations for the Diverging Patterns

Because the diverging pattern in educational homogamy by college selectivity is a key finding, it is worth considering potential explanatory factors other than college expansion. Supplementary analyses examined two possibilities (see Appendix Table A2). First, those familiar with the literature on U.S. higher education may wonder if the increasing selectivity of elite colleges (Hoxby 2009) can explain the diverging pattern. I estimated ordered logit models separately for men and women and limited the sample to three types of university graduates. Results did not reveal evidence that the selection into selective colleges, measured by father's education, has changed.

Second, the education–income gradient may have changed, similar to the increasing labor market return to a college degree in the United States (Autor 2010; Goldin and Katz 2009). I estimated an ordinary least-squares regression for logged hourly wage at age 35, limiting the sample to men because women's employment is often interrupted by family events. My analysis suggests that returns to selective colleges did not change over time, in line with earlier studies finding that earnings premiums among college graduates have not increased in Japan

(Kawaguchi and Mori 2016). Ideally, one would examine whether women's returns to selective colleges changed because an increase in their returns would indicate that the diverging homogamy patterns between national/public university and private university graduates may be driven by the increase in women's economic potential that makes them more attractive in the marriage market (from men's perspective). Perhaps more importantly, the value of women's college education in the marriage market has changed not only because of the increase in the economic return to women's education but also because of the growing symmetry in men's and women's economic opportunities. Such symmetry is likely to increase men's emphasis on their female spouse's earning role (National Institute of Population and Social Security Research 2017) or change their (stereotypical) views about career-oriented women as potential marital partners (Woźny 2022). Unfortunately, I cannot directly examine how such changing views of women's economic role potentially affect the educational homogamy pattern in Japan while examining the growth in within-group variation in higher education selectivity. Future studies should examine this point.

Third, there are good reasons to expect that delayed and fewer marriages among younger cohorts in Japan (Raymo et al. 2015) will shape assortative mating patterns. For instance, Mare's (1991) time gap hypothesis suggests that delayed marriage will decrease educational homogamy because the time between graduation and marriage will increase exposure to potential partners with different educational backgrounds. In that sense, the declining trend in educational homogamy in Japan may reflect delayed marriage. Meanwhile, Oppenheimer's (1988) classical theory on marriage timing states that delayed marriage may allow singles to estimate their potential spouse's earning potential more accurately, leading to more homogamy. I examined these speculations using an event-history technique that allowed me to incorporate both the

timing of marriage and assortative mating patterns. Results from the analysis, shown in the appendix and fully discussed in Uchikoshi (2018), suggest that the age at marriage does not change the likelihood of college graduates' marriage to a similarly educated spouse in Japan. Rather, the declining educational homogamy among college graduates is far more likely to be explained by a relative increase in highly educated women, who tend to prefer marrying similarly educated men (educational homogamy), but a decline in the relative supply of these men, resulting in so-called marriage market mismatch (Raymo and Iwasawa 2005). In a context where people are marrying less, the marriage market mismatch is likely more critical for homogamy among less educated individuals, among whom the declining marriage rate is more pronounced, especially for men (Fukuda et al. 2020). Although this is not a focus of this article, future studies should examine whether the lower marriage rate among less educated men affects assortative mating patterns.

6. Discussion

This study investigates the patterns of educational assortative mating in Japan over time, focusing on the roles of expansion and institutional differentiation in higher education. This article's primary contribution is demonstrating that patterns of educational assortative mating are dependent on how educational categories are measured in the context of rapid educational expansion. First, the results from using a finer categorization of university graduates than previously examined demonstrate that the strength of educational homogamy differs according to the level of institutional selectivity: the likelihood of homogamy is greater among national/public university graduates than among private university graduates. These findings are consistent with the exclusivity hypothesis (Hypothesis 1) and add to our understanding of heterogeneity in

school selectivity–based assortative mating patterns, which was obscured in earlier studies.

Another interesting finding is that among women, educational hypergamy is more likely to occur than educational hypogamy, even among university graduates. This result supports Hypothesis 2 and the notion of a strong preference for status hypergamy in Japan (Brinton et al. 2021; Raymo and Iwasawa 2005).

Second, in addition to the initial difference in homogamy strength across these groups, there has been a diverging trend in educational homogamy, which declined by approximately 27% over the three marriage cohorts. The tendency to marry similarly educated spouses has increased among national/public university graduates, whereas private university graduates have become increasingly less likely to marry these selective university graduates, consistent with the institutional differentiation hypothesis (Hypotheses 3a and 3b). Further, these less selective university graduates more frequently marry partners who did not complete college, although this change is small, at 12% (panel b, Figure 5). This finding was not hypothesized but echoes the interpretation by Fukuda et al. (2020) that an increase in hypogamy among university-educated women reflects the declining socioeconomic boundaries between less selective universities and other postsecondary institutions.

These results suggest that a relative increase in the number of private university graduates influenced educational homogamy patterns through two processes: (1) a compositional process in which the relative increase in less selective college graduates decreased the odds of educational homogamy among college graduates, and (2) a diverging process in which the increase in odds of homogamy among selective college graduates mitigated the decline in educational homogamy. Further, aside from theoretical expectations, the slight increase in the likelihood of intermarriage between less selective college graduates and junior college graduates

contributed to the decline in educational homogamy among college graduates. This study reveals such processes by distinguishing college graduates by the selectivity of the institution they attended.

Finally, consistent with Hypothesis 4, results suggest a decrease in female educational hypergamy but not necessarily for educational hypogamy. These findings provide important insights that improve the theoretical framework for the impact of institutional differentiation in higher education, which has not fully considered the role of relative gender difference in higher education expansion. Possibly reflecting the more rapid increase in the share of female students enrolled in private institutions, opportunities to “marry up” for women who graduate from private institutions decreased, and these women were more likely to marry non–university graduates. As such, the results of this study imply that it is critical for us to explicitly consider the role of relative gender differences in the rate of expansion in higher education.

A few limitations of the study are noteworthy. First, the classification of selectivity among university graduates in this analysis is crude. For example, there are a few recognizable selective private universities (e.g., Keio or Waseda), whereas earlier work has suggested that the odds of homogamy among these selective private university graduates are lower than those among graduates of selective national universities (Uchikoshi and Raymo 2021). Still, future studies could provide an improved picture by using a finer selectivity classification, such as one based on school name, rather than the simple national/public–private distinction. Second, because this study used cross-sectional information on spouse pairing, a potential bias was not addressed. In particular, given that older cohorts are more likely to appear to marry homogamously than younger cohorts in cross-sectional data as a result of selective attrition via divorce (Tzeng 1992), the current study may have overestimated the decline in educational

assortative mating. Third, this study could not quantify the contribution of the growth of within-group variation in higher education and assortative mating patterns net of compositional changes to trends in educational homogamy. Future studies would benefit from applying a decomposition method to estimate each contribution (e.g., Leesch and Skopek 2023).

Despite these limitations, the findings provide important insights into how horizontal stratification in higher education impacts educational assortative mating. The perspective on growing institutional heterogeneity in higher education may be applicable to other contexts. For example, the facilitation of higher education expansion through institutional differentiation has also occurred in the United States, where the number of for-profit universities increased from the early 1990s until 2010 (National Center for Education Statistics 2019). Researchers have argued that graduates from these colleges end up with heavy student loan debt (Deming et al. 2012) and almost no economic benefits (Cellini and Turner 2019), suggesting that the proliferation of these for-profit colleges may have attenuated the increase in educational homogamy among college graduates (Schwartz and Mare 2005). Thus, future research would also benefit from examining whether the growth in institutional heterogeneity in higher education is associated with changes in educational assortative mating in comparative perspective.

To conclude, the bridging of horizontal stratification and assortative mating, two determinants of social stratification in contemporary societies, provides important insights into overarching questions about social stratification. As a potential determinant of increasing economic inequality, assortative mating has drawn enormous attention (Breen and Andersen 2012; Breen and Salazar 2010; Esping-Andersen 2007; Schwartz 2010; Shen 2021; Torche 2010), although evidence for its influence on inequality is mixed (Schwartz 2013). This mixed evidence might be due to an inappropriate categorization of educational attainment. For example,

educational homogamy may increase for a particular subgroup (e.g., selective university graduates) but decrease for other subgroups (e.g., nonselective university graduates). If so, these groups likely impact growing income inequality differently. Therefore, my results point to the importance of the growing heterogeneity of institutional characteristics, which was obscured in earlier studies, for understanding the impact of educational assortative mating on economic inequality.

Table 1 Goodness-of-fit statistics for the models

Models			Goodness-of-Fit of Models			
			G^2	df	ID (%)	BIC
0	$[HC\ WC]$	Conditional independence	1,793.2	27	19.1	1,551.9
Models for Hypothesis 1						
1a	$[HC\ WC\ \delta^{HW}]$	Homogamy (Matrix 1)	219.7	25	4.8	-3.7
1b	$[HC\ WC\ \delta^{HW}]$	Homogamy (Matrix 2)	91.8	23	3.7	-113.7
1c	$[HC\ WC\ \delta^{HW}]$	Homogamy (Matrix 3)	257.7	23	4.3	52.2
1d	$[HC\ WC\ \gamma^{HW}]$	Crossing	93.8	24	3.8	-120.7
Model for Hypothesis 2						
2	$[HC\ WC\ \delta^{HW}]$	Homogamy (Matrix 4)	85.8	22	3.7	-110.8
Models for Describing Assortative Mating Trends						
3a	$[HC\ WC\ HW\ \delta^{HWC}]$	Changing homogamy (Matrix 1)	23.5	14	1.0	-101.6
3b	$[HC\ WC\ \delta^{HW}\beta^C]$	Homogamy, LM (Matrix 1)	206.6	23	4.2	1.1
Models for Hypotheses 3a and 3b						
3c	$[HC\ WC\ HW\ \delta^{HWC}]$	Changing homogamy (Matrix 2)	11.8	10	0.6	-77.6
3d	$[HC\ WC\ HW\ \delta^{HWC}]$	Changing homogamy (Matrix 3)	14.0	10	0.6	-75.4
3e	$[HC\ WC\ HW\ \gamma^{HWC}]$	Changing crossing	16.6	12	0.8	-90.7
Model for Hypothesis 4						
4	$[HC\ WC\ HW\ \delta^{HWC}]$	Changing homogamy (Matrix 4)	9.5	8	0.5	-62.0

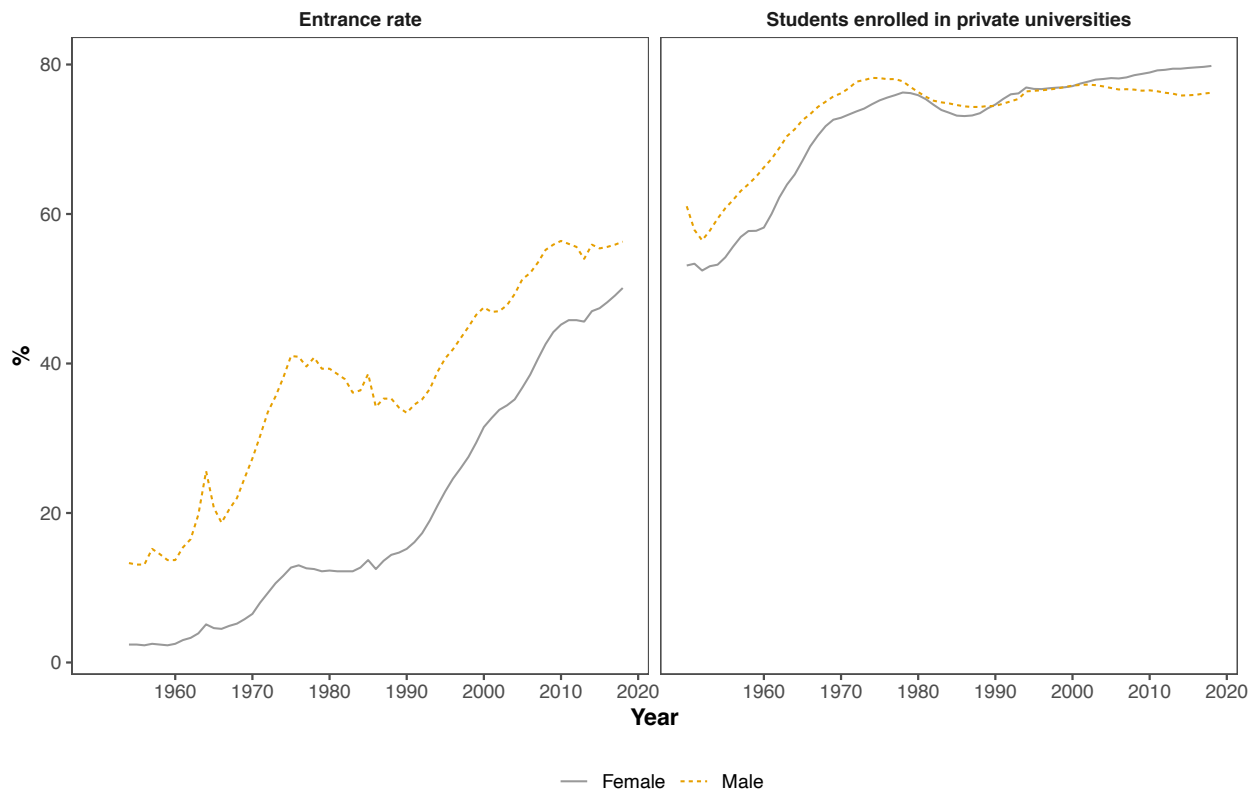


Figure 1 Trends in university enrollment in Japan. The entrance rate is calculated as the total number of high school graduates who are enrolled. Source: School Basic Survey, Ministry of Education, Culture, Sports, Science and Technology.

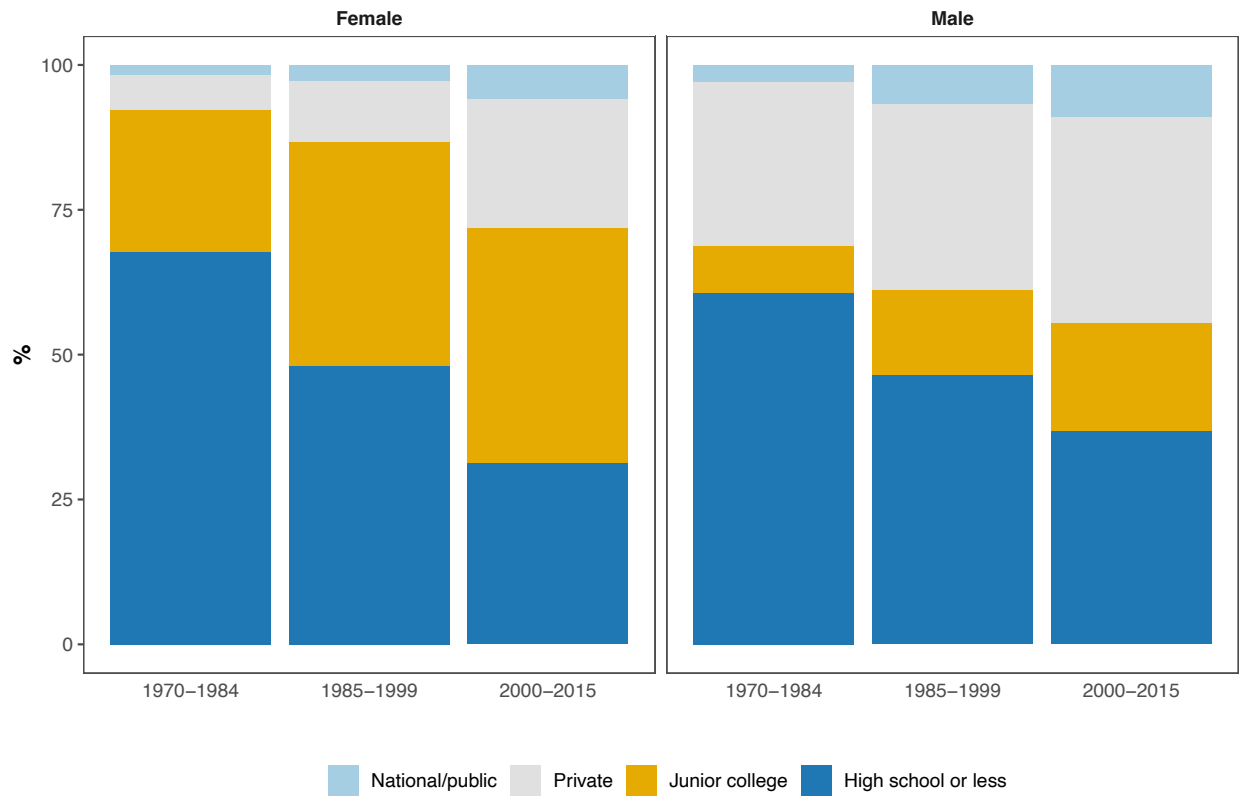


Figure 2 Respondents' educational attainment, by gender and marriage cohort

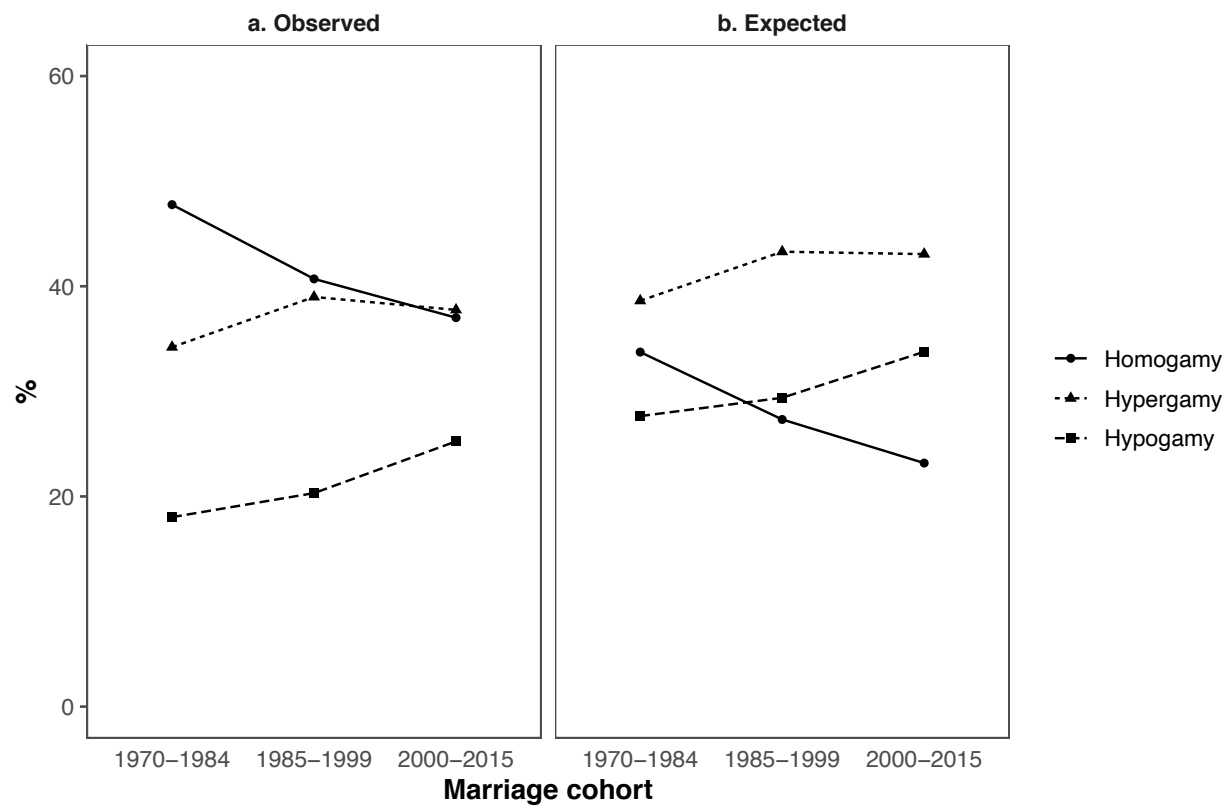


Fig. 3 Observed and expected distributions of homogamy, hypergamy, and hypogamy, by marriage cohort

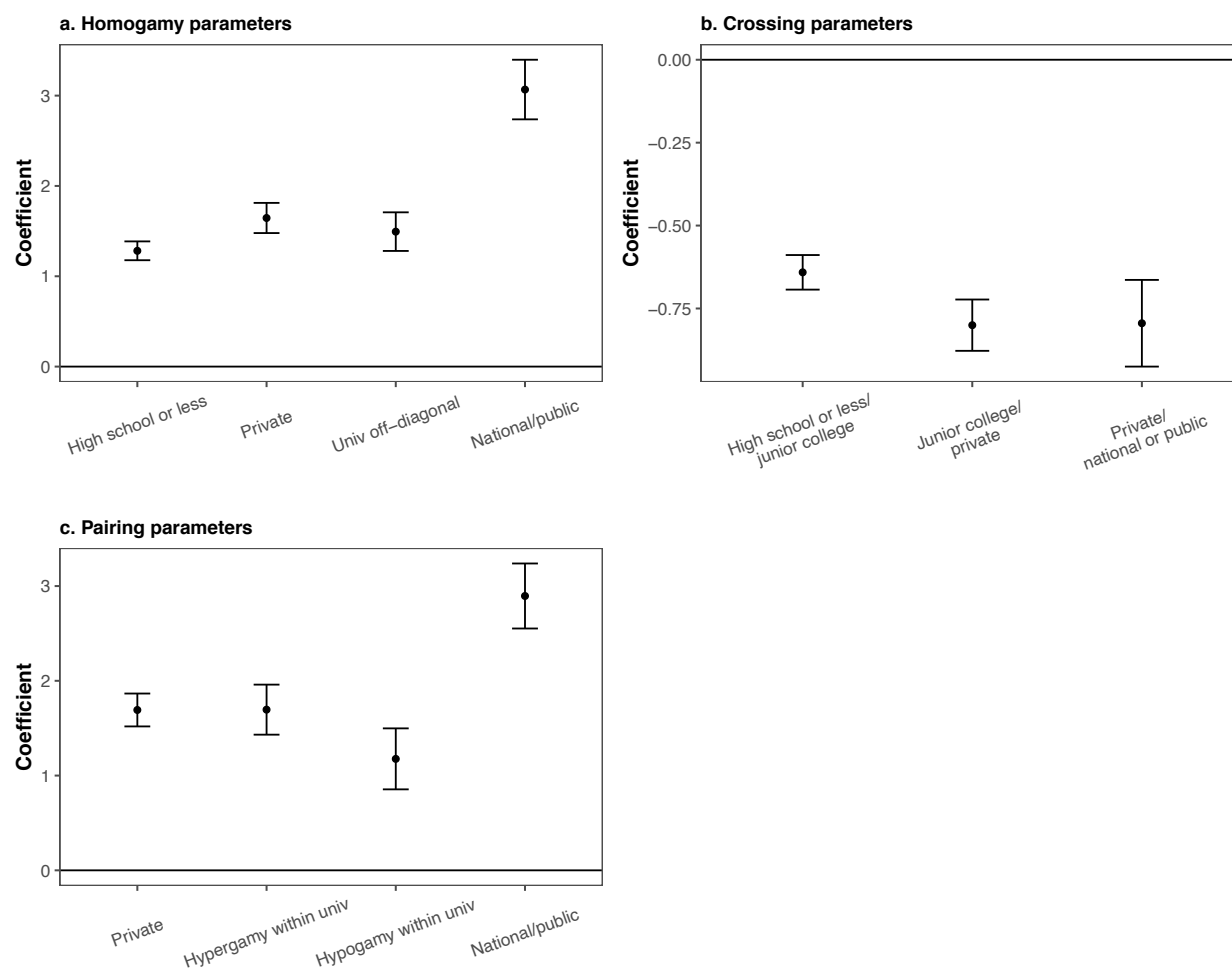


Figure 4 Parameters of association between husbands' and wives' educational attainment. Panel a is estimated by Model 1b, panel b is estimated by Model 1d, and panel c is estimated by Model 2a. Error bars indicate the 95% confidence intervals.

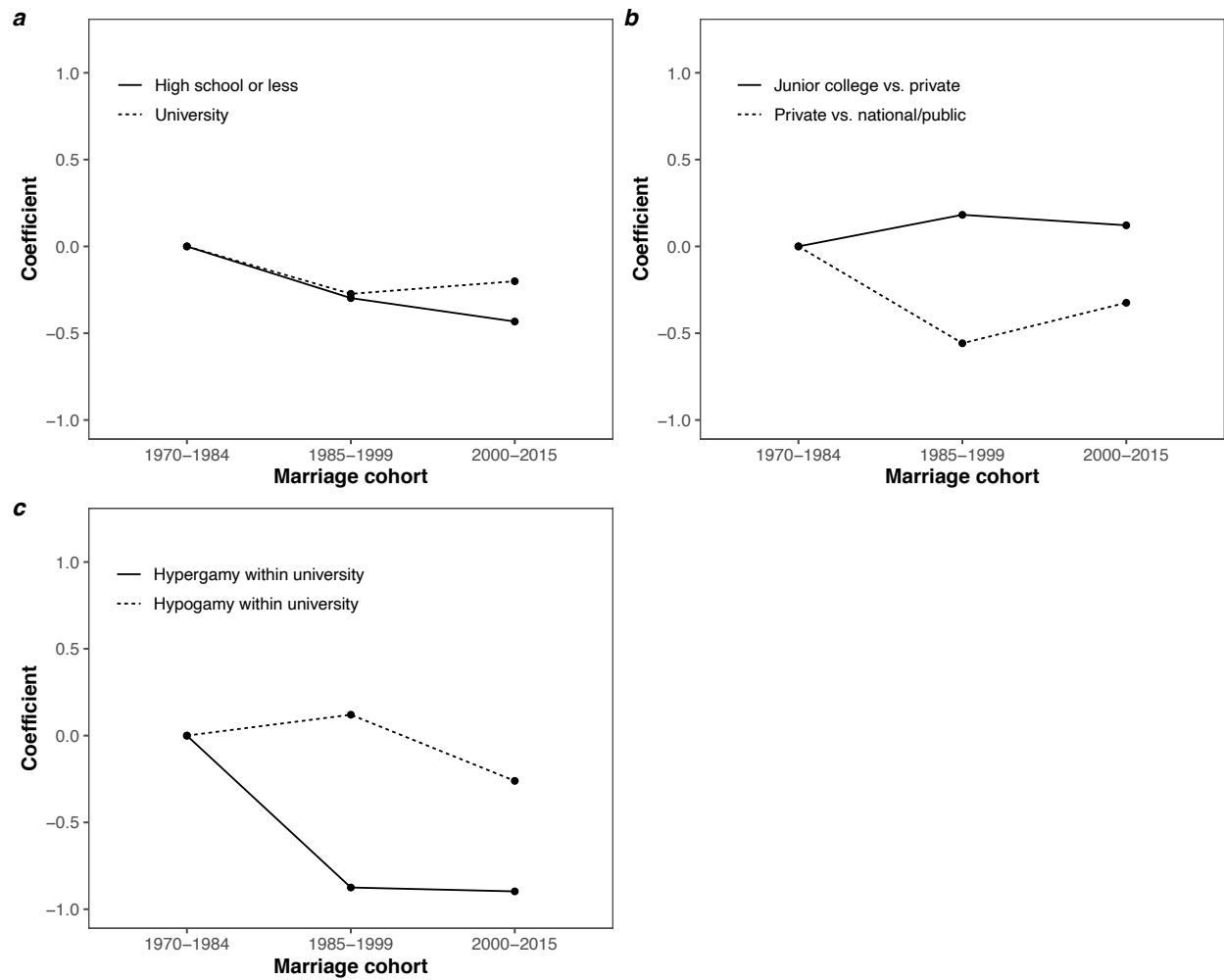


Figure 5 Changes in the homogamy and crossing parameters, by marriage cohort. Panel a is estimated by Model 3a, panel b is estimated by Model 4d, and panel c is estimated by Model 5a. Coefficients on the y-axis show the degree to which educational assortative mating varies by marriage cohort, which is expressed as δ_{ijk}^{HWC} in the equations.

Appendix for Chapter 2

Table A1 Design matrix
(Row: men's education, Column: women's education)

Matrix 1

	1	2	3	4
1	1	0	0	0
2	0	2	0	0
3	0	0	3	3
4	0	0	3	3

Matrix 2

	1	2	3	4
1	1	0	0	0
2	0	2	0	0
3	0	0	3	4
4	0	0	4	5

Matrix 3

	1	2	3	4
1	1	0	0	0
2	0	2	0	0
3	0	0	3	0
4	0	0	0	4

Matrix 4

	1	2	3	4
1	1	0	0	0
2	0	2	0	0
3	0	0	3	5
4	0	0	4	6

Note: Row and column numbers correspond to the following educational attainment levels: 1= high school or less; 2 = junior college, college of technology, or professional training college; 3 = private university; 4 = national and public universities

Table A2 Selection into and returns to selective colleges

Panel A: Selection into selective colleges	Male	Female
Marriage cohort 1985-1999	-0.03 (0.20)	0.03 (0.40)
Marriage cohort 2000-2015	-0.22 (0.26)	0.12 (0.37)
Father: college educated	-0.20 (0.40)	-1.43* (0.71)
1985-1999 # Father: college educated	0.35 (0.47)	0.71 (0.81)
2000-2015 # Father: college educated	0.76 (0.51)	1.36+ (0.74)
Observations	644	526
Log likelihood	-597.66	-507.45
Panel B: Returns to selective colleges		
Marriage cohort 2000-2015	111.77	(113.05)
High school or less	105.69	(109.20)
2000-2015 # High school or less	-95.95	(127.70)
Junior college	6.44	(130.36)
2000-2015 # Junior college	-29.77	(163.36)
Private (STEM)	50.72	(151.50)
2000-2015 # Private (STEM)	104.65	(169.14)
National/Public	60.26	(316.89)
2000-2015 # National/Public	-85.30	(348.19)
Constant	211.97*	(100.21)
Observations	215	

Standard errors in parentheses

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

Construction of cross-sectional and longitudinal weights

Ishii and Nozaki (2014) discussed how to construct these weights using KHPS, but the weights are not still publicly available. Therefore, I created both cross-sectional and longitudinal weights for KHPS and JCPS. Specifically, I used educational attainment, employment, marital status, age, and regions to estimate the weights to estimate cross-sectional weights by using iterative proportional fitting (I used Stata command *ipfweight*). I used census data and Employment Status Survey,²⁶ one of the largest administrative data that has been conducted every five years to construct the weights. The specific data source I referred to for each survey is shown in Table A3. The proportion of each variable is calculated separately by each survey and sex, which are shown in Tables A4, A5, and A6. Longitudinal weights were created based on the cross-sectional weights multiplied by the inverse of the probability of selection. The probability of selection is estimated by the logit models predicting the risk of attrition in the following year. Regression results can be found in Table A7. Based on these weights, I calculated the weighted frequencies that are used in the log-linear models. Substantive results with and without these weights are similar.

²⁶ I used this survey because census has asked educational attainment only every 10 years.

Table A3 Data source for creating cross-sectional weights

	Education	Employment status	Marital status	Age group
JPSC1993	ESS1992	Census 1995	Census 1995	Census 1995
JPSC1998	ESS1997	Census 2000	Census 2000	Census 2000
JPSC2003	ESS2002	Census 2005	Census 2005	Census 2005
JPSC2008	ESS2007	Census 2010	Census 2010	Census 2010
JPSC2013	ESS2012	Census 2015	Census 2015	Census 2015
KHPS2004	ESS2002	Census 2005	Census 2005	Census 2005
KHPS2007	ESS2007	Census 2005	Census 2005	Census 2005
KHPS2012	ESS2012	Census 2010	Census 2010	Census 2010

Note: ESS: Employment Status Survey.

Table A4 Proportional distribution of subgroups based on population census and administrative data (JPSC)

		JPSC1993	JPSC1998	JPSC2003	JPSC2008	JPSC2013
Age						
	24	0.103	0.234	0.150	0.188	0.190
	25	0.100	0.245	0.158	0.197	0.193
	26	0.098	0.258	0.163	0.203	0.199
	27	0.096	0.263	0.170	0.206	0.206
	28	0.096	-	0.176	0.207	0.212
	29	0.075	-	0.183	-	-
	30	0.093	-	-	-	-
	31	0.087	-	-	-	-
	32	0.086	-	-	-	-
	33	0.083	-	-	-	-
	34	0.082	-	-	-	-
Marital status						
	Married	0.586	0.322	0.338	0.303	0.290
	Not married	0.414	0.678	0.662	0.697	0.710
Employment status						
	Working	0.577	0.699	0.684	0.727	0.765
	Leaving a job		0.012	0.016	0.019	0.023
	Searching for a job	0.047	0.050	0.059	0.060	0.046
	Schooling or housework	0.376	0.239	0.241	0.194	0.167
Education						
	High school or less	0.572	0.508	0.415	0.339	0.388
	Junior college	0.305	0.348	0.388	0.381	0.261
	University or more	0.122	0.144	0.198	0.279	0.352

Note: JPSC 1993 cannot distinguish those who are leaving for a job and those searching

Table A5 Proportional distribution of subgroups based on population census and administrative data (KHPS, female)

KHPS female				
	KHPS2004	KHPS2007	KHPS2012	
Age				
20-24	0.080	0.080	0.074	
25-20	0.091	0.091	0.085	
30-34	0.109	0.109	0.098	
35-39	0.099	0.099	0.116	
40-44	0.094	0.094	0.104	
45-49	0.091	0.091	0.096	
50-54	0.106	0.106	0.093	
55-59	0.126	0.126	0.106	
60-64	0.107	0.107	0.124	
65-69	0.096	0.096	0.104	
Marital status				
Married	0.669	0.669	0.638	
Not married	0.331	0.331	0.362	
Employment status				
Working	0.572	0.572	0.596	
Leaving a job	0.010	0.010	0.011	
Searching for a job	0.030	0.030	0.032	
Schooling or housework	0.388	0.388	0.361	
Education				
High school or less	0.666	0.567	0.572	
Junior college	0.232	0.300	0.262	
University or more	0.102	0.133	0.165	

Table A6 Proportional distribution of subgroups based on population census and administrative data (KHPS, male)

		KHPS male		
		KHPS2004	KHPS2007	KHPS2012
Age				
	20-24	0.085	0.085	0.077
	25-29	0.095	0.095	0.087
	30-34	0.112	0.112	0.101
	35-39	0.102	0.102	0.119
	40-44	0.096	0.096	0.106
	45-49	0.092	0.092	0.097
	50-54	0.105	0.105	0.092
	55-59	0.124	0.124	0.104
	60-64	0.102	0.102	0.120
	65-69	0.088	0.088	0.096
Marital status				
	Married	0.656	0.656	0.620
	Not married	0.344	0.344	0.380
Employment status				
	Working	0.817	0.817	0.809
	Leaving a job	0.011	0.011	0.011
	Searching for a job	0.059	0.059	0.066
	Schooling or housework	0.113	0.113	0.114
Education				
	High school or less	0.636	0.556	0.563
	Junior college	0.084	0.126	0.090
	University or more	0.281	0.317	0.347

Table A7 Logit models predicting attrition from the survey

JPSC			KHPS		
	Coef.	SE		Coef.	SE
Age	-0.248***	-0.025	Female	-0.029	(0.028)
Age squared	0.003***	0.000	Age (ref: 20-24)		
Marital status (ref: married)			25-29	-0.279**	(0.087)
Not married	0.193***	-0.053	30-34	-0.720***	(0.088)
Employment (ref: working)			34-39	-1.013***	(0.088)
Leaving a job	-0.096	-0.177	40-44	-1.029***	(0.087)
Searching a job	0.098	-0.093	45-49	-1.045***	(0.088)
Not worked	-0.022	-0.058	50-54	-1.042***	(0.088)
Education (ref: High school or less)			55-59	-0.900***	(0.087)
Junior college	-0.060	-0.050	60-64	-0.902***	(0.086)
BA+	0.021	-0.060	65-69	-0.922***	(0.087)
Constant	2.074***	-0.472	70+	-0.724***	(0.085)
			Marital status (ref: married)		
			Not married	0.094**	(0.032)
			Employment (ref: working)		
			Leaving a job	0.199*	(0.096)
			Searching a job	0.093	(0.089)
			Not worked	0.131***	(0.035)
			Education (ref: High school or less)		
			Junior college	-0.152***	(0.037)
			BA+	-0.134***	(0.033)
			Constant	-1.503***	(0.082)
Observations	48,251			75,478	
Log likelihood	-8741.947			-21864.341	

Standard errors in parentheses

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

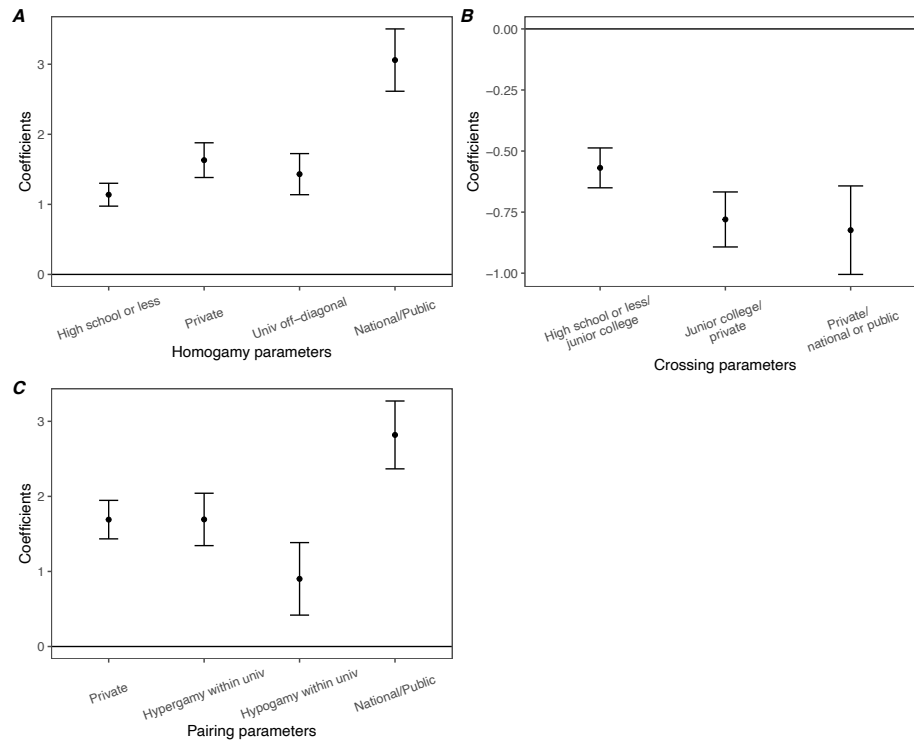


Figure A1 Parameters of association between husbands' and wives' educational attainment (A: estimated by Model 1b; B: estimated by Model 1d; C: estimated by Model 2a) based on JPSC sample

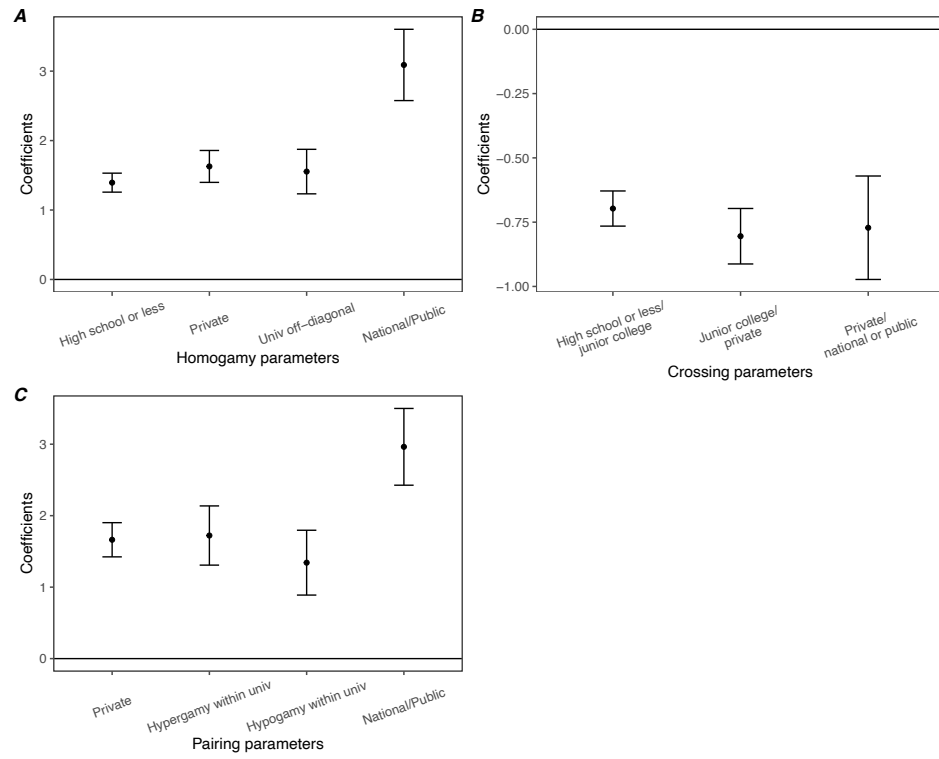


Figure A2 Parameters of association between husbands' and wives' educational attainment (A: estimated by Model 1b; B: estimated by Model 1d; C: estimated by Model 2a) based on KHPS sample

CHAPTER 3 Gender Differences in Response after Rejection: The Case of Female Underrepresentation in Selective Colleges in Japan

1. Introduction

In many wealthy countries, women outnumber men in higher education attendance and completion (DiPrete and Buchmann 2013; van Bavel 2012). Women outperform men on various indicators of academic success, including school grades or advanced course taking (Buchmann et al. 2008; Reeves 2022; Spinath et al. 2014). Reflecting the increasing gender gap in both academic achievement and attainment, recent studies have discussed potential sources and consequences of challenges faced by boys and men (Reeves 2022).

In this context, limited studies have discussed that women's underrepresentation in selective universities²⁷ is still the case in countries characterized by relatively stronger institutional differentiation in terms of selectivity (Bielby et al. 2014; Buchmann et al. 2010). This is surprising given that attending a selective college is linked to various socioeconomic advantages, especially for women (e.g., Ge et al. 2022). Meanwhile, a handful of studies have examined institutional mechanisms that favor men over women in admission to selective colleges. Specifically, psychological and behavioral economics literature argues that men perform better than women in high-stakes testing (Azmat et al. 2016; Niederle and Vesterlund 2010; Shurchkov 2012), shaping the gender composition of admitted students (Yu and Su 2024).

Motivated by these studies, this paper specifically focuses on the role of the risk of exam failure that characterized this high-stakes testing form in shaping the gender gap in educational attainment. Since high-stakes exam-based admission is competitive, a sizable number of

²⁷ Throughout this paper, I discuss the selectivity of colleges based on their admission competitiveness.

applicants fail admission in this testing system in the absence of a properly designed matching system based on test scores. This is especially the case when the number of schools a student can only apply to is limited. In such admission systems, applicants may end up spending an additional uncertain year to retake the exam (Krishna et al. 2018). Interestingly, studies have reported that there is a significant gender gap in exam-retaking for selective college applications in these admission systems characterized by a high prevalence of exam failure (Isa 2021; Kang et al. 2024; Landaud and Maurin 2020; Yu 2009), suggesting that the gender gap in exam-retaking is an important source of the gender gap in selective college attendance. However, a plausible mechanism to explain the gender gap in exam-retaking is still unclear, except for a few studies pointing out that gender differences in psychological traits such as risk preference may play a role (Kang et al. 2024; Landaud and Maurin 2020).

This study examines how high-stakes testing settings with a decently high risk of exam failure in the transition from upper-secondary to higher education can contribute to the gender gap in selective college attendance. Recognizing that the meaning of selectivity is different across institutional contexts, this paper refers selectivity to institutional hierarchy explicitly measured by the standardized rank score in testing. Specifically, I aim to advance the literature on the implications of the high-stakes exam for gender inequality in three ways. First, I provide descriptive evidence that women are significantly less likely to retake the exam than men; this is an important factor in accounting for the gender gap in higher education attendance, especially attendance to a selective college. Second, I examine the source of the gender gap in exam-retaking. While I did not find evidence that more women than men are likely to lower their top choice school from selective to less-selective one before admission, I instead found that significantly more women than men tend not to retake the exam when they fail the admission.

Third, I examined whether correlates of the gender differences in educational choice account for the gendered response to exam failure. Interestingly, results suggest that women's response to rejection is still different from men's net of any likely correlates suggested by previous studies, including educational aspirations, values to extrinsic and intrinsic rewards, or mother's educational expectation.

As an interesting case of potentially broader relevance to other societies, the current study examines the case of Japan, where (a) women still only account for 20-30% of the undergraduate student body in the nation's selective universities (so-called former imperial universities such as the University of Tokyo or Kyoto University) despite the gender gap convergence in overall college attendance, as shown in Panel A of Figure 1, (b) many high schoolers fail to pass the high-stakes entrance exams for college admission, especially admission to selective universities, and (c) those who fail admission often retake the exam the following year (Tsukada 1991; Yu 2009), as shown in Panel B of Figure 1.²⁸

This study provides important insights into potentially unintended consequences of the recent educational reforms that increasingly emphasize the high-stakes exams in school admissions (Furuta et al. 2021). In a sense, objectively measured test scores could be “open doors for the talented poor” (Cronbach 1975), and exam-retaking may be a fair system because it allows applicants who are willing to attend their desired school to attempt a second try, although sociologists have also criticized standardized testing as a gatekeeper that reproduces preexisting

²⁸ College quality in Japan is usually measured by two characteristics, selectivity and prestige. Selectivity is often made explicit by the standardized rank score (*Hensachi*), as discussed earlier. Another indicator of college quality is prestige. This is a less explicit measure based on the year of establishment. For example, seven schools that were imperial universities before World War II (Tokyo, Kyoto, Tohoku, Kyushu, Hokkaido, Nagoya, and Osaka) are considered the most prestigious schools in Japan. Importantly, selectivity and prestige are often correlated. The older a school is, the more selective it is. Therefore, in this study, I use selectivity rather than prestige.

social inequality (Alon and Tienda 2007). Studies with mixed arguments regarding the power of high-stakes exams in the United States, for example, have examined the role of standardized tests (e.g., the SAT) in relation to class origin or race/ethnicity (Buchmann et al. 2010; Grodsky et al. 2008; Vigdor and Clotfelter 2003). This study adds another aspect, namely, gender, by arguing that the high-stakes exams may exacerbate gender inequality in some education contexts, including but not limited to Japan.

[Figure 1 about here]

2. Background

Importance of horizontal stratification in higher education for gender inequality

Reflecting the cooccurrence of college expansion and the growth of institutional heterogeneity through the proliferation of lower-tier institutions (Arum et al. 2007) and the increased competitiveness of selective colleges (Bound et al. 2009; Hoxby 2009), scholars have increasingly paid attention to how qualitative aspects of higher education play a role in status attainment. Prior work has focused on selective colleges to examine heterogeneity within higher education in terms of labor market returns to higher education (Astin and Oseguera 2004; Brand and Halaby 2006; Brewer et al. 1999; Chetty et al. 2020; Ge et al. 2022; Haveman and Smeeding 2006; James et al. 1989; Karen 2002; Sekhri 2020; Thomas 2003; Thomas and Zhang 2005). Attending selective institutions provides students with social networks or access to relationships with recruiters from elite firms (Domina et al. 2017) or elite clubs (Khan 2011; Michelman et al. 2021), which can be transformed into economic returns via employment in highly rewarding occupations.

In light of the abundant evidence that attending selective colleges provides many advantages, especially for women (Ge et al. 2022), women's underrepresentation in these institutions may be an important mechanism that potentially explains gender inequality in the labor market. Indeed, women's underrepresentation in selective institutions varies to a great degree across countries. Elite schools in English-speaking countries (Ivy League in the US and Oxbridge in the UK), for example, achieve gender parity; more women than men are enrolled in Nordic, Dutch, and Irish top universities; and fewer female undergraduate students than male students are enrolled in other top universities in Switzerland and East Asia.²⁹ Against this backdrop, it is surprising that still limited studies have investigated the sources that could potentially explain the cross-national variation in women's underrepresentation in selective institutions and its consequences.

How the risk of exam failure may reinforce gender inequality in selective college attendance

In theory, admission based on objectively measured test scores should not treat applicants differentially based on their demographic characteristics, but studies suggest that high-stakes exams, and the risk of exam failure associated with this testing form, are likely to contribute to women's underrepresentation in selective institutions.

On the one hand, admission to selective colleges is highly stressful and uncertain, which is especially the case when there is non-ignorable risk of failure. Studies suggest that such a stressful and uncertain nature of high-stakes admission may penalize more women than men.

²⁹ College Factual (<https://www.collegefactual.com/>) for Ivy League colleges, Delaney and Devereux (2021) for Ireland, and Schubert and Marinica (2018) for top universities in Denmark, Switzerland, United Kingdom, and Japan. Also see The SNU Diversity Report (https://en.snu.ac.kr/snunow/snu_media/news?md=v&bbsidx=126626) and Times Higher Education World University Rankings (<https://www.timeshighereducation.com/world-university-rankings/2023/world-ranking>).

This is because, according to previous studies, women prefer less competition (Gneezy et al. 2003; Niederle and Vesterlund 2007; 2011), are more risk averse (Cohen and Einav 2007; Eckel and Grossman 2008; but see Nelson 2016), or report less confidence in their ability (Ehrlinger and Dunning 2003; Soll and Klayman 2004; van Houtte 2005). If this is the case, the high-stakes exam could be an important driver of women's underrepresentation in selective institutions. Partially supporting this expectation, a recent study by Yu and Su (2024) found that the transition from high-stakes exam-based admission to a more holistic admission at the most selective university in Taiwan benefits female applicants more than male applicants.³⁰

On the other hand, any observed relationship between high-stakes testing and the gender gap in selective college attendance could be spurious and driven by common antecedent factors. One aspect that potentially explains the gender gap in selective college attendance via exam-retaking is the gender gap in educational aspirations. Studies have shown that, for example, there is a robust relationship between educational aspirations or expectations and attainment (Kao and Tienda 1998; Marini and Greenberger 1978; Pinquart Ebeling 2020). While the gender gap in children's educational aspirations in terms of educational levels has diminished in the United States (Watt et al., 2012) as well as in Japan (Ojima and Aramaki 2018), no studies have reported whether aspirations for selective colleges differ by gender among those who aim to attend college. If women are less likely to aim to attend a selective college than men, this may explain the gender difference in exam-retaking.

Additionally, there is good reason to believe that this reflects a gender difference in expected returns to selective college attendance (Heckert et al. 2002; Hogue et al. 2010; Smith and Powell 1990). Previous literature also finds that men tend to value extrinsic rewards such as

³⁰ Also in South Korea, women are more likely to be admitted to the nation's most selective university (Seoul National University) via holistic admission than high stakes exams (The JoongAng Ilbo 2019).

economic returns or the prestige of a job, while women tend to place relative emphasis on intrinsic, social, and altruistic rewards such as helping people (Beutel and Marini 1995; Konrad et al. 2000; Ma 2009; Zafar 2013). Gender differences in these expectations and values may play a critical role in explaining the gender gap in selective college attendance in Japan. Previous studies have found that attending a selective college typically leads graduates to large firms (Hirasawa 2010; Ishida 1998; Yoshida 2020), but the working conditions in these firms, including long work hours and frequent relocation to other regions (JILPT 2016; MHLW 2022), often prevent women from continuing their employment after marriage and childbearing. Possibly reflecting this gender-unequal labor market structure, men enjoy more economic returns to elite college education than women do (Li et al. 2023). Studies also show that extrinsic and intrinsic rewards are the case in Japan (Hara 2023; Shirakawa 2020).

Japanese context

Since Japanese education and admission systems are quite distinctive compared with those in other rich countries, such as the United States, this section reviews their basic structure. For the sake of brevity, I limit the explanations to those relevant to my research question and hypotheses.

Secondary and tertiary education in Japan

Secondary education in Japan is characterized by comprehensive education at the lower level (from 7th to 9th grades) and hierarchical academic ranking at the upper level (from 10th to 12th grades). The former is similar to secondary education in other countries (e.g., the United States), while the latter is distinctive in the sense that high schools are differentiated according to their academic selectivity (Rohlen 1983). Junior high school students are sorted into high schools

with different selectivity depending on their academic ability, measured by the entrance exam organized by each high school. Importantly, the school hierarchy is widely shared among people (LeTendre et al. 2003), at least among those who live in the local areas. As such, Japan's distinctiveness in upper secondary education is characterized by between-school tracking, as opposed to US secondary education, where students are sorted within schools depending on their academic ability. As a result, it is often the case that the large majority of students in selective high schools apply to and enter four-year universities.

According to the comparative education policy literature, admission in Japanese secondary and tertiary education, as in other East Asian countries, is classified into a group of admissions systems that rely on test scores to select applicants into particular institutions (Helms 2009; Reshetar and Pitts 2020). Studies suggest that such admission systems have mixed consequences for students' well-being. On the one hand, the competitive environments pay because their ranking in high school predicts students' probability of attending elite colleges net of student ability (Ono 2001), which in turn leads to economic returns in the labor market, including higher earnings (Ono 2007), employment in large firms (Hirasawa 2010; Ishida 1998; Yoshida 2020), or access to managerial positions (Ishida et al. 1997). On the other hand, students are under high pressure in such high-stakes exams, which may increase students' emotional stress (Högberg and Horn 2022); previous studies have criticized the negative side of this admission system as "exam hell" (Kariya and Rosenbaum 2003; Rohlen 1983).

Admission system in Japanese higher education

In terms of college admissions, there are three institutional features that help us to understand the potential gendered consequences of college selectivity and the risk of exam

failure. First, Japanese universities are ranked within a distinct and widely recognized hierarchy of institutional selectivity (Yonezawa et al. 2002), where national and public universities are generally perceived to be more prestigious, more selective, and of better quality, while private universities (with a few notable, widely recognized exceptions) are in the lower ranks of the selectivity hierarchy (Ishida 1998; Ono 2008). Second, most students make decisions about their area of study before entering college, as the entrance examination is typically specific to each university department (Roth 2019). Therefore, a student's college major is usually determined upon entry into college, and transfers between departments are relatively rare (Itō and Hoshi 2020).

Third, and perhaps most importantly, the admission system in Japanese selective higher education is risky and uncertain. Specifically, admission periods (where exams are conducted) for national and public universities are controlled by the Ministry of Education and extremely limited (only one or two periods).³¹ Applicants can submit their application to only one school for each period, meaning that they can take one or two exams for admission. Importantly, most students are admitted to the first period, so the chance of getting admitted through the second period is extremely limited. This is enough to make students feel stressed, but admission to these national/public institutions often uses two-stage screening in which students are required to take a nationwide standardized test as a first stage and, after the nationwide exam, apply to each school they aim to enter and take the second exam coordinated by each university. Most selective schools typically establish a cutoff based on the score of the nationwide exam, so it is critical for

³¹ For example, in the 2020 academic year, national universities had only two periods, one from February 25 and the other from March 12. In addition to the two periods, public universities have another period starting from March 8. In reality, students, especially those who aim to enter national universities, have only one exam in the initial time period because most national universities accept a very limited number of students for the second period.

students to carefully choose and apply to schools with a threshold lower than their score on the nationwide entrance exam.

In contrast, private universities admit prospective students by using exams they design rather than the nationwide test; thus, they usually have a wide range of admission periods without multi-screening processes. Additionally, compared with the strict time period for national/public universities, private universities have more admission periods, so applicants can take an exam for the same school multiple times. This includes admissions not based on the high-stakes exam, where students are evaluated based on their grades in school, extracurricular activities, or interviews with the admission office, similar to US admission to four-year universities.³² Moreover, their exams are conducted earlier than the nationwide test.

Such risky and uncertain high-stakes exams to make it to national and public universities have two consequences. One is that students typically take entrance exams for private universities as a backup, and then take exams for national/public universities. The other is that not all students in these selective high schools are admitted without interruption. Rather, high school students often fail the entrance exam and take the same exam the next year.³³ Reflecting

³² This admission is called recommendation admission (*Suisen*) because students need to be recommended by the principal of their school. There are two types of recommendations, general (*Ippan Suisen*) and designated (*Shiteikou Suisen*). Applicants through the general recommendation must compete with other applicants, while applicants through the designated recommendation will almost certainly be admitted (Cremonini et al. 2011). Each year, high schools designated by private universities are given a maximum number of students they can recommend through the system. Based on school grades or other criteria, high schools recommend a certain number of students for the designated admission. This admission is efficient for all high schools, universities, and applicants in the sense that high schools benefit from sending their students to universities, universities can admit qualified students without an entrance exam and, most importantly, students do not have to risk exam failure.

³³ These students are called *Ronin* (examination repeaters, literally masterless samurai) (Zeng 1999). A proximate cause of exam failure is that a sizable number of students who are as competitive candidates as high schoolers also failed the exam in previous years. Against this backdrop, one may wonder why students fail the entrance exams because available seats (enrollments) are scarce but, importantly, the acceptance rate to universities was already high during the 1990s (above 50%). Currently, some low-ranked universities have adopted a de facto open admission where students are accepted without admission if they apply. This means that students do not have to spend an additional year to retake the exam. Takeuchi (1997: 185) explains that a

the risky admission structure for national/public universities, applying to private universities even if students' top choice school is a national/public university is a strategy often suggested by high schools, which have incentives to lower the risk of students spending an additional year to retake the exam (JILPT 2017). Meanwhile, it is also the case that applicants who get admitted to their second choice but not admitted to their top choice school may decide to retake the exam next year, if they do not necessarily think their admission outcome was successful.

Exam-retaking pays off in Japan. Because exam-retaking students spend a whole year exclusively on the entrance exam, typically attending a prep school for university admission (*Yobiko*) (Tsukada 1991), one year of exam-retaking experience increases their chances of being admitted to selective universities. By attending selective universities, exam repeaters also tend to enjoy better socioeconomic attainment in later life (Nishimaru 2006; Ono 2007).

The role of parents

Studies have suggested that parents' financial support to attend a selective college in Japan is critical because of the considerably limited public spending on higher education and the heavy emphasis on supplementary educational activities (the so-called "shadow education") (Hannum et al. 2019; Raymo et al. 2023). The lack of public spending results in children's heavy reliance on parents' financial support to attend a higher education institution. Parents' role is further emphasized for admission to selective universities because parents' investment in shadow education, including sending their children to a prep school when they retake the exam, is critical

sizable number of high schoolers still fail the exam and spend an additional year retaking the exam. This is especially the case for selective institutions because the explicit university ranking, which is measured by the standardized score based on the mock exam by testing companies (*Hensachi*, the score standardized with a mean of 50 and a standard deviation of 10), encourages students to aim for a university "one rank higher than the one he or she is confident of entering."

for success in meritocratic selection through high-stakes exams (Stevenson and Baker 1992). Previous studies suggest that parents still tend to have lower expectations for female children than for male children (Holloway 2010; Ojima and Aramaki 2018; Yamamoto 2014).

Even if students have the potential to make it to a selective college, parents may have different gendered expectations of children's educational attainment. As Yu (2009: 171) notes, "The importance of individuals' educational aspirations and their family's expectations for them, independent of their abilities, also rose with Japan's adoption of a two-stage exam system" under national universities' admission policy that forces applicants (and their parents) to think carefully about "how undesirable their situation will be if they fail. Japanese men and women are likely to have different answers to these questions." Specifically, Yu (2009) suggests that, although not directly examined, parents are less likely to support their daughters' exam-retaking. If this is the case, even men and women with similar academic profiles may have different responses to the potential risk of exam failure.

3. Research questions and hypotheses

The literature review above suggests that the macrolevel admission system in higher education is a critical source of the gender gap in access to selective universities and, in turn, the substantial gender inequality in the labor market in Japan, arguably one of the most gender-inegalitarian societies among rich countries (Brinton and Lee 2016; Raymo et al. 2023) despite women's rapid improvement in progression to four-year universities over the last three decades (from 15.2% in 1990 to 50.9% in 2020).³⁴

³⁴ Japan is among the most gender-inegalitarian countries in the world, which has the third largest gender wage gap (OECD 2023).

While the Japanese admission system is classified into a group of admission systems that rely on high-stakes exams from a comparative perspective, its admission system, especially for national and public universities, is distinctive in the sense that students often need to take two high-stakes exams to get into these universities. Importantly, students *must* choose schools they apply to based on the first nationwide test score. If they are not admitted, then they might spend another year to make it to the desired school.

Therefore, those who prefer not to retake the exam for various reasons are likely to lower their goal *before* taking the exam and apply to much safer schools, including private universities that have more holistic admission opportunities. This is possible because students typically take three to four nationwide mock exams each year, which are arranged by testing service companies.³⁵ This is an important opportunity for students as mock exams provide not only test scores but also admission chances to the school students are aiming for. Alternatively, even if there are no systematic group-level differences in application behaviors, the response *after* rejection may differ between applicant subgroups. Indeed, previous studies have argued that women are more likely to be admitted to universities without taking the high-stakes exam and are less likely to retake the exam (Isa 2021; Stevenson and Baker 1992; Yoshihara 1998); however, the focus of these studies was on college attendance in general and did not pay specific attention to selective universities. These studies also did not distinguish whether the gender gap in exam-retaking is due to either more men applying to selective universities relative to women with similar academic profiles or more men than women being likely to spend another year to retake the exam after rejection.

³⁵ This is almost mandatory since it is part of the curriculum (the exam fee is covered by high school), so that high schools can have a better assessment of students' placement.

In contrast to these studies, this study pays explicit attention to the “leaky pipeline” into selective universities as a potential explanation for the gender gap in selective institutions by focusing on the gender difference in the risk of exam failure and retaking. Specifically, I examine whether women are less likely to retake the exam than men even if they reported they were aiming for selective universities in their early stage of high school. The educational aspirations among students who choose to retake the exam are heterogeneous, but a majority of these students aim for a national or public university in their third year of high school. Unlike earlier studies (Stevenson and Baker 1992; Yu 2009), this study is the first to pay explicit attention to the mechanisms of the gender difference in exam-retaking with important implications for the gender gap in selective college attendance.

Based on the literature review, I examine the following three hypotheses. First, I examine whether there are gender differences in application behavior. Specifically, I hypothesize that, with the intention to avoid the risk of exam failure and retaking, women are more likely to switch to safer schools than men. This implies that men are likely to face higher rejection rates than women with similar academic profiles.

Hypothesis 1: Female students are more like to change their top choice to a less selective school than men before taking the exam.

Next, I examine whether men and women may have different responses to rejection even though they apply to schools with similar academic selectivity. Based on the evidence that exam-retaking experience increases students’ admission chance to selective universities (Nishimaru 2006; Ono 2007), this implies that the gender gap in response after rejection can contribute to female underrepresentation in selective universities. Specifically, I test the following hypothesis.

Hypothesis 2: Male students are more likely to retake the exam after getting rejected by their top choice school.

Third, I examine whether the compositional difference, if any, in academic aspirations, values to extrinsic and intrinsic rewards, and parental expectations for men and women accounts for the difference in exam-retaking for the two groups. I also expect that parents tend to have higher expectations for their sons' education than their daughters' education. If there are gender differences in these characteristics, this could at least partially explain women's underrepresentation in selective institutions via the gender gap in exam-retaking. To answer these questions, Hypothesis 3 tests the following relationship.

Hypothesis 3a: Students with lower academic aspirations are less likely to retake the exam.

Hypothesis 3b: Students who attach greater value to extrinsic (intrinsic) rewards are more (less) likely to retake the exam.

Hypothesis 3c: Students whose parents have lower educational expectations are less likely to retake the exam.

4. Data, variables, and method

Data

To answer the research questions discussed above, I use the Japanese Life-course Panel Survey of Junior High School Students and Mothers (JLPS-J). This is a longitudinal survey targeting pairs of 9th-grade children (aged 14-15) and their mothers, with detailed information about their educational experience. The population is based on households sampled by a survey company from the Basic Resident Register in Japan. After being recruited, they were asked to be members of an access panel and to participate in several surveys. From the list of all access panel

members, pairs of 9th-grade children and their mothers were selected and then stratified by regional blocks, population size, and gender. The initial survey questionnaires were mailed to 4,117 pairs of mothers and students, and answers were received from 1,854 pairs (45.0%) for the first wave which was conducted from October 2015 to January 2016. Although some populations are missing (e.g., students who dropped out of junior high school before the survey or single-father families), the data are nationally representative of junior high school students and their mothers (Fujihara 2016). When children are in high school, the survey asked about their educational aspirations and the name of their top choice school after graduating from high school if any, as well as other relevant questions including their school grades. When students graduated from high school, an additional survey questionnaire was sent to them asking about their plans after school graduation (e.g., whether they would attend a university or spend an additional year to retake the exam). In this study, I used the two waves of the JLPS-J survey (2017 when children were high school juniors, which is 11th grade, and 2019 when children graduated from high school) and limited the sample to those who answered both surveys. After omitting missing cases for the outcome variable, 652 cases remained. The descriptive table can be found in Appendix Table 1. For cases where predictor variables are missing, I employed multiple imputations by iterative chained equations (MICE) to create 10 imputed datasets to address the missing data.³⁶

Variables

To examine my research question, it is critical to distinguish students' intended schools based on selectivity. JLPS-J is one of the few surveys that asked respondents the *name* of the

³⁶ Missing is found for five variables, where missing rate ranges from 0.3% (intrinsic and extrinsic values) to 8.4% (parental SES).

school for three items: the school they aim for, the school they apply for, and the admission outcomes. Using this rich dataset, I examine the “leaky pipeline” into selective universities. To that end, I define selective universities in the following way.³⁷ First, a group of 29 selective national and public four-year universities is categorized as “Selective National and Public.” Although a majority (22 out of 29) of these schools are national universities (e.g., former imperial universities), I also included seven selective public universities.³⁸ Similarly, I also created a group of 14 selective private universities (“Selective Private”).³⁹ Although there is a qualitative difference in national and public universities with regards to selectivity and school quality, in general these universities are perceived to be more selective than most private universities (Ishida 1998; Ono 2008). Therefore, the subsequent analyses also treat these national/public universities and selective private universities collectively as “selective universities.”

To test Hypothesis 1, I first utilized students’ educational aspirations in their high school junior year and the top choice school they applied for in their high school senior year. In the second wave of the survey, respondents were asked: “Which of the following career paths do you hope to pursue after graduating from the school you are currently attending?” While respondents can raise up to three top choices, I focus on the top choice school (TCS) to generate educational aspirations. For a college application, I used the question asked in the third wave of the survey

³⁷ This definition of selective universities has been well-established measures (see Toyonaga 2022 for a detailed literature review).

³⁸ More specifically, selective national and public universities include Tokyo, Kyoto, Tohoku, Kyushu, Hokkaido, Osaka, Nagoya, Tokyo Institute of Technology, Tokyo Medical and Dental University, Hitotsubashi, Chiba, Tokyo University of Foreign Studies, Tsukuba, Ochanomizu, Yokohama National, Niigata, Kanazawa, Okayama, Hiroshima, Nagasaki, and Kumamoto (national universities), Tokyo Metropolitan, Yokohama City, Nagoya City, Kyoto Prefectural, Osaka City, Osaka Prefectural, and Kobe City University of Foreign Studies (public universities).

³⁹ This includes Keio, Waseda, Sophia, Tokyo University of Science, Meiji, Aoyama Gakuin, Rikkyo, Chuo, Hosei, Gakushuin, Kwansei-Gakuin, Kansai, Doshisha, and Ritsumeikan. Note that this is a small fraction of about 790 private universities in Japan.

(conducted two years after the second wave), where respondents were asked to answer which specific school they applied for in their college admission (again up to three top choices). They both involve measuring vertical levels of education (how far students want to go in terms of educational attainment) and horizontal levels of education in terms of selectivity defined earlier. This question was asked of all students regardless of whether they aimed for a university or not. Sorting universities based on selectivity, I created the following groups: selective national and public universities, other national and public universities, selective private universities, other private universities, and non-universities. For those who have an aspiration to attend a four-year university but do not indicate a specific school, I categorized them as “university (not decided).”

To test Hypothesis 2, I use students’ admission outcomes. In the third wave of the survey, they were asked if they were admitted to their TCS or not. They were also asked to answer if they were in school. If so, they were also asked a follow-up question about the name of the school they are attending. I categorized them similarly to the two variables defined above. I also added “exam retaking” to this variable if they answered they were preparing for the exam in a separate question.

To test Hypothesis 3, I use the following variables. First, I use students’ educational aspirations in their high school junior year (and the TCS they applied for) to see if the gender differences in aspirations account for the gender differences in exam-retaking. Second, I use students’ extrinsic and intrinsic rewards. Specifically, I use a series of eight questions asked to students in the second wave regarding their criteria for occupational choice they would consider using a four-point scale (strongly agree, somewhat agree, somewhat disagree, strongly disagree). This includes values related to extrinsic rewards such as prestige, income, and stability, or values related to intrinsic values such as making one’s dream come true, using skills or talents (a full list

of variables used to create the indexes are shown in Appendix Table 2). To construct extrinsic and intrinsic rewards based on these questions, I carried out exploratory factor analysis using principal component analysis with varimax rotation and the polychoric correlation matrix.⁴⁰ Third, I used parental educational expectations. This variable was constructed in a similar way to the student's educational aspirations.

Since parental socioeconomic status and students' academic profiles likely influence the relationship between admission outcomes and exam-retaking, I included parental socioeconomic status (SES), students' school grades, and school characteristics. Socioeconomic status is a standardized composite score based on the following variables: mother and father's years of education, logged equivalized household income, and family structure (single mother or two parents). These SES-related variables were all reported by mothers. For students' academic profiles, I used students' self-reported school grades and the selectivity of high school.⁴¹ I also controlled for the number of applications students submitted to adjust the risk of rejection. Lastly, I also included the dummy variable which indicates whether the admission type respondents applied for their TCS was a holistic one, rather than a high-stakes exam, to adjust the overall risk of exam-retaking. This is because, similar to early action in the United States, holistic admission takes place much earlier than high-stakes admission, where respondents are strongly expected to enter the school if they are admitted and their acceptance rates are generally systematically higher than high-stakes admissions.

In multivariate regressions, I differentiate children's educational aspirations, the school they applied for, and their mother's educational expectations by using a continuous measure of college selectivity based on admission competitiveness. This is because these predictors are

⁴⁰ This is an appropriate method given the ordinal nature of these variables (Gauthier et al. 2021).

⁴¹ This is based on the standardized rank score (*Hensachi*) of each high school created by a testing company.

highly correlated with the admission outcome if we treat them categorically and thus there are few cases for specific combinations (e.g., students aimed for a less selective private university in their high school junior year but got admitted to a selective national university) or one value of a predictor is strongly associated with a specific value of the outcome (e.g., applying for a selective national/public university and getting admitted to these universities). Although regression results are robust to a different operationalization of these predictors, the main results are based on the continuous measure of college selectivity. This is called *Hensachi*, measured by the standardized score based on the mock exam by testing companies. The selectivity score is highly correlated with the categorical measure of college selectivity as I described above (See Appendix Table 3). Since the selectivity score was only assigned to a specific university, I created a dummy variable which is 1 if the value of these predictors is either “non-university” or “university (not decided),” while I assigned 0 to each of the selectivity variables if the value is missing. By doing so I can include cases where the selectivity score is missing (essentially, those who aim for, applied for, or expected their child to attend a non-university or university without a specific name).

Method

To better understand mechanisms of gender differences in the “leaky pipeline” out of selective college attendance, I estimate the following multinomial logistic regressions. Specifically, I examine how gender shapes the way respondents’ rejection by the TCS is associated with admission outcomes including exam-retaking. First, I estimate the baseline model, where I assume gender and rejection by the TCS are independently associated with admission outcomes with control variables such as parental SES.

$$\ln \left[\frac{p_{ij}}{1 - p_{ij}} \right] = \beta_{0j} + \beta_{1j}Female_i + \beta_{2j}Rejection_i + \sum_{k=3}^K \beta_{kj}X_{ki} + \varepsilon_{ij} \dots (\text{Model 1})$$

where j is a dependent variable that includes *Selective National/Public* ($j=1$), *Other National/Public* ($j=2$), *Selective Private* ($j=3$), *Other Private* ($j=4$, reference category), *Non-University* ($j=5$), and *Exam-retaking* ($j=6$). Thus, the dependent variable $\ln \left[\frac{p_{ij}}{1 - p_{ij}} \right]$ is the log of the ratio of the probability of a given admission outcome ($j \neq 1$) to the probability of attending a non-selective private university. β_{0j} represents the intercept for outcome j . We chose non-selective private university as the reference category because they are qualitatively different from national and public universities and selective universities in terms of their selectivity.

To test Hypothesis 2, we added an interaction variable between the female dummy and the rejection by the TCS:

$$\ln \left[\frac{p_{ij}}{1 - p_{ij}} \right] = \beta_{0j} + \beta_{1j}Female_i + \beta_{2j}Rejection_i + \beta_{3j}Female \times Rejection_i + \sum_{k=4}^K \beta_{kj}X_{ki} + \varepsilon_{ij} \dots (\text{Model 2})$$

Finally, to test Hypothesis 3a-3c, we added several potential factors that could explain the gendered response to the rejection by the TCS. Specifically, I examine respondents' educational aspirations, values to extrinsic and intrinsic rewards, and parental educational expectations.

$$\begin{aligned}
\ln \left[\frac{p_{ij}}{1 - p_{ij}} \right] = & \beta_{0j} + \beta_{1j}Female_i + \beta_{2j}Rejection_i + \beta_{3j}Female \times Rejection_i \\
& + \beta_{4j}Aspiration_i + \beta_{5j}Application_i + \beta_{6j}Values_i + \beta_{7j}Expectation_i \\
& + \sum_{k=8}^K \beta_{kj}X_{ki} + \varepsilon_{ij} \dots \text{(Model 3)}
\end{aligned}$$

5. Results

Descriptive results

Trajectories of educational aspirations and admission outcomes

Figure 2 presents the trajectories of male and female high school students' educational aspirations and outcomes. The first bar from the left shows their aspirations in their high school junior year, including educational levels (whether they aim for a university or not) and horizontal stratification in university education (whether they aim for a national/public or private university or are undecided). The second bar shows the TCS they applied for, while the third and fourth bars show their admission outcomes reported immediately after high school graduation and one year after graduation.

The first two bars show that (1) there are gender differences in the distribution of aspiration and application, (2) high school students' aspiration and application are clearly linked, but not all of them apply for the school they aimed for, and (3) there are very few students who change their TCS to a more selective one. First, the distribution of educational aspirations and top choice applications is different for men and women. We can see that, for example, relatively fewer female students than male students aim for a selective national and public university (28.8% vs. 19.8%). Second, a sizable number of students applied for a school they aimed for in their junior year. For example, close to half (44.1%) of men and women who aimed for a

selective national and public university in their junior year did apply for these universities, but those who aimed for selective national and public universities eventually switched to applying for other national and public universities. Third, in contrast, we also see that very few students move upward in terms of their application behavior. For example, only 10.5% of students who applied for a selective national and public university aimed for other types of universities in their junior year. This underscores that aspiration prior to application is a good predictor for future application behaviors.

Looking at admission outcomes, we can see that there is a sizable gender gap in exam-retaking. Slightly more than one in six men (17.8%) who applied for a university spend another year preparing for the entrance exam, while fewer than 7.1% of women do the same. For both male (85.3%) and female (77.8%) university applicants, a majority of exam retakers applied for a selective university (national/public universities and selective private universities) as their TCS, suggesting that the vast majority of them failed the entrance exam for these selective universities and were likely to retake the entrance exam for these universities in the following year.

Interestingly, there is no major gender difference in attending a selective university upon high school graduation (26.5% for men and 24.8% for women), but the gap increased to 7.4% points (33.9% vs. 26.5%). Since one year of exam-retaking experience increases students' chance of entering a selective college (Nishimaru 2006; Ono 2007), this result suggests that exam-retaking is likely an important mechanism explaining the gender gap in selective institutions in Japan.

[Figure 2 about here]

Distributional differences in key predictors

Earlier results show that men tend to report higher educational aspirations than women do at vertical and horizontal levels, while the distribution of other key predictor variables may also be different for men and women. Figure 3 presents the distribution of predictors used in this study separately by gender (self-reported school grade and the selectivity of high school are shown for reference). The gender differences are mostly consistent with the previous literature. For example, men are more likely to emphasize extrinsic rewards than intrinsic rewards for their occupational choice, while we see that women tend to emphasize intrinsic values than men. Also, mother's expectation for children's education is also higher for sons than daughters. Specifically, mothers of male children tend to report that they expect their sons to attend a selective national or public university, while mothers of female children tend to report that they expect their daughters to attend non-BA institutions. We also see that the self-reported school grades are higher for women than men. In contrast, we do not see a major difference in school selectivity.

The earlier descriptive figures are consistent with my theoretical expectations. Possibly reflecting gender differences in educational aspirations, values for occupational choice, or parental expectations, female students may be less likely to apply to selective national and public institutions. We also see that women are less likely to retake the exam when they fail, which may be also explained by gender differences in these characteristics. Meanwhile, there are no gender differences in switching to less selective institutions, which suggests that women's lower prevalence of exam-retaking compared with men is driven by either more men than women applying to selective national and public universities or by fewer women than men retaking the exam when they were rejected.

To investigate the second possibility, Figure 4 shows the distribution of admission outcomes for men and women by whether they were accepted to or rejected by their TCS.

Looking at those who are admitted, we can see that women are slightly less likely to be accepted to selective universities, but the distributional difference mainly reflects the gender differences in application. Meanwhile, we can see a stark gender difference in exam retaking among those who are rejected. Among those who are rejected by their TCS, approximately 13.7% of female students choose to spend another year retaking the exam, while 33.7% of male students do so. Since a large majority of retaking students applied to national and public universities or selective private universities for both men and women and many, though not all, retakers end up attending selective universities, it is valuable to examine the sources of the gender gap in exam retaking, which we examine in the next section.

[Figure 3 about here]

[Figure 4 about here]

Multivariate results

Descriptive results suggest that the gender gap in exam retaking stems from the gender difference in response after the rejection by their TCS, rather than fewer women aiming for a selective university. I also do not find evidence that women are more likely to lower their TCS from selective to less-selective one before admission than men. To make a conclusion robust to potential confounders, I performed a series of multinomial regression models.

In this analysis, I primarily examine exam-retaking as the outcome of interest since descriptive figures show that this is a critical source of the gender difference, while I also briefly discuss other relevant outcomes. Table 1 presents the results of multinomial regression models predicting respondent's admission outcomes. In Model 1, I add a female dummy, rejection by their TCS, and other relevant control variables. The results clearly show that even after

controlling for covariates such as school grade or high school selectivity, women are less likely to choose to spend another year to retake the exam compared with attending a non-selective private university than men, while rejection by the TCS increases one's odds of exam retaking.

Several results are worth noting. First, we can see that high school selectivity is positively associated with exam retaking as well as admission to selective universities. This underscores important contextual characteristics in Japanese college admission, where students are rejected by their TCS (and thus likely to retake the exam) not because they are less qualified but rather because they aim high under uncertain situations caused by the risky admission system. Second, other variables show results that are consistent with my expectations. For example, we can see that the more applications respondents submitted, the less they are likely to retake the exam. Somewhat inconsistent with my expectations is the result of the holistic admission. Although I included this variable to control the overall risk of exam retaking since acceptance rates are much higher for holistic admission than high-stakes admission, results suggest that the risk of exam-retaking is not different for those who applied for their TCS via holistic admission and high-stakes admission.

Looking at Model 2 where I add an interaction between the female dummy and the rejection by the TCS, we can see that the gender gap is primarily driven by those who were rejected by their TCS. Specifically, comparing Model 1 and Model 2, women are on average less likely to retake the exam than men but this is especially the case when they were not admitted to their TCS. In Model 3, I add key variables that explain the gender gap in exam-retaking. By and large, adding these variables does not change the relationship, although the distributional differences in these traits are largely consistent with my expectations.

Figure 5 presents predicted probabilities of exam-retaking by gender and the admission outcome for the TCS, based on the multinomial regression models predicting respondents' admission outcomes. According to Model 2 where I added interaction between gender and rejection by the TCS, there is little gender gap in exam-retaking when they were admitted to the TCS (1.7% for men versus 2.8% for women), but the gender gap widens for those who did not make it to their TCS (21.1% for men versus 8.1% for women). These results are consistent with Hypothesis 2. Meanwhile, women's lower likelihood of exam-retaking when they are rejected by the TCS does not change even after adding key predictors, which is not consistent with any of Hypothesis 3.

[Table 1 about here]

[Figure 5 about here]

6. Supplementary analysis

The current analysis has a 6-category outcome, while the sample size is not necessarily large (625 cases). To deal with potential concerns about estimating complicated outcomes with a smaller sample size, I estimate models based on an alternative outcome specification. Superficially, I collapsed admission to universities with different selectivity into one category. This approach allows me to estimate the likelihood of exam retaking in a 3-category outcome (any university, non-university, and exam retaking).

Results from multinomial regression models are shown in Appendix Table 4. We generally see similar results to the models with more complicated outcome operationalization. Looking at Appendix Table 4, we can see that women are less likely to retake the exam than men

retake the exam (Model 1). We also see that this is especially the case when they are rejected by their first choice (Model 2). The negative interaction between the female dummy and rejection by their 1st choice does not change even after controlling for potential confounders (Model 3). These results are quantitatively and qualitatively similar to Table 1, while I changed the definition of the reference category.

I also estimate predicted probabilities based on Model 3, which are estimated similarly to Figure 5. Results suggest that the risk of exam-retaking is 3.3% for women and 1.9% for men if they are accepted to their first-choice school. Meanwhile, the risk diverges between women and men when they are rejected by their first-choice school. Specifically, the risk of exam-retaking is 7.9% for women and 19.5% for men. Again, these results are similar to the models with a more complicated outcome operationalization.

7. Discussion and conclusion

Taking advantage of the unique combination of college application and outcome available in a longitudinal dataset in Japan, where higher education is characterized by an extremely low number of female students in selective institutions, this study is the first attempt to examine the role of high stakes testing associated with gender differences in exam-retaking. The results of the analysis show the following findings. First, net of academic ability measured as high school selectivity and school grade, a good proxy of college selectivity in Japan, women are less likely to choose to retake the exam. Second, the gender gap in exam-retaking is primarily driven by the fact that fewer women than men retake the exam when they are rejected by their TCS. Third, I found that likely correlates, including educational aspirations, values of extrinsic or intrinsic rewards, or parental expectation for children's education, do not account for the

gender difference. Although we need to explore mechanisms in future studies, one tentative conclusion drawn from the set of current analyses is that pathways into exam-retaking are gendered.

This study made an explicit case selection by choosing the Japanese case, an outlier in comparative perspective in terms of women's representation in selective higher education. What can we learn from this single case study? The gender differences in preferences, values, or aspirations have been well documented across countries (e.g., Niederle and Vesterlund 2011). This situation may be even worse in Japan, which is characterized by persistent gender inequality in the labor market and gender-specific socialization at home. However, the lack of evidence supporting the explanatory power of these characteristics needs an alternative explanation for why few women aim for a selective college.

One important insight, although still suggestive, is that academic aspirations are institutionalized in the transition from secondary to higher education in the sense that students' attitudes are evaluated in a gendered way. Theoretically, exam-retaking should not occur in contemporary Japan because the number of applicants to universities is almost the same as the capacity of universities, but in reality, a sizable number of high school students end up spending an additional year. This happens because the admission opportunities for selective institutions are considerably limited and high-stakes, and students must take a risk in making it to their dream school or failing.

In this context, exam-retaking offers an informal means for a second try, but the results indicate that men and women do not respond to the opportunity equally. Even if women have similar academic profiles to men, their aspirations do not necessarily translate into actual admission outcomes. Specifically, results suggest that female respondents are particularly likely

to opt out of exam retaking if they are rejected by their TCS. Looking at other admission outcomes in Model 3, we can see that both men and women who are rejected by the TCS are equally likely not to make it to selective universities including national and public universities as well as selective private universities, as the interaction coefficient is not statistically significant. These results provide important insights into how the high-stakes exams may exacerbate gender inequality. In the case of Japan, the distinctive admission system with a higher risk of exam failure contributes to stalled trends in the gender gap in selective college attendance despite the ongoing gender convergence in four-year university enrollment.

The case of Japan is an illustrative example of how high-stakes exam and associated risk of exam-failure may penalize women over men. This does not mean, however, that the implication is limited to Japan because high-stakes exams exist almost everywhere in contemporary societies (Furuta et al. 2021; Högberg and Horn 2022; Verger et al. 2019). For example, although the mechanisms are still unclear, the gender gap in admission and matriculation for New York City's Specialized High Schools, which is much larger than the gap between White and Black or Hispanic students, remains even after controlling for students' prior test scores (Corcoran and Baker-Smith 2018). As such, it is likely that we can find similar institutional mechanisms that unintentionally locate women in a less advantaged position, especially in gender inequalitarian contexts. As such, this study contributes to reorienting our focus on gender inequality in higher education, where the existing scholarship has discussed the sources and consequences of the gender gap reversal in various kinds of academic success (Buchmann et al. 2008; Reeves 2022; Spinath et al. 2014).

If correct, this speculation provides important social, economic, and political implications for gender equality. Despite the fact that women now outnumber men in higher education in

most rich countries (DiPrete and Buchmann 2013; van Bavel 2012), the gender gap in labor market outcomes remains substantial and has stalled among college graduates (England 2010; Goldin 2014). A number of studies have suggested that fields of study may be a source of the gender pay gap (Zafar 2013) because women are less likely than men to specialize in fields associated with high-paying occupations, most notably STEM majors (Ceci and Williams 2011; Riegle-Crumb and Peng 2021; Weeden et al. 2020). Even after considering gender differences in fields of study, however, the gender pay gap remains (Kim et al. 2015; Zafar 2013). Although this is likely accounted for by gender differences in career interruption after family events, the remaining gender pay gap net of gender differences in fields of study among university graduates suggests that women's underrepresentation in selective institutions may be a critical source of gender stratification in the labor market. This is particularly the case in Japan, where attending a selective college is a pipeline to high-stakes positions (e.g., bureaucrats, researchers, and leadership positions in large firms), suggesting it is critical to further investigate the underlying mechanisms behind the gender gap in selective universities for gender equality.

In terms of policy interventions, findings from this study suggest that a properly designed admission system that reduces the risk of exam retaking or the avoidance of these exams may have implications for the gender gap in selective college attendance in high-stakes exam contexts. Indeed, one recent study found that the transition from high-stakes exam-based admission to a holistic one increase the share of female applicants in Taiwan (Yu and Su 2024). In Japan, it is the case that universities increasingly use holistic admission for admission (Bastedo 2021). However, most applicants to national and public universities are still admitted through high-stakes exams, while private universities increasingly admit their applicants through

holistic admissions (Yonezawa and Akiyama 2015). In this sense, holistic admission is still not a mainstream way of admission for selective institutions.

Future studies need to identify causal mechanisms that can help us to understand what is happening during high school years and why more women than men are likely to drop out of the meritocratic competition for selective universities even if they are equally qualified in terms of their academic achievements and aspirations. Specifically, future studies would benefit from using data that include rich information about individuals' risk preferences, attitudes toward competition, or confidence in their ability.⁴² If these attitudes are properly measured, we could perhaps explain the remaining gender difference in exam-retaking, which would allow us to distinguish the psychological explanation from a more structural explanation, including female students being discouraged to retake the exam regardless of their mindset.

For future studies, it should also be noted that school climate, which is missing from experimental studies, is an important institutional mechanism that reinforces students' gender stereotypes (e.g., Nakanishi 1998). It is also necessary to expand the role of high-stakes exams under high pressure for gender inequality in selective higher education from a comparative perspective. Reflecting diverse views on what should be counted as merit and what is fair competition, there is a large between- and within-country variation in admissions (Michel and Pollard 2020). Although many countries increasingly use national-level high-stakes exams, these admission systems are also constrained by institutional path dependency and cultural norms in each country (Furuta et al. 2021; Zwick 2017; Wikström and Wikström 2020), leading to speculation that the comparative perspective on meritocratic selection may help in understanding

⁴² Ideally, it would be preferable if the survey could ask about these psychological attitudes after taking the nationwide exam since it is likely that students' risk preference may change depending on the admission results.

women's underrepresentation in elite education across countries. I expect that the high-stakes exam penalizes women more or less, but this is open to empirical investigation. If we find consistent patterns, then education policymakers should consider how to reduce gender inequality due to the potential bias in admission systems.

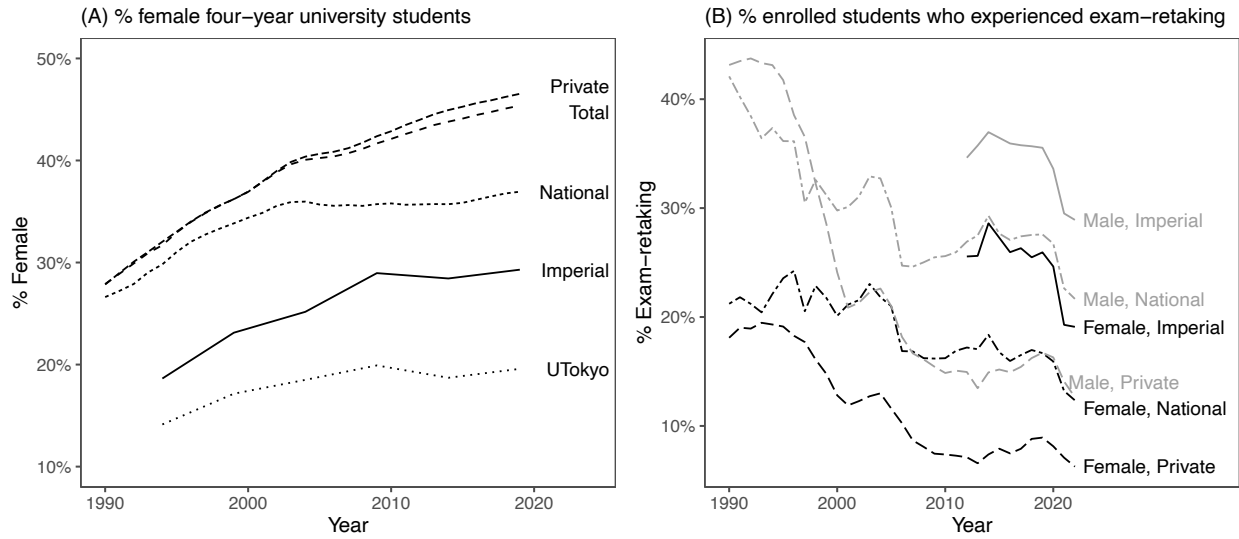
Table 1 Multinomial logistic regression results predicting admission outcomes (other private university as a reference category)

	Model 1		Model 2		Model 3	
<i>Selective national/public</i>	Coef.	SE	Coef.	SE	Coef.	SE
Female	-0.76+	0.46	-0.71	0.51	-0.99+	0.58
Rejection by 1st choice	-2.96***	0.67	-2.97***	0.92	-4.21***	1.02
Number of applications	-0.16	0.29	-0.15	0.29	-0.62+	0.32
1st choice rec.	-1.32*	0.63	-1.32*	0.63	-1.29+	0.67
High school selectivity	2.50***	0.38	2.50***	0.38	2.09***	0.43
High school grade in junior year	1.37***	0.28	1.36***	0.28	1.06***	0.31
SES composite score	0.52+	0.30	0.52+	0.30	0.37	0.32
Female # Rejection by 1st choice			0.06	1.20	0.58	1.27
Selectivity score of aspiration in HS junior year					-0.30	1.16
Aspiration: university not specified or non-university					-1.39	2.59
Selectivity score of university applied					6.71***	1.40
Applied to non-university					13.65***	3.17
Intrinsic values					0.09	0.26
Extrinsic values					-0.18	0.25
Selectivity score of mother's expectation					-0.4	1.24
Expectation: university not specified or non-university					-0.88	2.68
Constant	-2.18***	0.53	-2.21***	0.54	-5.45***	1.06
<i>Other national/public</i>						
Female	-0.32	0.29	-0.37	0.35	-0.56	0.37
Rejection by 1st choice	-1.37***	0.40	-1.56***	0.57	-1.85***	0.60
Number of applications	-0.29	0.20	-0.29	0.21	-0.47*	0.23
1st choice rec.	-1.10***	0.36	-1.08***	0.36	-1.02***	0.38
High school selectivity	1.16***	0.21	1.15***	0.21	1.04***	0.25
High school grade in junior year	0.73***	0.16	0.72***	0.16	0.62***	0.18
SES composite score	0.18	0.16	0.19	0.16	0.07	0.16
Female # Rejection by 1st choice			0.32	0.65	0.46	0.67
Selectivity score of aspiration in HS junior year					-0.55	0.64
Aspiration: university not specified or non-university					-2.69*	1.36
Selectivity score of university applied					1.75*	0.70
Applied to non-university					3.46*	1.46
Intrinsic values					0.00	0.15
Extrinsic values					-0.01	0.16
Selectivity score of mother's expectation					0.24	0.66
Expectation: university not specified or non-university					0.24	1.36
Constant	-0.33	0.28	-0.31	0.30	-0.61	0.52
<i>Selective private</i>						
Female	-0.54	0.36	-0.26	0.48	-0.83	0.59
Rejection by 1st choice	-0.73	0.48	-0.37	0.64	-1.81*	0.80
Number of applications	0.01	0.25	0.01	0.25	-0.53+	0.30
1st choice rec.	0.54	0.46	0.54	0.46	0.59	0.60
High school selectivity	2.08***	0.29	2.08***	0.29	1.30***	0.35
High school grade in junior year	0.80***	0.20	0.81***	0.20	0.18	0.25
SES composite score	0.17	0.19	0.15	0.19	-0.03	0.23
Female # Rejection by 1st choice			-0.65	0.73	0.29	0.89
Selectivity score of aspiration in HS junior year					-1.86+	1.04
Aspiration: university not specified or non-university					-3.91+	2.28
Selectivity score of university applied					9.33***	1.35
Applied to non-university					19.36***	3.07
Intrinsic values					0.13	0.23
Extrinsic values					0.02	0.23
Selectivity score of mother's expectation					2.02*	1.01
Expectation: university not specified or non-university					4.12+	2.27
Constant	-2.25***	0.45	-2.41***	0.49	-8.61***	1.22

Table 1 Multinomial regression results (cont.)

	Model 1		Model 2		Model 3	
<i>Non-university</i>	Coef.	SE	Coef.	SE	Coef.	SE
Female	-0.12	0.28	-0.12	0.31	-0.34	0.41
Rejection by 1st choice	3.58***	0.52	3.57***	0.63	3.07***	0.68
Number of applications	-5.10***	0.49	-5.11***	0.49	-2.73***	0.44
1st choice rec.	-0.15	0.34	-0.16	0.34	0.29	0.40
High school selectivity	-0.40*	0.18	-0.40*	0.18	-0.42+	0.25
High school grade in junior year	0.03	0.14	0.03	0.14	-0.09	0.18
SES composite score	0.21	0.14	0.22	0.14	0.30+	0.17
Female # Rejection by 1st choice			0.07	0.71	0.25	0.73
Selectivity score of aspiration in HS junior year					-0.6	0.77
Aspiration: university not specified or non-university					-0.86	1.42
Selectivity score of university applied					1.72*	0.83
Applied to non-university					6.22***	1.58
Intrinsic values					-0.04	0.16
Extrinsic values					0.05	0.17
Selectivity score of mother's expectation					-0.60	0.85
Expectation: university not specified or non-university					-0.59	1.57
Constant	-3.50***	0.48	-3.51***	0.49	-4.03***	0.73
<i>Exam-retaking</i>						
Female	-0.97***	0.34	0.33	0.73	0.29	0.75
Rejection by 1st choice	1.99***	0.50	2.88***	0.73	2.51***	0.76
Number of applications	-0.84***	0.23	-0.84***	0.23	-0.99***	0.25
1st choice rec.	-0.98+	0.54	-1.05+	0.55	-0.92	0.57
High school selectivity	1.05***	0.26	1.04***	0.26	0.85***	0.29
High school grade in junior year	0.09	0.17	0.09	0.17	-0.10	0.19
SES composite score	0.14	0.19	0.11	0.19	0.04	0.20
Female # Rejection by 1st choice			-1.70*	0.84	-1.72*	0.86
Selectivity score of aspiration in HS junior year					-0.57	0.82
Aspiration: university not specified or non-university					-0.78	1.68
Selectivity score of university applied					2.77***	0.89
Applied to non-university					5.43***	1.92
Intrinsic values					-0.02	0.19
Extrinsic values					-0.38*	0.19
Selectivity score of mother's expectation					1.13	0.81
Expectation: university not specified or non-university					2.14	1.70
Constant	-1.87***	0.44	-2.57***	0.64	-4.54***	0.91
Observations			652			
Log Likelihood	-1165.45		-1123.30		-1061.04	

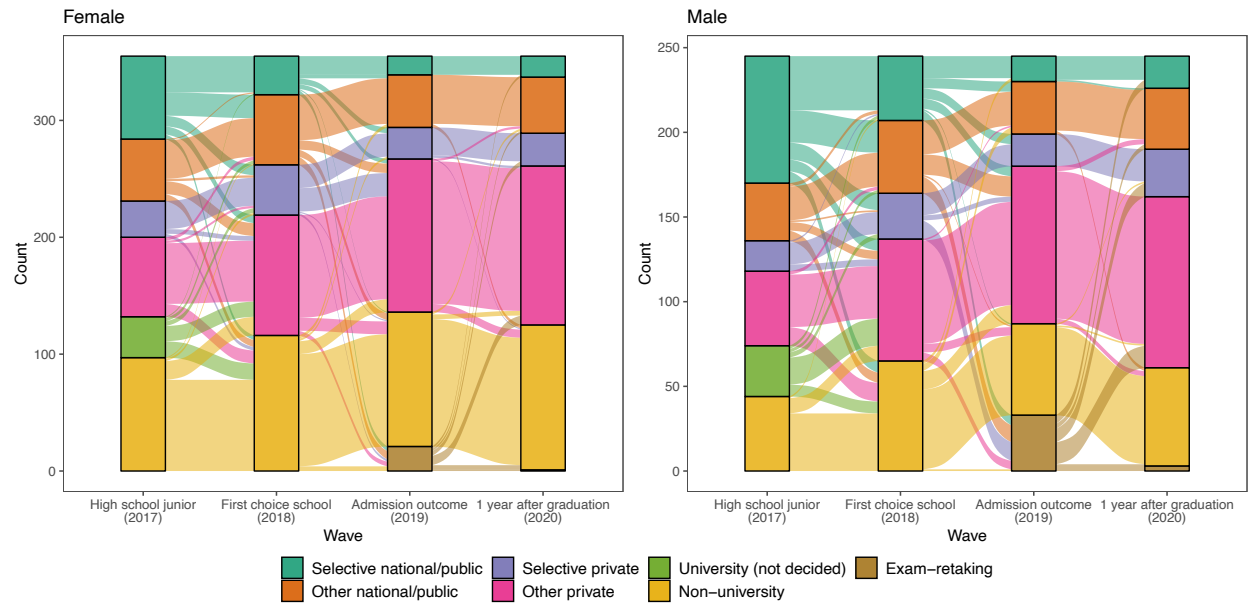
Standard errors in parentheses. + p<0.10 * p<0.05 ** p<0.01 *** p<0.001



Source: School Basic Survey and author's own calculation based on demographic information provided by each university.

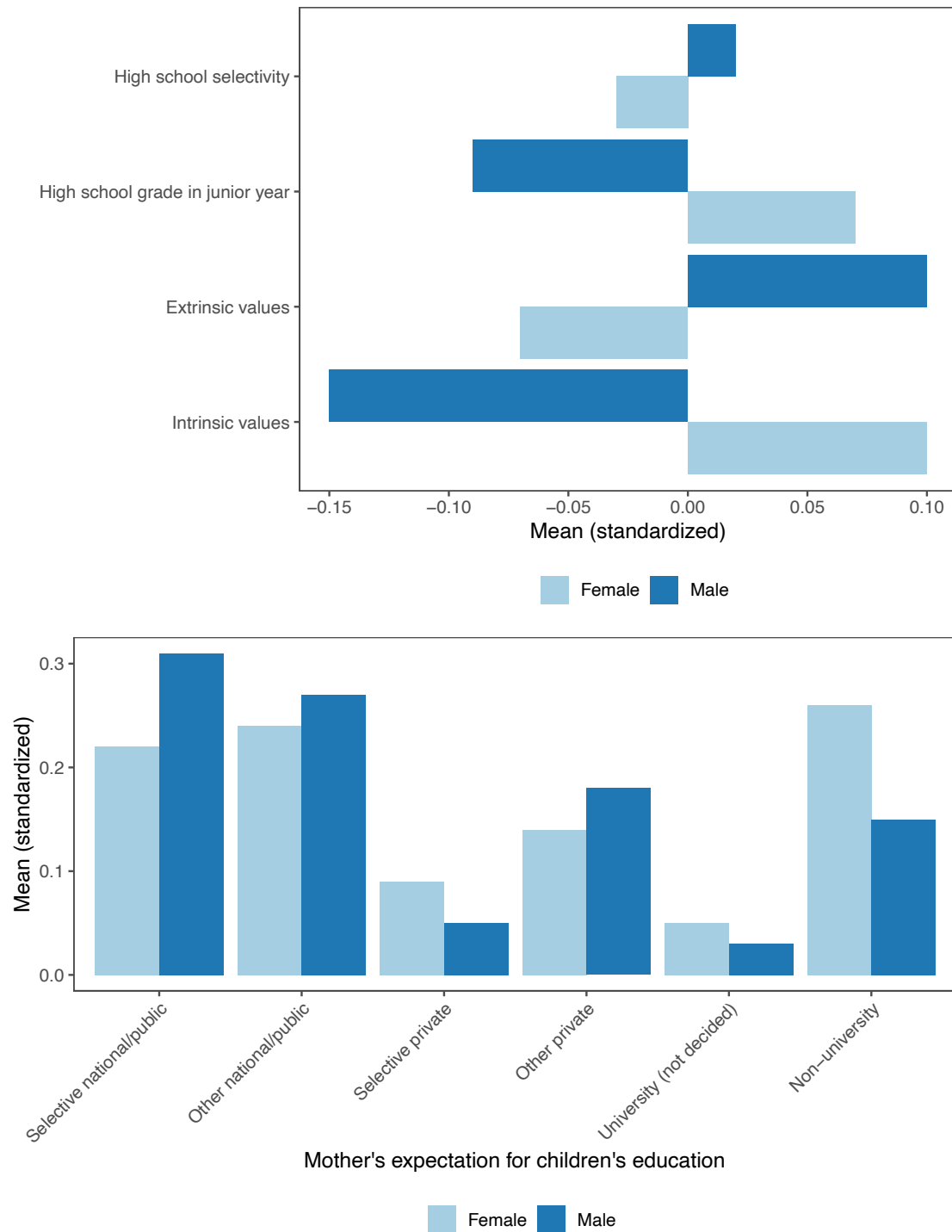
Note: Imperial universities comprise seven national universities (University of Tokyo, Kyoto, Tohoku, Kyushu, Hokkaido, Osaka, and Nagoya) founded and run by the imperial government of Japan until the end of the WWII. These universities are perceived as the nation's top universities

Figure 1 The proportion of female four-year university students and enrolled students who experienced exam retaking



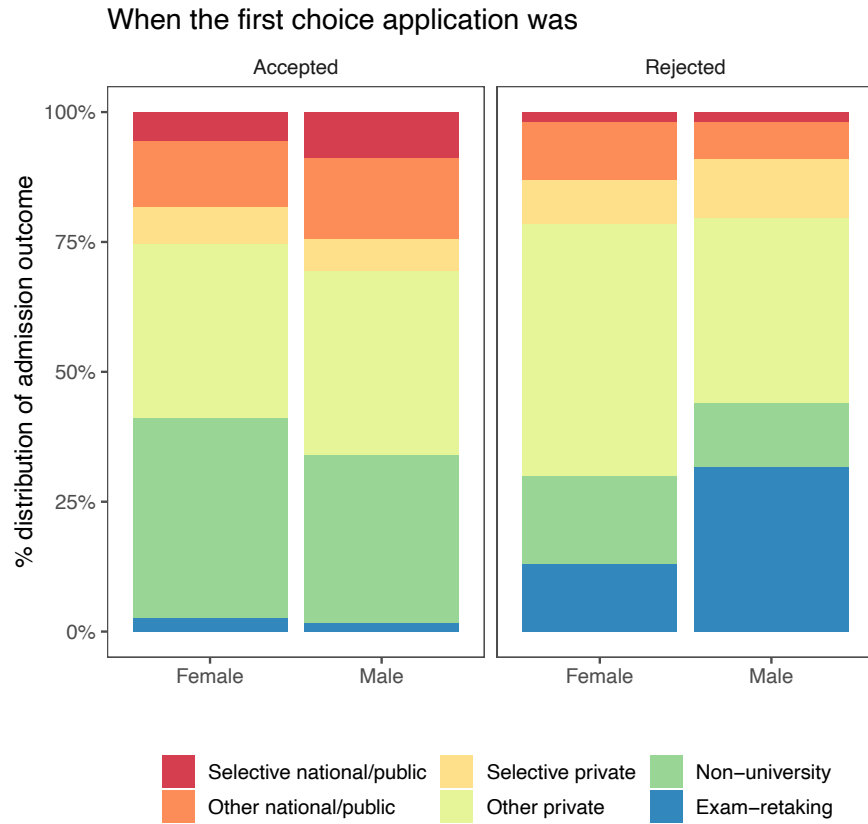
Source: the Japanese Life-course Panel Survey of Junior High School Students and Mothers (JLPS-J).

Figure 2 Trajectories of male and female students' educational aspirations and outcomes



Source: the Japanese Life-course Panel Survey of Junior High School Students and Mothers (JLPS-J).

Figure 3 Gender differences in key individual characteristics



Source: the Japanese Life-course Panel Survey of Junior High School Students and Mothers.

Figure 4 Admission outcomes by the first choice application result and gender

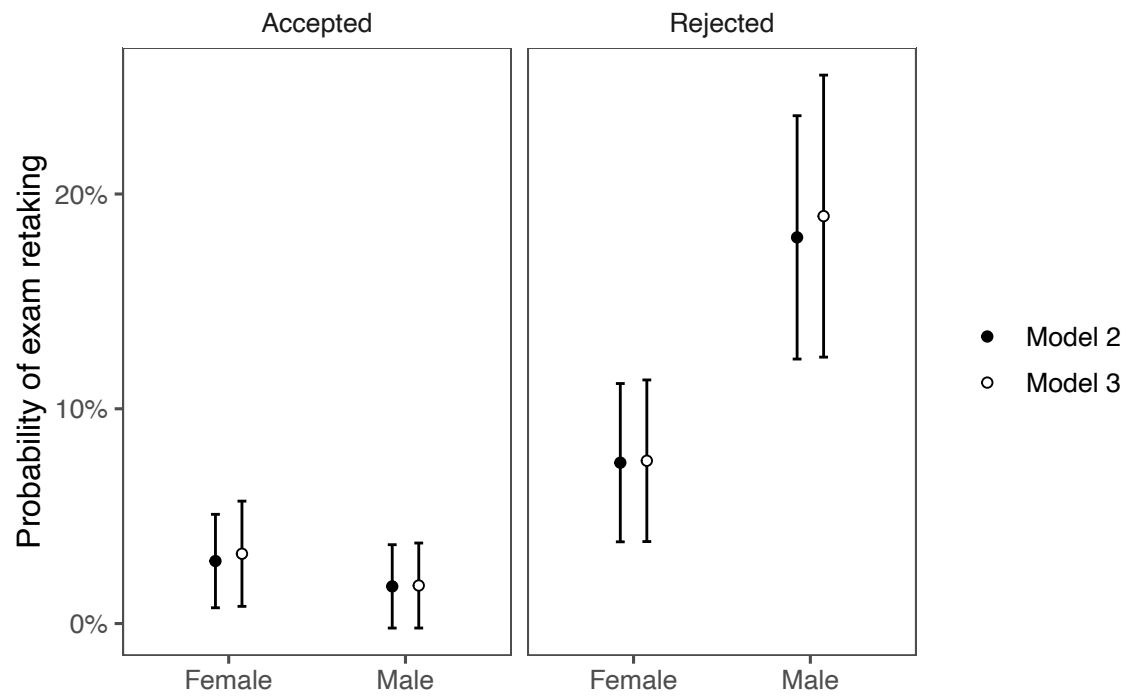


Figure 5 Predicted probability of exam-retaking by sex and admission outcomes with 95% confidence intervals

Appendix for Chapter 3

Table A1 Descriptive statistics

	Mean	SD
<i>Admission outcome in HS senior year</i>		
Selective national/public	0.05	0.01
Other national/public	0.12	0.01
Selective private	0.08	0.01
Other private	0.37	0.02
Non-university	0.29	0.02
Exam-retaking	0.08	0.01
Female	0.57	0.02
Rejection by top choice school	0.31	0.02
Number of applications	0.00	0.04
1st choice: holistic admission	0.48	0.02
High school selectivity	0.00	0.04
High school grade in junior year	0.00	0.04
SES composite score	0.00	0.04
Selectivity score of aspiration in HS junior year	0.00	0.04
Aspiration: university not specified or non-university	0.36	0.02
Selectivity score of university applied	0.00	0.04
Applied to non-university	0.31	0.02
Intrinsic values	0.00	0.04
Extrinsic values	0.00	0.04
Selectivity score of mother's expectation	0.00	0.04
Mother's expectation: university not specified or non-university	0.38	0.02
Observations	652	

Table A2 The list of items for extrinsic and intrinsic values and factor loadings from the
exploratory factor analysis

Item	Extrinsic	Intrinsic
The company is prestigious	0.773	0.087
The job offers high salary	0.848	-0.027
The job is high status	0.792	0.187
The job is stable and without worry about bankruptcy	0.715	0.143
The job requires fewer overtime work and offers more holidays	0.600	0.035
I can use and develop my talent in the job	0.109	0.927
The job makes my dream come true	0.016	0.920
I can use technique or knowledge in the job	0.074	0.917

Table A3 Selectivity measured by the standardized rank score across different university groups

	Selective national/public	National/public	Selective private	Non-selective private
Aspirations in the HS junior year	0.93	0.48	0.97	0.34
Top choice school applied	0.92	0.58	1.01	0.33
School admitted in the HS senior year	1.11	0.20	1.30	-0.53
Mother's expectation for children's education	0.94	0.02	1.00	-0.07

Table 4 Multinomial logistic regression results predicting admission outcomes (any university as a reference category)

	Model 1		Model 2		Model 3	
<i>Non-university</i>	Coef.	SE	Coef.	SE	Coef.	SE
Female	0.03	0.27	0.02	0.30	-0.18	0.40
Rejection by 1st choice	3.88***	0.51	3.86***	0.62	3.49***	0.66
Number of applications	-5.00***	0.48	-5.00***	0.48	-2.54***	0.43
1st choice rec.	0.04	0.32	0.03	0.32	0.41	0.39
High school selectivity	-0.81***	0.17	-0.81***	0.17	-0.74***	0.23
High school grade in junior year	-0.18	0.13	-0.18	0.13	-0.20	0.17
SES composite score	0.16	0.14	0.16	0.14	0.27	0.17
Female # Rejection by 1st choice			0.10	0.70	0.28	0.71
Selectivity score of aspiration in HS junior year					-0.78	0.75
Aspiration: university not specified or non-university					-0.98	1.39
Selectivity score of university applied					0.97	0.77
Applied to non-university					4.95***	1.49
Intrinsic values					-0.04	0.16
Extrinsic values					0.03	0.16
Selectivity score of mother's expectation					-0.68	0.82
Expectation: university not specified or non-university					-0.76	1.52
Constant	-4.28***	0.47	-4.28***	0.47	-4.38***	0.71
<i>Exam-retaking</i>						
Female	-0.73*	0.32	0.60	0.71	0.59	0.72
Rejection by 1st choice	2.59***	0.47	3.48***	0.69	3.37***	0.71
Number of applications	-0.73***	0.22	-0.74***	0.22	-0.68***	0.22
1st choice rec.	-0.82	0.52	-0.90+	0.53	-0.84	0.55
High school selectivity	0.40+	0.22	0.39+	0.23	0.31	0.26
High school grade in junior year	-0.25	0.16	-0.25	0.16	-0.29+	0.18
SES composite score	0.08	0.18	0.06	0.18	0.06	0.19
Female # Rejection by 1st choice			-1.74*	0.81	-1.82*	0.82
Selectivity score of aspiration in HS junior year					-0.49	0.75
Aspiration: university not specified or non-university					-0.49	1.54
Selectivity score of university applied					0.82	0.75
Applied to non-university					1.80	1.67
Intrinsic values					-0.02	0.18
Extrinsic values					-0.40*	0.17
Selectivity score of mother's expectation					0.83	0.74
Expectation: university not specified or non-university					1.63	1.56
Constant	-2.83***	0.41	-3.53***	0.62	-4.43***	0.83
Observations	652					

Standard errors in parentheses. + p<0.10 * p<0.05 ** p<0.01 *** p<0.001

CONCLUSION

Since I discussed the implications and limitations of each chapter already, I here briefly conclude this dissertation by discussing (1) a few thoughts on future research on horizontal stratification and (2) policy implications.

I have two thoughts on the future directions of horizontal social stratification research. One is that we need to think carefully about the necessity of a comparative measure of horizontal stratification. If we need the comparative measure, then we also need to discuss how we can make such a measure. The other is the disconnection between concepts and measurement.

One of the key approaches in social stratification research is a focus on a comparative perspective (Hout and DiPrete 2006; Treiman and Ganzeboom 2000). This perspective is important because institutional contexts that differ across societies play a critical role in shaping inequality-generating processes. In this context, educational expansion is one key institutional mechanism that could potentially explain variations in inequality and mobility across societies. Decades of social stratification research have examined how college expansion shapes social stratification and mobility across different institutional contexts (e.g., Breen 2010; Breen et al. 2009; Hannum et al. 2019; Smits 2003; Smits and Park 2009). This is primarily because, I believe, the operationalization of college expansion is easier. A college or university is a tertiary education institution, which is internationally defined by the International Standard Classification of Education (ISCED) issued by UNESCO. There is a clear distinction between university and non-university based on degree. In contrast, horizontal stratification in terms of selectivity is hard to compare across societies. For example, the University of Tokyo (UTokyo) and Peking University (PKU) are the two most selective Asian universities in the world. Each university is recognized as the most selective institution in each country. Meanwhile, the former

is far less competitive to get in than the latter. PKU admits about 11,000 students each year, while UTokyo admits 3,000 students. Looking at the population who is eligible to apply to these universities, about 1.3 million students take China's nationwide entrance exam, meaning that less than 1 out of 1,000 (0.08%) students who are likely to make it to university can make it to PKU. Meanwhile, roughly about 630,000 students in Japan entered a university in 2023. This means that about 5 in 1,000 (0.48%) students who make it to a university attend UTokyo. Does this mean that PKU is 6 times more selective than UTokyo in a comparative sense? To what extent are the Ivy League colleges comparable to the former Imperial universities in Japan? There is no satisfying answer yet.

Second, the last paragraph already suggests that there is no consensus about how to measure horizontal stratification. One way is to use numerical measures such as acceptance rate. This is how US universities are differentiated. Meanwhile, we can also rely upon a more categorical measure, such as Ivy League colleges. Is either of these more suitable for the conceptualization of horizontal stratification? This seems a similar debate about how to measure social class. European tradition focuses more on categorical differences across social classes, while American tradition focuses on continuous aspects (e.g., socio-economic index). Unfortunately, in my view, there is no compelling theoretical argument about which direction we should aim for in horizontal stratification. Without clear theory and concepts, we cannot move forward to measurement. Future research should discuss more theoretical foundations of horizontal stratification. How is this similar to vertical stratification (i.e., years of education)? If different, how can we measure the difference? These are all open questions.

I conclude this dissertation by briefly touching on policy implications. Although these three dissertation chapters examine different aspects of horizontal stratification in higher

education, one overreaching policy implication is that we need to carefully think about the efficiency, equity, and consequences of qualitative diversification of higher education systems. On the one hand, increasing institutional stratification in higher education in terms of selectivity is expected to improve the efficiency of educational outcomes because studies suggest that students will receive a more clear message about their future plans in highly differentiated educational systems. On the other hand, my dissertation found that access to such selective colleges is highly unequal, which may contribute to the persistence of inequality across generations. Thinking about how to make such selective colleges more accessible is critical since my dissertation also found that attending a selective college is associated with the labor market and marriage market outcomes. I hope to discuss several potential ways to increase the accessibility of selective college attendance in my dissertation.

BIBLIOGRAPHY

- Alon, Sigal. 2009. "The Evolution of Class Inequality in Higher Education: Competition, Exclusion, and Adaptation." *American Sociological Review* 74(5):731–55. doi: [10.1177/000312240907400503](https://doi.org/10.1177/000312240907400503).
- Alon, Sigal, and Marta Tienda. 2007. "Diversity, Opportunity, and the Shifting Meritocracy in Higher Education." *American Sociological Review* 72(4):487–511. doi: [10.1177/000312240707200401](https://doi.org/10.1177/000312240707200401).
- Andrade, Stefan B., and Jens-Peter Thomsen. 2019. "Educational Assortative Mating: A Micro-educational Approach." *The British Journal of Sociology* 70(4):1245–75. doi: [10.1111/1468-4446.12488](https://doi.org/10.1111/1468-4446.12488).
- Arum, Richard, Adam Gamoran, and Yossi Shavit. 2007. "More Inclusion than Diversion: Expansion, Differentiation, and Market Structure in Higher Education." Pp. 1–35 in *Stratification in Higher Education: A Comparative Study*, edited by Y. Shavit, R. Arum, and A. Gamoran. Stanford: Stanford University Press.
- Arum, Richard, and Josipa Roksa. 2014. *Aspiring Adults Adrift: Tentative Transitions of College Graduates*. University of Chicago Press.
- Arum, Richard, Josipa Roksa, and Michelle J. Budig. 2008. "The Romance of College Attendance: Higher Education Stratification and Mate Selection." *Research in Social Stratification and Mobility* 26(2):107–21. doi: [10.1016/j.rssm.2008.02.003](https://doi.org/10.1016/j.rssm.2008.02.003).
- Astin, Alexander W., and Leticia Oseguera. 2004. "The Declining 'Equity' of American Higher Education." *The Review of Higher Education* 27(3):321–41. doi: [10.1353/rhe.2004.0001](https://doi.org/10.1353/rhe.2004.0001).
- Autor, David. 2010. *The Polarization of Job Opportunities in the U.S. Labor Market*. (Joint report for the Center for American Progress and the Hamilton Project). Retrieved from <https://economics.mit.edu/files/5554>.
- Azmat, Ghazala, Caterina Calsamiglia, and Nagore Iriberry. 2016. "Gender Differences in Response to Big Stakes." *Journal of the European Economic Association* 14(6):1372–1400. doi: [10.1111/jeea.12180](https://doi.org/10.1111/jeea.12180).
- Baier, Tina, and Volker Lang. 2019. "The Social Stratification of Environmental and Genetic Influences on Education: New Evidence Using a Register-Based Twin Sample." *Sociological Science* 6:143–71. doi: [10.15195/v6.a6](https://doi.org/10.15195/v6.a6).
- Baier, Tina, Volker Lang, Michael Grätz, Kieron J. Barclay, Dalton C. Conley, Christopher T. Dawes, Thomas Laidley, and Torkild H. Lyngstad. 2022. "Genetic Influences on Educational Achievement in Cross-National Perspective." *European Sociological Review* 38(6):959–74. doi: [10.1093/esr/jcac014](https://doi.org/10.1093/esr/jcac014).

- Baker, Therese L., and William Velez. 1996. "Access to and Opportunity in Postsecondary Education in the United States: A Review." *Sociology of Education* 69:82. doi: [10.2307/3108457](https://doi.org/10.2307/3108457).
- Becker, Joel, Casper A. P. Burik, Grant Goldman, Nancy Wang, Hariharan Jayashankar, Michael Bennett, Daniel W. Belsky, Richard Karlsson Linnér, Rafael Ahlskog, Aaron Kleinman, David A. Hinds, 23andMe Research Group, Michelle Agee, Babak Alipanahi, Adam Auton, Robert K. Bell, Katarzyna Bryc, Sarah L. Elson, Pierre Fontanillas, Nicholas A. Furlotte, Karen E. Huber, Nadia K. Litterman, Jennifer C. McCreight, Matthew H. McIntyre, Joanna L. Mountain, Carrie A. M. Northover, Steven J. Pitts, J. Fah Sathirapongsasuti, Olga V. Sazonova, Janie F. Shelton, Suyash Shringarpure, Chao Tian, Joyce Y. Tung, Vladimir Vacic, Catherine H. Wilson, Avshalom Caspi, David L. Corcoran, Terrie E. Moffitt, Richie Poulton, Karen Sugden, Benjamin S. Williams, Kathleen Mullan Harris, Andrew Steptoe, Olesya Ajnakina, Lili Milani, Tõnu Esko, William G. Iacono, Matt McGue, Patrik K. E. Magnusson, Travis T. Mallard, K. Paige Harden, Elliot M. Tucker-Drob, Pamela Herd, Jeremy Freese, Alexander Young, Jonathan P. Beauchamp, Philipp D. Koellinger, Sven Oskarsson, Magnus Johannesson, Peter M. Visscher, Michelle N. Meyer, David Laibson, David Cesarini, Daniel J. Benjamin, Patrick Turley, and Aysu Okbay. 2021. "Resource Profile and User Guide of the Polygenic Index Repository." *Nature Human Behaviour* 5(12):1744–58. doi: [10.1038/s41562-021-01119-3](https://doi.org/10.1038/s41562-021-01119-3).
- Belsky, Dan, Ben Domingue, and Kathleen Mullan Harris. 2020. *Add Health Wave I & IV Documentation: Constructed SES Variables*. Carolina Population Center.
- Belsky, Daniel W., Benjamin W. Domingue, Robbee Wedow, Louise Arseneault, Jason D. Boardman, Avshalom Caspi, Dalton Conley, Jason M. Fletcher, Jeremy Freese, Pamela Herd, Terrie E. Moffitt, Richie Poulton, Kamil Sicinski, Jasmin Wertz, and Kathleen Mullan Harris. 2018. "Genetic Analysis of Social-Class Mobility in Five Longitudinal Studies." *Proceedings of the National Academy of Sciences* 115(31):E7275–84. doi: [10.1073/pnas.1801238115](https://doi.org/10.1073/pnas.1801238115).
- Belsky, Daniel W., Terrie E. Moffitt, David L. Corcoran, Benjamin Domingue, HonaLee Harrington, Sean Hogan, Renate Houts, Sandhya Ramrakha, Karen Sugden, Benjamin S. Williams, Richie Poulton, and Avshalom Caspi. 2016. "The Genetics of Success: How Single-Nucleotide Polymorphisms Associated With Educational Attainment Relate to Life-Course Development." *Psychological Science* 27(7):957–72. doi: [10.1177/0956797616643070](https://doi.org/10.1177/0956797616643070).
- Bernardi, Fabrizio, and Héctor-Cebolla Boado. 2014. "Previous School Results and Social Background: Compensation and Imperfect Information in Educational Transitions." *European Sociological Review* 30(2):207–17. doi: [10.1093/esr/jct029](https://doi.org/10.1093/esr/jct029).
- Beutel, Ann M., and Margaret Mooney Marini. 1995. "Gender and Values." *American Sociological Review* 60(3):436–48. doi: [10.2307/2096423](https://doi.org/10.2307/2096423).

- Beyer, Sylvia. 1990. "Gender Differences in the Accuracy of Self-Evaluations of Performance." *Journal of Personality and Social Psychology* 59(5):960–70. doi: [10.1037/0022-3514.59.5.960](https://doi.org/10.1037/0022-3514.59.5.960).
- Beyer, Sylvia, and Edward M. Bowden. 1997. "Gender Differences in Self-Perceptions: Convergent Evidence from Three Measures of Accuracy and Bias." *Personality and Social Psychology Bulletin* 23(2):157–72. doi: [10.1177/0146167297232005](https://doi.org/10.1177/0146167297232005).
- Bielby, Rob, Julie Renee Posselt, Ozan Jaquette, and Michael N. Bastedo. 2014. "Why Are Women Underrepresented in Elite Colleges and Universities? A Non-Linear Decomposition Analysis." *Research in Higher Education* 55(8):735–60. doi: [10.1007/s11162-014-9334-y](https://doi.org/10.1007/s11162-014-9334-y).
- Black, Dan A., and Jeffrey A. Smith. 2006. "Estimating the Returns to College Quality with Multiple Proxies for Quality." *Journal of Labor Economics* 24(3):701–28. doi: [10.1086/505067](https://doi.org/10.1086/505067).
- Black, Sandra E., Jeffrey T. Denning, and Jesse Rothstein. 2023. "Winners and Losers? The Effect of Gaining and Losing Access to Selective Colleges on Education and Labor Market Outcomes." *American Economic Journal: Applied Economics* 15(1):26–67. doi: [10.1257/app.20200137](https://doi.org/10.1257/app.20200137).
- Blau, Peter M., and Joseph E. Schwartz. 1984. *Crosscutting Social Circles: Testing a Macrostructural Theory of Intergroup Relations*. Academic Press.
- Bleemer, Zachary. 2021. "Top Percent Policies and the Return to Postsecondary Selectivity." *Unpublished Manuscript*.
- Blossfeld, Hans-Peter. 2009. "Educational Assortative Marriage in Comparative Perspective." *Annual Review of Sociology* 35(1):513–30. doi: [10.1146/annurev-soc-070308-115913](https://doi.org/10.1146/annurev-soc-070308-115913).
- Blossfeld, Hans-Peter, and A. Timm. 2003. *Who Marries Whom?* Springer Science & Business Media.
- Bouchet-Valat, Milan. 2014. "Les Évolutions de l'homogamie de Diplôme, de Classe et d'origine Sociales En France (1969-2011) : Ouverture d'ensemble, Repli Des Élités." *Revue Française de Sociologie* 55(3):459. doi: [10.3917/rfs.553.0459](https://doi.org/10.3917/rfs.553.0459).
- Bound, John, Brad Hershbein, and Bridget Terry Long. 2009. "Playing the Admissions Game: Student Reactions to Increasing College Competition." *Journal of Economic Perspectives* 23(4):119–46.
- Bowen, William, Martin Kurzweil, and Eugene Tobin. 2005. *Equity and Excellence in American Higher Education*. University Press of Virginia.
- Brand, J. E., and Y. Xie. 2010. "Who Benefits Most from College?: Evidence for Negative Selection in Heterogeneous Economic Returns to Higher Education." *American Sociological Review* 75(2):273–302. doi: [10.1177/0003122410363567](https://doi.org/10.1177/0003122410363567).

- Brand, Jennie E., and Charles N. Halaby. 2006. "Regression and Matching Estimates of the Effects of Elite College Attendance on Educational and Career Achievement." *Social Science Research* 35(3):749–70. doi: [10.1016/j.ssresearch.2005.06.006](https://doi.org/10.1016/j.ssresearch.2005.06.006).
- Breen, Richard. 2010. "Educational Expansion and Social Mobility in the 20th Century." *Social Forces* 89(2):365–88. doi: [10.1353/sof.2010.0076](https://doi.org/10.1353/sof.2010.0076).
- Breen, Richard, and Signe Hald Andersen. 2012. "Educational Assortative Mating and Income Inequality in Denmark." *Demography* 49(3):867–87. doi: [10.1007/s13524-012-0111-2](https://doi.org/10.1007/s13524-012-0111-2).
- Breen, Richard, and Jan O. Jonsson. 2007. "Explaining Change in Social Fluidity: Educational Equalization and Educational Expansion in Twentieth-Century Sweden." *American Journal of Sociology* 112(6):1775–1810. doi: [10.1086/508790](https://doi.org/10.1086/508790).
- Breen, Richard, and Ruud Luijkx. 2007. "Social Mobility and Education: A Comparative Analysis of Period and Cohort Trends in Britain and Germany." Pp. 102–24 in *From Origin to Destination: Trends and Mechanisms in Social Stratification Research*, edited by S. Scherer, R. Pollak, G. Otte, and M. Gangl. Campus Verlag.
- Breen, Richard, and Leire Salazar. 2010. "Has Increased Women's Educational Attainment Led to Greater Earnings Inequality in the United Kingdom? A Multivariate Decomposition Analysis." *European Sociological Review* 26(2):143–57. doi: [10.1093/esr/jcp011](https://doi.org/10.1093/esr/jcp011).
- Breinholt, Asta, and Dalton Conley. 2023. "Child-Driven Parenting: Differential Early Childhood Investment by Offspring Genotype." *Social Forces* 102(1):310–29. doi: [10.1093/sf/soac155](https://doi.org/10.1093/sf/soac155).
- Brewer, Dominic J., Eric R. Eide, and Ronald G. Ehrenberg. 1999. "Does It Pay to Attend an Elite Private College? Cross-Cohort Evidence on the Effects of College Type on Earnings." *The Journal of Human Resources* 34(1):104–23. doi: [10.2307/146304](https://doi.org/10.2307/146304).
- Brinton, Mary C. 1993. *Women and the Economic Miracle: Gender and Work in Postwar Japan*. California: University of California Press.
- Brinton, Mary C., and Dong-Ju Lee. 2016. "Gender-Role Ideology, Labor Market Institutions, and Post-Industrial Fertility: Gender-Role Ideology and Post-Industrial Fertility." *Population and Development Review* 42(3):405–33. doi: [10.1111/padr.161](https://doi.org/10.1111/padr.161).
- Brinton, Mary C., Eunmi Mun, and Ekaterina Hertog. 2021. "Singlehood in Contemporary Japan: Rating, Dating, and Waiting for a Good Match." *Demographic Research* 44:239–76. doi: [10.4054/DemRes.2021.44.10](https://doi.org/10.4054/DemRes.2021.44.10).
- Buchmann, C., D. J. Condron, and V. J. Roscigno. 2010. "Shadow Education, American Style: Test Preparation, the SAT and College Enrollment." *Social Forces* 89(2):435–61. doi: [10.1353/sof.2010.0105](https://doi.org/10.1353/sof.2010.0105).
- Buchmann, Claudia, Thomas A. DiPrete, and Anne McDaniel. 2008. "Gender Inequalities in Education." *Annual Review of Sociology* 34(1):319–37. doi: [10.1146/annurev.soc.34.040507.134719](https://doi.org/10.1146/annurev.soc.34.040507.134719).

- Burtless, G. 1999. "Effects of Growing Wage Disparities and Changing Family Composition on the US Income Distribution." *European Economic Review* 43:853–65.
- Carnevale, Anthony P., and Stephen J. Rose. 2004. "Socioeconomic Status, Race/Ethnicity, and Selective College Admissions." Pp. 101–56 in *America's Untapped Resources*, edited by R. D. Kahlenberg. The Century Foundation Press.
- Ceci, Stephen J., and Wendy M. Williams. 2011. "Understanding Current Causes of Women's Underrepresentation in Science." *Proceedings of the National Academy of Sciences* 108(8):3157–62. doi: [10.1073/pnas.1014871108](https://doi.org/10.1073/pnas.1014871108).
- Cellini, Stephanie Riegg, and Nicholas Turner. 2019. "Gainfully Employed?: Assessing the Employment and Earnings of For-Profit College Students Using Administrative Data." *Journal of Human Resources* 54(2):342–70. doi: [10.3368/jhr.54.2.1016.8302R1](https://doi.org/10.3368/jhr.54.2.1016.8302R1).
- Charles, Maria, and Karen Bradley. 2009. "Indulging Our Gendered Selves? Sex Segregation by Field of Study in 44 Countries." *American Journal of Sociology* 114(4):924–76. doi: [10.1086/595942](https://doi.org/10.1086/595942).
- Chetty, Raj, John N. Friedman, Emmanuel Saez, Nicholas Turner, and Danny Yagan. 2017. *Mobility Report Cards: The Role of Colleges in Intergenerational Mobility*. NBER Working Paper 23618. doi: [10.3386/w23618](https://doi.org/10.3386/w23618).
- Chetty, Raj, John N. Friedman, Emmanuel Saez, Nicholas Turner, and Danny Yagan. 2020. "Income Segregation and Intergenerational Mobility Across Colleges in the United States." *The Quarterly Journal of Economics* 135(3):1567–1633. doi: [10.1093/qje/qjaa005](https://doi.org/10.1093/qje/qjaa005).
- Cohen, Alma, and Liran Einav. 2007. "Estimating Risk Preferences from Deductible Choice." *The American Economic Review* 97(3):59.
- Collier, Peter J., and David L. Morgan. 2008. "'Is That Paper Really Due Today?': Differences in First-Generation and Traditional College Students' Understandings of Faculty Expectations." *Higher Education* 55(4):425–46. doi: [10.1007/s10734-007-9065-5](https://doi.org/10.1007/s10734-007-9065-5).
- Collins, Randall. 1979. *The Credential Society: An Historical Sociology of Education and Stratification*. Academic Press.
- Conley, Dalton, and Benjamin Domingue. 2016. "The Bell Curve Revisited: Testing Controversial Hypotheses with Molecular Genetic Data." *Sociological Science* 3:520–39. doi: [10.15195/v3.a23](https://doi.org/10.15195/v3.a23).
- Conley, Dalton, Benjamin Domingue, David Cesarini, Christopher Dawes, Cornelius Rietveld, and Jason Boardman. 2015. "Is the Effect of Parental Education on Offspring Biased or Moderated by Genotype?" *Sociological Science* 2:82–105. doi: [10.15195/v2.a6](https://doi.org/10.15195/v2.a6).
- Conley, Dalton, and Jason Fletcher. 2017. *The Genome Factor: What the Social Genomics Revolution Reveals about Ourselves, Our History, and the Future*. Princeton University Press.

- Conley, Dalton, Thomas Laidley, Daniel W. Belsky, Jason M. Fletcher, Jason D. Boardman, and Benjamin W. Domingue. 2016. "Assortative Mating and Differential Fertility by Phenotype and Genotype across the 20th Century." *Proceedings of the National Academy of Sciences* 113(24):6647–52. doi: [10.1073/pnas.1523592113](https://doi.org/10.1073/pnas.1523592113).
- Corcoran, Sean Patrick, and E. Christine Baker-Smith. 2018. "Pathways to an Elite Education: Application, Admission, and Matriculation to New York City's Specialized High Schools." *Education Finance and Policy* 13(2):256–79. doi: [10.1162/edfp_a_00220](https://doi.org/10.1162/edfp_a_00220).
- Cremonini, Leon, Liudvika Leisyte, Elke Weyer, and Hans Vossensteyn. 2011. *Selection and Matching in Higher Education: An International Comparative Study*. Center for Higher Education Policy Studies.
- Cronbach, Lee J. 1975. "Five Decades of Public Controversy Over Mental Testing." *American Psychologist* 30:1–14.
- Currie, Janet. 2009. "Healthy, Wealthy, and Wise: Socioeconomic Status, Poor Health in Childhood, and Human Capital Development." *Journal of Economic Literature* 47(1):87–122. doi: [10.1257/jel.47.1.87](https://doi.org/10.1257/jel.47.1.87).
- Dale, Stacy B., and Alan B. Krueger. 2002. "Estimating the Payoff to Attending a More Selective College: An Application of Selection on Observables and Unobservables." *Quarterly Journal of Economics* 117(4):1491–1527.
- Dale, Stacy B., and Alan B. Krueger. 2014. "Estimating the Effects of College Characteristics over the Career Using Administrative Earnings Data." *Journal of Human Resources* 49(2):323–58.
- Davies, Scott, and Neil Guppy. 1997. "Fields of Study, College Selectivity, and Student Inequalities in Higher Education." *Social Forces* 75(4):1417–38.
- Delaney, Judith M., and Paul J. Devereux. 2021. "Gender Differences in College Applications: Aspiration and Risk Management." *Economics of Education Review* 80:102077. doi: [10.1016/j.econedurev.2020.102077](https://doi.org/10.1016/j.econedurev.2020.102077).
- Deming, David, Claudia Goldin, and Lawrence Katz. 2013. "For-Profit Colleges." *The Future of Children* 23(1):137–63. doi: [10.1353/foc.2013.0005](https://doi.org/10.1353/foc.2013.0005).
- Deming, David J., Claudia Goldin, and Lawrence F. Katz. 2012. "The For-Profit Postsecondary School Sector: Nimble Critters or Agile Predators?" *Journal of Economic Perspectives* 26(1):139–64. doi: [10.1257/jep.26.1.139](https://doi.org/10.1257/jep.26.1.139).
- Deming, David J., Noam Yuchtman, Amira Abulafi, Claudia Goldin, and Lawrence F. Katz. 2016. "The Value of Postsecondary Credentials in the Labor Market: An Experimental Study." *American Economic Review* 106(3):778–806. doi: [10.1257/aer.20141757](https://doi.org/10.1257/aer.20141757).
- DiPrete, Thomas A., and Claudia Buchmann. 2013. *The Rise of Women: The Growing Gender Gap in Education and What It Means for American Schools*. Russell Sage Foundation.

- Domina, Thurston, Andrew Penner, and Emily Penner. 2017. "Categorical Inequality: Schools As Sorting Machines." *Annual Review of Sociology* 43(1):311–30. doi: [10.1146/annurev-soc-060116-053354](https://doi.org/10.1146/annurev-soc-060116-053354).
- Domingue, Benjamin, Sam Trejo, Emma Armstrong-Carter, and Elliot Tucker-Drob. 2020. "Interactions between Polygenic Scores and Environments: Methodological and Conceptual Challenges." *Sociological Science* 7:365–86. doi: [10.15195/v7.a19](https://doi.org/10.15195/v7.a19).
- Eckel, Catherine C., Mahmoud A. El-Gamal, and Rick K. Wilson. 2009. "Risk Loving after the Storm: A Bayesian-Network Study of Hurricane Katrina Evacuees." *Journal of Economic Behavior & Organization* 69(2):110–24. doi: [10.1016/j.jebo.2007.08.012](https://doi.org/10.1016/j.jebo.2007.08.012).
- Eckel, Catherine C., and Philip J. Grossman. 2008. "Chapter 113 Men, Women and Risk Aversion: Experimental Evidence." Pp. 1061–73 in *Handbook of Experimental Economics Results*. Vol. 1. Elsevier.
- Edwards, Linda N., and Margaret K. Pasquale. 2003. "Women's Higher Education in Japan: Family Background, Economic Factors, and the Equal Employment Opportunity." *Journal of the Japanese and International Economies* 17(1):1–32. doi: [10.1016/S0889-1583\(03\)00004-2](https://doi.org/10.1016/S0889-1583(03)00004-2).
- Ehrlinger, Joyce, and David Dunning. 2003. "How Chronic Self-Views Influence (and Potentially Mislead) Estimates of Performance." *Journal of Personality and Social Psychology* 84(1):5–17. doi: [10.1037/0022-3514.84.1.5](https://doi.org/10.1037/0022-3514.84.1.5).
- England, Paula. 2010. "The Gender Revolution: Uneven and Stalled." *Gender & Society* 24(2):149–66. doi: [10.1177/0891243210361475](https://doi.org/10.1177/0891243210361475).
- Esping-Andersen, G. 2007. "Sociological Explanations of Changing Income Distributions." *American Behavioral Scientist* 50(5):639–58.
- Esteve, Albert, Joan Garcia-Roman, and Inaki Permanyer. 2012. "The Gender-Gap Reversal in Education and Its Effect on Union Formation: The End of Hypergamy?" *Population and Development Review* 38(3):535–46. doi: [10.1111/j.1728-4457.2012.00515.x](https://doi.org/10.1111/j.1728-4457.2012.00515.x).
- Esteve, Albert, Christine R. Schwartz, J. Van Bavel, Inaki Permanyer, Martin Klesment, and Joan Garcia-Roman. 2016. "The End of Hypergamy: Global Trends and Implications." *Population and Development Review* 42(4):615–25.
- Farkas, George. 2003. "Cognitive Skills and Noncognitive Traits and Behaviors in Stratification Processes." *Annual Review of Sociology* 29(1):541–62. doi: [10.1146/annurev.soc.29.010202.100023](https://doi.org/10.1146/annurev.soc.29.010202.100023).
- Feng, Acton Jiashi. 2022. "Revisiting Horizontal Stratification in Higher Education: College Prestige Hierarchy and Educational Assortative Mating in China." *Demography* 59(1):349–69. doi: [10.1215/00703370-9656369](https://doi.org/10.1215/00703370-9656369).

- Fiel, Jeremy E. 2020. "Great Equalizer or Great Selector? Reconsidering Education as a Moderator of Intergenerational Transmissions." *Sociology of Education* 93(4):353–71. doi: [10.1177/0038040720927886](https://doi.org/10.1177/0038040720927886).
- Fletcher, Jason M., and Dalton Conley. 2013. "The Challenge of Causal Inference in Gene–Environment Interaction Research: Leveraging Research Designs From the Social Sciences." *American Journal of Public Health* 103(S1):S42–45. doi: [10.2105/AJPH.2013.301290](https://doi.org/10.2105/AJPH.2013.301290).
- Ford, Karly Sarita. 2020. "Marrying Within the Alma Mater: Understanding the Role of Same-University Marriages in Educational Homogamy." *Sociological Research Online* 25(2):254–72. doi: [10.1177/1360780419867710](https://doi.org/10.1177/1360780419867710).
- Fujihara, Sho. 2016. "The Design of the Panel Survey of Junior High School Students and Their Mothers and the Characteristics of the Survey Samples." *University of Tokyo Institute of Social Science Panel Survey Discussion Paper Series* (in Japanese).
- Fujihara, Sho, and Fumiya Uchikoshi. 2019. "Declining Association with Persistent Gender Asymmetric Structure: Patterns and Trends in Educational Assortative Marriage in Japan, 1950–1979." *Research in Social Stratification and Mobility* 60:66–77. doi: [10.1016/j.rssm.2018.12.001](https://doi.org/10.1016/j.rssm.2018.12.001).
- Fukuda, Setsuya, James M. Raymo, and Shohei Yoda. 2020. "Revisiting the Educational Gradient in Marriage in Japan." *Journal of Marriage and Family* 82(4):1378–96. doi: [10.1111/jomf.12648](https://doi.org/10.1111/jomf.12648).
- Fukuda, Setsuya, Shohei Yoda, and Ryohei Mogi. 2021. "Educational Assortative Mating in Japan: Evidence from the 1980–2010 Census." *Jinko Mondai Kenkyu (Journal of Population Research)* 57:1–20. (in Japanese).
- Furuta, Jared, Evan Schofer, and Shawn Wick. 2021. "The Effects of High Stakes Educational Testing on Enrollments in an Era of Hyper-Expansion: Cross-National Evidence, 1960–2010." *Social Forces* 99(4):1631–57. doi: [10.1093/sf/soaa071](https://doi.org/10.1093/sf/soaa071).
- Gauthier, Anne H., Caroline Bryson, Luisa Fadel, Tina Haux, Judith Koops, and Monika Mynarska. 2021. "Exploring the Concept of Intensive Parenting in a Three-Country Study." *Demographic Research* 44:333–48. doi: [10.4054/DemRes.2021.44.13](https://doi.org/10.4054/DemRes.2021.44.13).
- Ge, Suqin, Elliott Isaac, and Amalia Miller. 2022. "Elite Schools and Opting In: Effects of College Selectivity on Career and Family Outcomes." *Journal of Labor Economics* 40(S1):S383–427. doi: [10.1086/717931](https://doi.org/10.1086/717931).
- Gerber, Theodore P., and Sin Yi Cheung. 2008. "Horizontal Stratification in Postsecondary Education: Forms, Explanations, and Implications." *Annual Review of Sociology* 34(1):299–318. doi: [10.1146/annurev.soc.34.040507.134604](https://doi.org/10.1146/annurev.soc.34.040507.134604).

- Giani, Matt S. 2016. "Are All Colleges Equally Equalizing?: How Institutional Selectivity Impacts Socioeconomic Disparities in Graduates' Labor Outcomes." *The Review of Higher Education* 39(3):431–61. doi: [10.1353/rhe.2016.0013](https://doi.org/10.1353/rhe.2016.0013).
- Gneezy, U., M. Niederle, and A. Rustichini. 2003. "Performance in Competitive Environments: Gender Differences." *The Quarterly Journal of Economics* 118(3):1049–74. doi: [10.1162/00335530360698496](https://doi.org/10.1162/00335530360698496).
- Goldin, Claudia. 2006. "The Quiet Revolution That Transformed Women's Employment, Education, and Family." *American Economic Review* 96:1–21.
- Goldin, Claudia. 2014. "A Grand Gender Convergence: Its Last Chapter." *American Economic Review* 104(4):1091–1119. doi: [10.1257/aer.104.4.1091](https://doi.org/10.1257/aer.104.4.1091).
- Goldin, Claudia Dale, and Lawrence F. Katz. 2009. *The Race between Education and Technology*. Harvard University Press.
- Gottschling, J., E. Hahn, C. R. Beam, F. M. Spinath, S. Carroll, and E. Turkheimer. 2019. "Socioeconomic Status Amplifies Genetic Effects in Middle Childhood in a Large German Twin Sample." *Intelligence* 72:20–27. doi: [10.1016/j.intell.2018.11.006](https://doi.org/10.1016/j.intell.2018.11.006).
- Grodsky, Eric. 2007. "Compensatory Sponsorship in Higher Education." *American Journal of Sociology* 112(6):1662–1712. doi: [10.1086/512707](https://doi.org/10.1086/512707).
- Grodsky, Eric, John Robert Warren, and Erika Felts. 2008. "Testing and Social Stratification in American Education." *Annual Review of Sociology* 34(1):385–404. doi: [10.1146/annurev.soc.34.040507.134711](https://doi.org/10.1146/annurev.soc.34.040507.134711).
- Guo, Guang. 1998. "The Timing of the Influences of Cumulative Poverty on Children's Cognitive Ability and Achievement." *Social Forces* 77(1):257–88.
- Han, Hongyun. 2010. "Trends in Educational Assortative Marriage in China from 1970 to 2000." *Demographic Research* 22:733–70. doi: [10.4054/DemRes.2010.22.24](https://doi.org/10.4054/DemRes.2010.22.24).
- Hannum, Emily, and Claudia Buchmann. 2003. "The Consequences of Global Educational Expansion." *American Academy of Arts and Sciences*.
- Hannum, Emily, Hiroshi Ishida, Hyunjoon Park, and Tony Tam. 2019. "Education in East Asian Societies: Postwar Expansion and the Evolution of Inequality." *Annual Review of Sociology* 45(1). doi: [10.1146/annurev-soc-073018-022507](https://doi.org/10.1146/annurev-soc-073018-022507).
- Hara, Yuko. 2023. "Gender Differences in Scaling Back: Family Formation and Aspirations toward Work Achievement among Japanese Adults." *Socius: Sociological Research for a Dynamic World* 9:237802312311576. doi: [10.1177/23780231231157682](https://doi.org/10.1177/23780231231157682).
- Haveman, Robert H., and Timothy M. Smeeding. 2006. "The Role of Higher Education in Social Mobility." *The Future of Children* 16(2):125–50. doi: [10.1353/foc.2006.0015](https://doi.org/10.1353/foc.2006.0015).
- Hearn, James C. 1991. "Academic and Nonacademic Influences on the College Destinations of 1980 High School Graduates." *Sociology of Education* 64(3):158. doi: [10.2307/2112849](https://doi.org/10.2307/2112849).

- Heckert, Teresa M., Heather E. Droste, Patrick J. Adams, Christopher M. Griffin, Lisa L. Roberts, Michael A. Mueller, and Hope A. Wallis. 2002. "Gender Differences in Anticipated Salary: Role of Salary Estimates for Others, Job Characteristics, Career Paths, and Job Inputs." *Sex Roles* 13.
- Heckman, J. J. 2006. "Skill Formation and the Economics of Investing in Disadvantaged Children." *Science* 312(5782):1900–1902. doi: [10.1126/science.1128898](https://doi.org/10.1126/science.1128898).
- Helms, Robin Matross. 2009. "University Admissions: Practices and Procedures Worldwide." *International Higher Education* 54(Winter):5–7.
- Hersch, Joni. 2013. "Opting out among Women with Elite Education." *Review of Economics of the Household* 11(4):469–506. doi: [10.1007/s11150-013-9199-4](https://doi.org/10.1007/s11150-013-9199-4).
- Hirasawa, Kazushi. 2010. "Daisotsu Shyushoku Kikai Ni Kansuru Shokasetsu No Kensho [Testing Hypotheses on Employment Opportunities for University Graduates]." Pp. 61–85 in *Daisotsu Shushoku no Shakaigaku [The Sociology of Transition from University to Work]*, edited by T. Kariya and Y. Honda. Tokyo: The University of Tokyo Press.
- Högberg, Björn, and Daniel Horn. 2022. "National High-Stakes Testing, Gender, and School Stress in Europe: A Difference-in-Differences Analysis." *European Sociological Review* 38(6):975–87. doi: [10.1093/esr/jcac009](https://doi.org/10.1093/esr/jcac009).
- Hogue, Mary, Cathy L. Z. DuBois, and Lee Fox-Cardamone. 2010. "Gender Differences in Pay Expectations: The Roles of Job Intention and Self-View." *Psychology of Women Quarterly* 34(2):215–27. doi: [10.1111/j.1471-6402.2010.01563.x](https://doi.org/10.1111/j.1471-6402.2010.01563.x).
- Holloway, Susan D. 2010. *Women and Family in Contemporary Japan*. Cambridge University Press.
- Holm, Anders, Anders Hjorth-Trolle, and Mads Meier Jæger. 2019. "Signals, Educational Decision-Making, and Inequality." *European Sociological Review* 35(4):447–60. doi: [10.1093/esr/jcz010](https://doi.org/10.1093/esr/jcz010).
- Hout, Michael. 1984. "Status, Autonomy, and Training in Occupational Mobility." *American Journal of Sociology* 89(6):1379–1409. doi: [10.1086/228020](https://doi.org/10.1086/228020).
- Hout, Michael. 1988. "More Universalism, Less Structural Mobility: The American Occupational Structure in the 1980s." *American Journal of Sociology* 93(6):1358–1400. doi: [10.1086/228904](https://doi.org/10.1086/228904).
- Hout, Michael. 2012. "Social and Economic Returns to College Education in the United States." *Annual Review of Sociology* 38(1):379–400. doi: [10.1146/annurev.soc.012809.102503](https://doi.org/10.1146/annurev.soc.012809.102503).
- Hout, Michael, and Thomas A. DiPrete. 2006. "What We Have Learned: RC28's Contributions to Knowledge about Social Stratification." *Research in Social Stratification and Mobility* 24(1):1–20. doi: [10.1016/j.rssm.2005.10.001](https://doi.org/10.1016/j.rssm.2005.10.001).

- Howe, Laurence J., Michel G. Nivard, Tim T. Morris, Ailin F. Hansen, Humaira Rasheed, Yoonsu Cho, Geetha Chittoor, Penelope A. Lind, Teemu Palviainen, Matthijs D. van der Zee, Rosa Cheesman, Massimo Mangino, Yunzhang Wang, Shuai Li, Lucija Klaric, Scott M. Ratliff, Lawrence F. Bielak, Marianne Nygaard, Chandra A. Reynolds, Jared V. Balbona, Christopher R. Bauer, Dorret I. Boomsma, Aris Baras, Archie Campbell, Harry Campbell, Zhengming Chen, Paraskevi Christofidou, Christina C. Dahm, Deepika R. Dokuru, Luke M. Evans, Eco JC de Geus, Sudheer Giddaluru, Scott D. Gordon, K. Paige Harden, Alexandra Havdahl, W. David Hill, Shona M. Kerr, Yongkang Kim, Hyeokmoon Kweon, Antti Latvala, Liming Li, Kuang Lin, Pekka Martikainen, Patrik KE Magnusson, Melinda C. Mills, Deborah A. Lawlor, John D. Overton, Nancy L. Pedersen, David J. Porteous, Jeffrey Reid, Karri Silventoinen, Melissa C. Southey, Travis T. Mallard, Elliot M. Tucker-Drob, Margaret J. Wright, Social Science Genetic Association Consortium, Within Family Consortium, John K. Hewitt, Matthew C. Keller, Michael C. Stallings, Kaare Christensen, Sharon LR Kardia, Patricia A. Peyser, Jennifer A. Smith, James F. Wilson, John L. Hopper, Sara Hägg, Tim D. Spector, Jean-Baptiste Pingault, Robert Plomin, Meike Bartels, Nicholas G. Martin, Anne E. Justice, Iona Y. Millwood, Kristian Hveem, Øyvind Naess, Cristen J. Willer, Bjørn Olav Åsvold, Philipp D. Koellinger, Jaakko Kaprio, Sarah E. Medland, Robin G. Walters, Daniel J. Benjamin, Patrick Turley, David M. Evans, George Davey Smith, Caroline Hayward, Ben Brumpton, Gibran Hemani, and Neil M. Davies. 2021. “Within-Sibship GWAS Improve Estimates of Direct Genetic Effects.” *bioRxiv*. doi: [10.1101/2021.03.05.433935](https://doi.org/10.1101/2021.03.05.433935).
- Hoxby, Caroline M. 2009. “The Changing Selectivity of American Colleges.” *Journal of Economic Perspectives* 23(4):95–118.
- Hoxby, Caroline M., and Christopher Avery. 2013. “The Missing ‘One-Offs’: The Hidden Supply of High-Achieving, Low-Income Students.” *Brookings Papers on Economic Activity* 1–50.
- Hoxby, Caroline M., and Sarah Turner. 2013. “Expanding College Opportunities for High-Achieving, Low Income Students.” *Stanford Institute for Economic Policy Research*.
- Hoxby, Caroline M., and Sarah Turner. 2015. “What High-Achieving Low-Income Students Know About College.” *American Economic Review* 105(5):514–17. doi: [10.1257/aer.p20151027](https://doi.org/10.1257/aer.p20151027).
- Hu, Anning, and Zhenchao Qian. 2015. “Educational Homogamy and Earnings Inequality of Married Couples: Urban China, 1988–2007.” *Research in Social Stratification and Mobility* 40:1–15. doi: [10.1016/j.rssm.2015.01.004](https://doi.org/10.1016/j.rssm.2015.01.004).
- Isa, Natsumi. 2021. “Why Getting into Highly-Selective Universities Is Harder for Girls.” *The Journal of Educational Sociology* 109:5–27.
- Ishida, H., S. Spilerman, and K. H. Su. 1997. “Educational Credentials and Promotion Chances in Japanese and American Organizations.” *American Sociological Review* 62(6):866–82.

- Ishida, Hiroshi. 1998. "Educational Credentials and Labour-Market Entry Outcomes in Japan." Pp. 287–309 in *From School to Work: A Comparative Study of Educational Qualifications and Occupational Destinations*, edited by Y. Shavit and W. Muller. Clarendon Press.
- Ishida, Hiroshi. 2007. "Japan: Educational Expansion and Inequality in Access to Higher Education." Pp. 63–86 in *Stratification in Higher Education: A Comparative Study*, edited by Y. Shavit, R. Arum, and A. Gamoran. Stanford: Stanford University Press.
- Ishii, K. and Nozaki, H. (2014). Constructing Longitudinal and Cross-sectional Weights in KHPS and JHPS. *Mita Business Review* 57(4): 123-145. (in Japanese)
- Itō, Takatoshi, and Takeo Hoshi. 2020. *The Japanese Economy*. Second Edition. Cambridge, MA: MIT Press.
- Jack, Anthony Abraham. 2016. "(No) Harm in Asking: Class, Acquired Cultural Capital, and Academic Engagement at an Elite University." *Sociology of Education* 89(1):1–19. doi: [10.1177/0038040715614913](https://doi.org/10.1177/0038040715614913).
- James, Estelle, Nabeel Alsalam, Joseph C. Conaty, and Duc-LE To. 1989. "College Quality and Future Earnings: Where Should You Send Your Child to College?" *American Economic Review* 79(2):247–52.
- Japan Institute for Labour Policy and Training. 2017. *Results of a Survey on Methods of Career Guidance in High Schools*.
- Japan Institute for Labour Policy and Training (JILPT). 2016. *Results of a Survey on Job Relocation*.
- Jencks, Christopher. 1979. *Who Gets Ahead? The Determinants of Economic Success in America*. Basic Books.
- Jerrim, John, Anna K. Chmielewski, and Phil Parker. 2015. "Socioeconomic Inequality in Access to High-Status Colleges: A Cross-Country Comparison." *Research in Social Stratification and Mobility* 42:20–32. doi: [10.1016/j.rssm.2015.06.003](https://doi.org/10.1016/j.rssm.2015.06.003).
- Kalmijn, Matthijs. 1998. "Intermarriage and Homogamy: Causes, Patterns, Trends." *Annual Review of Sociology* 395–421.
- Kang, Le, Ziteng Lei, Yang Song, and Peng Zhang. 2024. "Gender Differences in Reactions to Failure in High-Stakes Competition: Evidence from the National College Entrance Exam Retakes." *Journal of Political Economy Microeconomics* 729535. doi: [10.1086/729535](https://doi.org/10.1086/729535).
- Kao, Grace, and Marta Tienda. 1998. "Educational Aspirations of Minority Youth." *American Journal of Education* 106(3):349–84. doi: [10.1086/444188](https://doi.org/10.1086/444188).
- Karabel, Jerome. 2005. *The Chosen: The Hidden History of Admission and Exclusion at Harvard, Yale, and Princeton*. Mariner Books.
- Karabel, Jerome, and Alexander W. Astin. 1975. "Social Class, Academic Ability, and College 'Quality.'" *Social Forces* 53(3):381–98.

- Karen, David. 2002. "Changes in Access to Higher Education in the United States: 1980-1992." *Sociology of Education* 75(3):191. doi: [10.2307/3090265](https://doi.org/10.2307/3090265).
- Kariya, Takehiko, and James E. Rosenbaum. 1987. "Self-Selection in Japanese Junior High Schools: A Longitudinal Study of Students' Educational Plans." *Sociology of Education* 60(3):168–80. doi: [10.2307/2112274](https://doi.org/10.2307/2112274).
- Kariya, Takehiko, and James E. Rosenbaum. 2003. "Stratified Incentives and Life Course Behaviors." Pp. 51–78 in *Handbook of the Life Course, Handbooks of Sociology and Social Research*, edited by J. T. Mortimer and M. J. Shanahan. Boston, MA: Springer.
- Karlson, Kristian Bernt. 2019. "College as Equalizer? Testing the Selectivity Hypothesis." *Social Science Research* 80:216–29. doi: [10.1016/j.ssresearch.2018.12.001](https://doi.org/10.1016/j.ssresearch.2018.12.001).
- Katrňák, Tomáš, and Beatrice Chromková Manea. 2020. "Change in Prevalence or Preference? Trends in Educational Homogamy in Six European Countries in a Time of Educational Expansion." *Social Science Research* 91:102460. doi: <https://doi.org/10.1016/j.ssresearch.2020.102460>.
- Kawaguchi, Daiji, and Yuko Mori. 2016. "Why Has Wage Inequality Evolved so Differently between Japan and the US? The Role of the Supply of College-Educated Workers." *Economics of Education Review* 52:29–50. doi: [10.1016/j.econedurev.2016.01.002](https://doi.org/10.1016/j.econedurev.2016.01.002).
- Keller, Matthew C. 2014. "Gene × Environment Interaction Studies Have Not Properly Controlled for Potential Confounders: The Problem and the (Simple) Solution." *Biological Psychiatry* 75(1):18–24. doi: [10.1016/j.biopsych.2013.09.006](https://doi.org/10.1016/j.biopsych.2013.09.006).
- Khan, Shamus. 2011. *Privilege: The Making of an Adolescent Elite at St. Paul's School*. Princeton University Press.
- Kim, ChangHwan, Christopher R. Tamborini, and Arthur Sakamoto. 2015. "Field of Study in College and Lifetime Earnings in the United States." *Sociology of Education* 88(4):320–39. doi: [10.1177/0038040715602132](https://doi.org/10.1177/0038040715602132).
- Klein, Markus. 2021. "Who Benefits from Attending Elite Universities? Family Background and Graduates' Career Trajectories." *Research in Social Stratification and Mobility* 72:100585. doi: [10.1016/j.rssm.2021.100585](https://doi.org/10.1016/j.rssm.2021.100585).
- Kong, Augustine, Gudmar Thorleifsson, Michael L. Frigge, Bjarni J. Vilhjalmsón, Alexander I. Young, Thorgeir E. Thorgeirsson, Stefania Benonisdóttir, Asmundur Oddsson, Bjarni V. Halldorsson, Gisli Masson, Daniel F. Gudbjartsson, Agnar Helgason, Gyda Bjornsdóttir, Unnur Thorsteinsdóttir, and Kari Stefansson. 2018. "The Nature of Nurture: Effects of Parental Genotypes." *Science* 359(6374):424–28. doi: [10.1126/science.aan6877](https://doi.org/10.1126/science.aan6877).
- Konrad, Alison M., J. Edgar Ritchie, Pamela Lieb, and Elizabeth Corrigall. 2000. "Sex Differences and Similarities in Job Attribute Preferences: A Meta-Analysis." *Psychological Bulletin* 126(4):593–641. doi: [10.1037/0033-2909.126.4.593](https://doi.org/10.1037/0033-2909.126.4.593).

- Krapohl, E., and R. Plomin. 2016. "Genetic Link between Family Socioeconomic Status and Children's Educational Achievement Estimated from Genome-Wide SNPs." *Molecular Psychiatry* 21(3):437–43. doi: [10.1038/mp.2015.2](https://doi.org/10.1038/mp.2015.2).
- Krishna, Kala, Sergey Lychagin, and Veronica Frisanchio. 2018. "Retaking in High Stakes Exams: Is Less More?" *International Economic Review* 59(2):449–77. doi: [10.1111/iere.12276](https://doi.org/10.1111/iere.12276).
- Landaud, Fanny, and Éric Maurin. 2020. "Aim High and Persevere! Competitive Pressure and Access Gaps in Top Science Graduate Programs."
- Lee, James J., Robbee Wedow, Aysu Okbay, Edward Kong, Omeed Maghzian, Meghan Zacher, Tuan Anh Nguyen-Viet, Peter Bowers, Julia Sidorenko, Richard Karlsson Linnér, Mark Alan Fontana, Tushar Kundu, Chanwook Lee, Hui Li, Ruoxi Li, Rebecca Royer, Pascal N. Timshel, Raymond K. Walters, Emily A. Willoughby, Loïc Yengo, 23andMe Research Team, COGENT (Cognitive Genomics Consortium), Social Science Genetic Association Consortium, Maris Alver, Yanchun Bao, David W. Clark, Felix R. Day, Nicholas A. Furlotte, Peter K. Joshi, Kathryn E. Kemper, Aaron Kleinman, Claudia Langenberg, Reedik Mägi, Joey W. Trampush, Shefali Setia Verma, Yang Wu, Max Lam, Jing Hua Zhao, Zhili Zheng, Jason D. Boardman, Harry Campbell, Jeremy Freese, Kathleen Mullan Harris, Caroline Hayward, Pamela Herd, Meena Kumari, Todd Lencz, Jian'an Luan, Anil K. Malhotra, Andres Metspalu, Lili Milani, Ken K. Ong, John R. B. Perry, David J. Porteous, Marylyn D. Ritchie, Melissa C. Smart, Blair H. Smith, Joyce Y. Tung, Nicholas J. Wareham, James F. Wilson, Jonathan P. Beauchamp, Dalton C. Conley, Tõnu Esko, Steven F. Lehrer, Patrik K. E. Magnusson, Sven Oskarsson, Tune H. Pers, Matthew R. Robinson, Kevin Thom, Chelsea Watson, Christopher F. Chabris, Michelle N. Meyer, David I. Laibson, Jian Yang, Magnus Johannesson, Philipp D. Koellinger, Patrick Turley, Peter M. Visscher, Daniel J. Benjamin, and David Cesarini. 2018. "Gene Discovery and Polygenic Prediction from a Genome-Wide Association Study of Educational Attainment in 1.1 Million Individuals." *Nature Genetics* 50(8):1112–21. doi: [10.1038/s41588-018-0147-3](https://doi.org/10.1038/s41588-018-0147-3).
- Leesch, Julia, and Jan Skopek. 2023. "Decomposing Trends in Educational Homogamy and Heterogamy – The Case of Ireland." *Social Science Research* 110:102846. doi: [10.1016/j.ssresearch.2023.102846](https://doi.org/10.1016/j.ssresearch.2023.102846).
- LeTendre, Gerald K., Barbara K. Hofer, and Hidetada Shimizu. 2003. "What Is Tracking? Cultural Expectations in the United States, Germany, and Japan." *American Educational Research Journal* 40(1):43–89. doi: [10.3102/00028312040001043](https://doi.org/10.3102/00028312040001043).
- Li, Wen, Kunio Urakawa, and Fumihiko Suga. 2023. "The Gender Gap in the Returns From College Education in Japan: The Impact of Attending a High-Ranking College." *Social Science Japan Journal* 26(1):61–76. doi: [10.1093/ssjj/jyac026](https://doi.org/10.1093/ssjj/jyac026).

- Lichter, Daniel T., and Zhenchao Qian. 2019. "The Study of Assortative Mating: Theory, Data, and Analysis." Pp. 303–37 in *Analytical Family Demography*. Vol. 47, edited by R. Schoen. Cham: Springer International Publishing.
- Lin, Meng-Jung. 2020. "The Social and Genetic Inheritance of Educational Attainment: Genes, Parental Education, and Educational Expansion." *Social Science Research* 86:102387. doi: [10.1016/j.ssresearch.2019.102387](https://doi.org/10.1016/j.ssresearch.2019.102387).
- Liu, Hexuan. 2018. "Social and Genetic Pathways in Multigenerational Transmission of Educational Attainment." *American Sociological Review* 83(2):278–304. doi: [10.1177/0003122418759651](https://doi.org/10.1177/0003122418759651).
- Logan, John Allen. 1996. "Rules of Access and Shifts in Demand: A Comparison of Log-Linear and Two-Sided Logit Models." *Social Science Research* 25(2):174–99. doi: [10.1006/ssre.1996.0008](https://doi.org/10.1006/ssre.1996.0008).
- Long, Mark C. 2010. "Changes in the Returns to Education and College Quality." *Economics of Education Review* 29(3):338–47. doi: [10.1016/j.econedurev.2009.10.005](https://doi.org/10.1016/j.econedurev.2009.10.005).
- Lovenheim, Michael, and Jonathan Smith. 2022. *Returns to Different Postsecondary Investments: Institution Type, Academic Programs, and Credentials*. w29933. Cambridge, MA: National Bureau of Economic Research. doi: [10.3386/w29933](https://doi.org/10.3386/w29933).
- Lucas, Samuel R. 2001. "Effectively Maintained Inequality: Education Transitions, Track Mobility, and Social Background Effects." *American Journal of Sociology* 106(6):1642–90. doi: [10.1086/321300](https://doi.org/10.1086/321300).
- Manzoni, Anna, and Jessi Streib. 2019. "The Equalizing Power of a College Degree for First-Generation College Students: Disparities Across Institutions, Majors, and Achievement Levels." *Research in Higher Education* 60(5):577–605. doi: [10.1007/s11162-018-9523-1](https://doi.org/10.1007/s11162-018-9523-1).
- Mare, Robert D. 1991. "Five Decades of Educational Assortative Mating." *American Sociological Review* 56(1):15–32.
- Marini, Margaret Mooney, Pi-Ling Fan, Erica Finley, and Ann M. Beutel. 1996. "Gender and Job Values." *Sociology of Education* 69(1):49–65. doi: [10.2307/2112723](https://doi.org/10.2307/2112723).
- Marini, Margaret Mooney, and Ellen Greenberger. 1978. "Sex Differences in Occupational Aspirations and Expectations." *Sociology of Work and Occupations* 5(2):147–78. doi: [10.1177/009392857852001](https://doi.org/10.1177/009392857852001).
- Marks, Gary N. 2013. "Evaluating Effectively Maintained Inequality: School and Post-School Transitions, Socioeconomic Background, Academic Ability and Curricular Placement." *Social Science Research* 42(6):1635–49. doi: [10.1016/j.ssresearch.2013.07.004](https://doi.org/10.1016/j.ssresearch.2013.07.004).
- Marks, Gary N. 2014. *Education, Social Background and Cognitive Ability: The Decline of the Social*. Routledge.

- Michel, Rochelle, and Simone Pollard. 2020. "An Overview of Higher Education Admissions Processes." Pp. 5–17 in *Higher Education Admissions Practices*, edited by M. E. Oliveri and C. Wendler. Cambridge University Press.
- Michelman, Valerie, Joseph Price, and Seth Zimmerman. 2021. "Old Boys' Clubs and Upward Mobility Among the Educational Elite." *National Bureau of Economic Research Working Paper Series* w28583. doi: [10.3386/w28583](https://doi.org/10.3386/w28583).
- Mills, Melinda C., and Felix C. Tropf. 2020. "Sociology, Genetics, and the Coming of Age of Sociogenomics." *Annual Review of Sociology* 46(1):553–81. doi: [10.1146/annurev-soc-121919-054756](https://doi.org/10.1146/annurev-soc-121919-054756).
- Ministry of Education, Culture Sports, Science and Technology (MEXT). 2022. *Statistical Abstract*. National Printing Bureau.
- Ministry of Health, Labour, and Welfare (MHLW). 2022. *Monthly Labour Survey*.
- Miwa, Satoshi. 2007. "Long-Term Trends in Status Homogamy." Pp. 140–60 in *Deciphering Stratification and Inequality*, edited by Y. Sato. Trans Pacific Press.
- Mizutani Noriko, Okudaira Hiroko, Kinari Yusuke, and Ohtake Fumiya. 2009. "Overconfidence Makes Men Compete More." *Journal of Behavioral Economics and Finance* 2:60–73.
- Monks, James. 2000. "The Returns to Individual and College Characteristics Evidence from the National Longitudinal Survey of Youth." *Economics of Education Review* 19:279–89.
- Nakanishi, Yuko. 1998. *Gender Track*. Toyokan Shuppansha. (in Japanese).
- Naoi, Michio. 2006. "Household Housing Movements and Sample Attrition." *Keio University Market Quality Research Project Discussion Paper Series*.
- National Center for Education Statistics. 2019. *The Condition of Education 2019*.
- Nelson, Julie A. 2016. "Not-So-Strong Evidence for Gender Differences in Risk Taking." *Feminist Economics* 22(2):114–42. doi: [10.1080/13545701.2015.1057609](https://doi.org/10.1080/13545701.2015.1057609).
- Niederle, M., and L. Vesterlund. 2007. "Do Women Shy Away From Competition? Do Men Compete Too Much?" *The Quarterly Journal of Economics* 122(3):1067–1101. doi: [10.1162/qjec.122.3.1067](https://doi.org/10.1162/qjec.122.3.1067).
- Niederle, Muriel, and Lise Vesterlund. 2010. "Explaining the Gender Gap in Math Test Scores: The Role of Competition." *Journal of Economic Perspectives* 24(2):129–44. doi: [10.1257/jep.24.2.129](https://doi.org/10.1257/jep.24.2.129).
- Niederle, Muriel, and Lise Vesterlund. 2011. "Gender and Competition." *Annual Review of Economics* 3(1):601–30. doi: [10.1146/annurev-economics-111809-125122](https://doi.org/10.1146/annurev-economics-111809-125122).
- Nishimaru, Ryoichi. 2006. "An Effect of Ronin on University Admission." *Butsudai Shakaigaku* 31:14–23.

Ojima, Fumiaki, and Sohei Aramaki, eds. 2018. *Kokosei Tachi No Yukue*. Sekai-Shisosh. (in Japanese).

Okbay, Aysu, Yeda Wu, Nancy Wang, Hariharan Jayashankar, Michael Bennett, Seyed Moeen Nehzati, Julia Sidorenko, Hyeokmoon Kweon, Grant Goldman, Tamara Gjorgjieva, Yunxuan Jiang, Barry Hicks, Chao Tian, David A. Hinds, Rafael Ahlskog, Patrik K. E. Magnusson, Sven Oskarsson, Caroline Hayward, Archie Campbell, David J. Porteous, Jeremy Freese, Pamela Herd, 23andMe Research Team, Michelle Agee, Babak Alipanahi, Adam Auton, Robert K. Bell, Katarzyna Bryc, Sarah L. Elson, Pierre Fontanillas, Nicholas A. Furlotte, David A. Hinds, Karen E. Huber, Aaron Kleinman, Nadia K. Litterman, Jennifer C. McCreight, Matthew H. McIntyre, Joanna L. Mountain, Carrie A. M. Northover, Steven J. Pitts, J. Fah Sathirapongsasuti, Olga V. Sazonova, Janie F. Shelton, Suyash Shringarpure, Joyce Y. Tung, Vladimir Vacic, Catherine H. Wilson, Social Science Genetic Association Consortium, Mark Alan Fontana, Tune H. Pers, Cornelius A. Rietveld, Guo-Bo Chen, Valur Emilsson, S. Fleur W. Meddens, Joseph K. Pickrell, Kevin Thom, Pascal Timshel, Ronald de Vlaming, Abdel Abdellaoui, Tarunveer S. Ahluwalia, Jonas Bacelis, Clemens Baumbach, Gyda Bjornsdottir, Johannes H. Brandsma, Maria Pina Concas, Jaime Derringer, Tessel E. Galesloot, Giorgia Girotto, Richa Gupta, Leanne M. Hall, Sarah E. Harris, Edith Hofer, Momoko Horikoshi, Jennifer E. Huffman, Kadri Kaasik, Ioanna P. Kalafati, Robert Karlsson, Jari Lahti, Sven J. van der Lee, Christiaan de Leeuw, Penelope A. Lind, Karl-Oskar Lindgren, Tian Liu, Massimo Mangino, Jonathan Marten, Evelin Mihailov, Michael B. Miller, Peter J. van der Most, Christopher Oldmeadow, Antony Payton, Natalia Pervjakova, Wouter J. Peyrot, Yong Qian, Olli Raitakari, Rico Rueedi, Erika Salvi, Borge Schmidt, Katharina E. Schraut, Jianxin Shi, Albert V. Smith, Raymond A. Poot, Beate St Pourcain, Alexander Teumer, Gudmar Thorleifsson, Niek Verweij, Dragana Vuckovic, Juergen Wellmann, Harm-Jan Westra, Jingyun Yang, Wei Zhao, Zhihong Zhu, Behrooz Z. Alizadeh, Najaf Amin, Andrew Bakshi, Sebastian E. Baumeister, Ginevra Biino, Klaus Bønnelykke, Patricia A. Boyle, Harry Campbell, Francesco P. Cappuccio, Gail Davies, Jan-Emmanuel De Neve, Panos Deloukas, Ilja Demuth, Jun Ding, Peter Eibich, Lewin Eisele, Niina Eklund, David M. Evans, Jessica D. Faul, Mary F. Feitosa, Andreas J. Forstner, Ilaria Gandin, Bjarni Gunnarsson, Bjarni V. Halldórsson, Tamara B. Harris, Andrew C. Heath, Lynne J. Hocking, Elizabeth G. Holliday, Georg Homuth, Michael A. Horan, Jouke-Jan Hottenga, Philip L. de Jager, Peter K. Joshi, Astanand Jugessur, Marika A. Kaakinen, Mika Kähönen, Stavroula Kanoni, Liisa Keltigangas-Järvinen, Lambertus A. L. M. Kiemeny, Ivana Kolcic, Seppo Koskinen, Aldi T. Kraja, Martin Kroh, Zoltan Kutalik, Antti Latvala, Lenore J. Launer, Maël P. Lebreton, Douglas F. Levinson, Paul Lichtenstein, Peter Lichtner, David C. M. Liewald, LifeLines Cohort Study, Anu Loukola, Pamela A. Madden, Reedik Mägi, Tomi Mäki-Opas, Riccardo E. Marioni, Pedro Marques-Vidal, Gerardus A. Meddens, George McMahon, Christa Meisinger, Thomas Meitinger, Yusplitri Milaneschi, Lili Milani, Grant W. Montgomery, Ronny Myhre, Christopher P. Nelson, Dale R. Nyholt, William E. R. Ollier, Aarno Palotie, Lavinia Paternoster, Nancy L. Pedersen, Katja E. Petrovic, Katri Räikkönen, Susan M. Ring, Antonietta Robino, Olga Rostapshova, Igor Rudan, Aldo Rustichini, Veikko Salomaa, Alan R. Sanders, Antti-Pekka Sarin, Helena

Schmidt, Rodney J. Scott, Blair H. Smith, Jennifer A. Smith, Jan A. Staessen, Elisabeth Steinhagen-Thiessen, Konstantin Strauch, Antonio Terracciano, Martin D. Tobin, Sheila Ulivi, Simona Vaccargiu, Lydia Quaye, Frank J. A. van Rooij, Cristina Venturini, Anna A. E. Vinkhuyzen, Uwe Völker, Henry Völzke, Judith M. Vonk, Diego Vozzi, Johannes Waage, Erin B. Ware, Gonneke Willemsen, John R. Attia, David A. Bennett, Klaus Berger, Lars Bertram, Hans Bisgaard, Dorret I. Boomsma, Ingrid B. Borecki, Ute Bültmann, Christopher F. Chabris, Francesco Cucca, Daniele Cusi, Ian J. Deary, George V. Dedoussis, Cornelia M. van Duijn, Johan G. Eriksson, Barbara Franke, Lude Franke, Paolo Gasparini, Pablo V. Gejman, Christian Gieger, Hans-Jörgen Grabe, Jacob Gratten, Patrick J. F. Groenen, Vilmundur Gudnason, Pim van der Harst, Wolfgang Hoffmann, Elina Hyppönen, William G. Iacono, Bo Jacobsson, Marjo-Riitta Järvelin, Karl-Heinz Jöckel, Jaakko Kaprio, Sharon L. R. Kardia, Terho Lehtimäki, Steven F. Lehrer, Nicholas G. Martin, Matt McGue, Andres Metspalu, Neil Pendleton, Brenda W. J. H. Penninx, Markus Perola, Nicola Pirastu, Mario Pirastu, Ozren Polasek, Danielle Posthuma, Christine Power, Michael A. Province, Nilesh J. Samani, David Schlessinger, Reinhold Schmidt, Thorkild I. A. Sørensen, Tim D. Spector, Kari Stefansson, Unnur Thorsteinsdottir, A. Roy Thurik, Nicholas J. Timpson, Henning Tiemeier, André G. Uitterlinden, Veronique Vitart, Peter Vollenweider, David R. Weir, James F. Wilson, Alan F. Wright, Dalton C. Conley, Robert F. Krueger, George Davey Smith, Albert Hofman, David I. Laibson, Sarah E. Medland, Jian Yang, Tõnu Esko, Chelsea Watson, Jonathan Jala, Dalton Conley, Philipp D. Koellinger, Magnus Johannesson, David Laibson, Michelle N. Meyer, James J. Lee, Augustine Kong, Loic Yengo, David Cesarini, Patrick Turley, Peter M. Visscher, Jonathan P. Beauchamp, Daniel J. Benjamin, and Alexander I. Young. 2022. “Polygenic Prediction of Educational Attainment within and between Families from Genome-Wide Association Analyses in 3 Million Individuals.” *Nature Genetics* 54(4):437–49. doi: [10.1038/s41588-022-01016-z](https://doi.org/10.1038/s41588-022-01016-z).

- Ono, Hiroshi. 2001. “Who Goes to College? Features of Institutional Tracking in Japanese Higher Education.” *American Journal of Education* 109(2):161–95. doi: [10.1086/444265](https://doi.org/10.1086/444265).
- Ono, Hiroshi. 2004. “Are Sons and Daughters Substitutable?” *Journal of the Japanese and International Economies* 18(2):143–60. doi: [10.1016/S0889-1583\(03\)00049-2](https://doi.org/10.1016/S0889-1583(03)00049-2).
- Ono, Hiroshi. 2007. “Does Examination Hell Pay off? A Cost–Benefit Analysis of ‘Ronin’ and College Education in Japan.” *Economics of Education Review* 26(3):271–84. doi: [10.1016/j.econedurev.2006.01.002](https://doi.org/10.1016/j.econedurev.2006.01.002).
- Ono, Hiroshi. 2008. “Training the Nation’s Elites: National–Private Sector Differences in Japanese University Education.” *Research in Social Stratification and Mobility* 26(4):341–56. doi: [10.1016/j.rssm.2008.08.002](https://doi.org/10.1016/j.rssm.2008.08.002).
- Oppenheimer, Valerie Kincade. 1988. “A Theory of Marriage Timing.” *American Journal of Sociology* 94(3):563–91.
- Organisation for Economic Co-operation and Development (OECD). 2023. *Earnings and Wages Database*.

- Ors, Evren, Frédéric Palomino, and Eloïc Peyrache. 2013. "Performance Gender Gap: Does Competition Matter?" *Journal of Labor Economics* 31(3):443–99. doi: [10.1086/669331](https://doi.org/10.1086/669331).
- Papageorge, Nicholas W., and Kevin Thom. 2020. "Genes, Education, and Labor Market Outcomes: Evidence from the Health and Retirement Study." *Journal of the European Economic Association* 18(3):1351–99. doi: [10.1093/jeaa/jvz072](https://doi.org/10.1093/jeaa/jvz072).
- Parkin, Frank. 1971. *Class Inequality and Political Order*. University of California Press.
- Pfeffer, Fabian T., and Florian R. Hertel. 2015. "How Has Educational Expansion Shaped Social Mobility Trends in the United States?" *Social Forces* 94(1):143–80. doi: [10.1093/sf/sov045](https://doi.org/10.1093/sf/sov045).
- Pinquart, Martin, and Markus Ebeling. 2020. "Parental Educational Expectations and Academic Achievement in Children and Adolescents—a Meta-Analysis." *Educational Psychology Review* 32(2):463–80. doi: [10.1007/s10648-019-09506-z](https://doi.org/10.1007/s10648-019-09506-z).
- Plomin, Robert. 2018. *Blueprint: How DNA Makes Us Who We Are*. MIT Press.
- Price, Joseph. 2008. "Gender Differences in the Response to Competition." *ILR Review* 61(3):320–33.
- Raftery, Adrian E. 1995. "Bayesian Model Selection in Social Research." *Sociological Methodology* 25:111–63. doi: [10.2307/271063](https://doi.org/10.2307/271063).
- Rauscher, Emily. 2015. "Effects of Early U.S. Compulsory Schooling Laws on Educational Assortative Mating: The Importance of Context." *Demography* 52(4):1219–42. doi: [10.1007/s13524-015-0402-5](https://doi.org/10.1007/s13524-015-0402-5).
- Rauscher, Emily. 2016. "Does Educational Equality Increase Mobility? Exploiting Nineteenth-Century U.S. Compulsory Schooling Laws." *American Journal of Sociology* 121(6):1697–1761. doi: [10.1086/685443](https://doi.org/10.1086/685443).
- Ravazzini, Laura, Ursina Kuhn, and Christian Suter. 2017. "Do Opposites Attract? Educational Assortative Mating and Dynamics of Wage Homogamy in Switzerland, 1992–2014." *Swiss Journal of Sociology* 43(3):567–86. doi: [10.1515/sjs-2017-0028](https://doi.org/10.1515/sjs-2017-0028).
- Raymo, James M., and Miho Iwasawa. 2005. "Marriage Market Mismatches in Japan: An Alternative View of the Relationship Between Women's Education and Marriage." *American Sociological Review* 70(5):801–22. doi: <https://doi.org/10.1177/000312240507000504>.
- Raymo, James M., Hyunjoon Park, Yu Xie, and Wei-jun Jean Yeung. 2015. "Marriage and Family in East Asia: Continuity and Change." *Annual Review of Sociology* 41(1):471–92. doi: [10.1146/annurev-soc-073014-112428](https://doi.org/10.1146/annurev-soc-073014-112428).
- Raymo, James M., Hyunjoon Park, and Jia Yu. 2023. "Diverging Destinies in East Asia." *Annual Review of Sociology* 49(1):443–63. doi: [10.1146/annurev-soc-020321-032642](https://doi.org/10.1146/annurev-soc-020321-032642).

- Reeves, Richard V. 2022. *Of Boys and Men: Why the Modern Male Is Struggling, Why It Matters, and What to Do about It*. Brookings Institution Press.
- Reshetar, Rosemary, and Martha F. Pitts. 2020. "General Academic and Subject-Based Examinations Used in Undergraduate Higher Education Admissions." Pp. 237–55 in *Higher Education Admissions Practices*, edited by M. E. Oliveri and C. Wendler. Cambridge University Press.
- Riegle-Crumb, Catherine, and Menglu Peng. 2021. "Examining High School Students' Gendered Beliefs about Math: Predictors and Implications for Choice of STEM College Majors." *Sociology of Education* 003804072110147. doi: [10.1177/00380407211014777](https://doi.org/10.1177/00380407211014777).
- Rietveld, Cornelius A., Sarah E. Medland, Jaime Derringer, Jian Yang, Tõnu Esko, Nicolas W. Martin, Harm-Jan Westra, Konstantin Shakhbazov, Abdel Abdellaoui, Arpana Agrawal, Eva Albrecht, Behrooz Z. Alizadeh, Najaf Amin, John Barnard, Sebastian E. Baumeister, Kelly S. Benke, Lawrence F. Bielak, Jeffrey A. Boatman, Patricia A. Boyle, Gail Davies, Christiaan De Leeuw, Niina Eklund, Daniel S. Evans, Rudolf Ferhmann, Krista Fischer, Christian Gieger, Håkon K. Gjessing, Sara Hägg, Jennifer R. Harris, Caroline Hayward, Christina Holzapfel, Carla A. Ibrahim-Verbaas, Erik Ingelsson, Bo Jacobsson, Peter K. Joshi, Astanand Jugessur, Marika Kaakinen, Stavroula Kanoni, Juha Karjalainen, Ivana Kolcic, Kati Kristiansson, Zoltán Kutalik, Jari Lahti, Sang H. Lee, Peng Lin, Penelope A. Lind, Yongmei Liu, Kurt Lohman, Marisa Loitfelder, George McMahon, Pedro Marques Vidal, Osorio Meirelles, Lili Milani, Ronny Myhre, Marja-Liisa Nuotio, Christopher J. Oldmeadow, Katja E. Petrovic, Wouter J. Peyrot, Ozren Polašek, Lydia Quaye, Eva Reinmaa, John P. Rice, Thais S. Rizzi, Helena Schmidt, Reinhold Schmidt, Albert V. Smith, Jennifer A. Smith, Toshiko Tanaka, Antonio Terracciano, Matthijs J. H. M. Van Der Loos, Veronique Vitart, Henry Völzke, Jürgen Wellmann, Lei Yu, Wei Zhao, Jüri Allik, John R. Attia, Stefania Bandinelli, François Bastardot, Jonathan Beauchamp, David A. Bennett, Klaus Berger, Laura J. Bierut, Dorret I. Boomsma, Ute Bültmann, Harry Campbell, Christopher F. Chabris, Lynn Cherkas, Mina K. Chung, Francesco Cucca, Mariza De Andrade, Philip L. De Jager, Jan-Emmanuel De Neve, Ian J. Deary, George V. Dedoussis, Panos Deloukas, Maria Dimitriou, Guðný Eiríksdóttir, Martin F. Elderson, Johan G. Eriksson, David M. Evans, Jessica D. Faul, Luigi Ferrucci, Melissa E. Garcia, Henrik Grönberg, Vilmundur Guðnason, Per Hall, Juliette M. Harris, Tamara B. Harris, Nicholas D. Hastie, Andrew C. Heath, Dena G. Hernandez, Wolfgang Hoffmann, Adriaan Hofman, Rolf Holle, Elizabeth G. Holliday, Jouke-Jan Hottenga, William G. Iacono, Thomas Illig, Marjo-Riitta Järvelin, Mika Kähönen, Jaakko Kaprio, Robert M. Kirkpatrick, Matthew Kowgier, Antti Latvala, Lenore J. Launer, Debbie A. Lawlor, Terho Lehtimäki, Jingmei Li, Paul Lichtenstein, Peter Lichtner, David C. Liewald, Pamela A. Madden, Patrik K. E. Magnusson, Tomi E. Mäkinen, Marco Masala, Matt McGue, Andres Metspalu, Andreas Mielck, Michael B. Miller, Grant W. Montgomery, Sutapa Mukherjee, Dale R. Nyholt, Ben A. Oostra, Lyle J. Palmer, Aarno Palotie, Brenda W. J. H. Penninx, Markus Perola, Patricia A. Peyser, Martin Preisig, Katri Räikkönen, Olli T. Raitakari, Anu Realo, Susan M. Ring, Samuli Ripatti, Fernando Rivadeneira, Igor Rudan, Aldo Rustichini,

- Veikko Salomaa, Antti-Pekka Sarin, David Schlessinger, Rodney J. Scott, Harold Snieder, Beate St Pourcain, John M. Starr, Jae Hoon Sul, Ida Surakka, Rauli Svento, Alexander Teumer, The LifeLines Cohort Study, Henning Tiemeier, Frank J. A. Van Rooij, David R. Van Wagoner, Erkki Vartiainen, Jorma Viikari, Peter Vollenweider, Judith M. Vonk, Gérard Waeber, David R. Weir, H.-Erich Wichmann, Elisabeth Widen, Gonneke Willemsen, James F. Wilson, Alan F. Wright, Dalton Conley, George Davey-Smith, Lude Franke, Patrick J. F. Groenen, Albert Hofman, Magnus Johannesson, Sharon L. R. Kardia, Robert F. Krueger, David Laibson, Nicholas G. Martin, Michelle N. Meyer, Danielle Posthuma, A. Roy Thurik, Nicholas J. Timpson, André G. Uitterlinden, Cornelia M. Van Duijn, Peter M. Visscher, Daniel J. Benjamin, David Cesarini, and Philipp D. Koellinger. 2013. "GWAS of 126,559 Individuals Identifies Genetic Variants Associated with Educational Attainment." *Science* 340(6139):1467–71. doi: [10.1126/science.1235488](https://doi.org/10.1126/science.1235488).
- Rivera, Lauren A. 2015. *Pedigree: How Elite Students Get Elite Jobs*. Princeton, NJ: Princeton University Press.
- Rohlen, Thomas P. 1983. *Japan's High Schools*. University of California Press.
- Roksa, Josipa, Eric Grodsky, Richard Arum, and Adam Gamoran. 2007. "United States: Changes in Higher Education and Social Stratification." Pp. 165–91 in *Stratification in Higher Education: A Comparative Study*, edited by Y. Shavit, R. Arum, and A. Gamoran. Stanford: Stanford University Press.
- Roth, Ian. 2019. "Similar Examinations, Different Tests: A Comparative Description of the SAT and Juken Systems." *Journal of International and Comparative Education* 8(2):61–83. doi: [10.14425/jice.2019.8.2.61](https://doi.org/10.14425/jice.2019.8.2.61).
- Rowe, David C., Kristen C. Jacobson, and Edwin J. C. G. Van den Oord. 1999. "Genetic and Environmental Influences on Vocabulary IQ: Parental Education Level as Moderator." *Child Development* 70(5):1151–62. doi: [10.1111/1467-8624.00084](https://doi.org/10.1111/1467-8624.00084).
- Royston, Patrick, and Ian White. 2011. "Multiple Imputation by Chained Equations (MICE): Implementation in Stata." *Journal of Statistical Software* 45(4). doi: [10.18637/jss.v045.i04](https://doi.org/10.18637/jss.v045.i04).
- Sakaguchi, Naofumi. 2014. "Attrition of Respondents from Japanese Panel Survey of Consumers." *Japanese Journal of Research on Household Economics* 104:34–41. (in Japanese).
- Sattin-Bajaj, Carolyn, and Allison Roda. 2020. "Opportunity Hoarding in School Choice Contexts: The Role of Policy Design in Promoting Middle-Class Parents' Exclusionary Behaviors." *Educational Policy* 34(7):992–1035. doi: [10.1177/0895904818802106](https://doi.org/10.1177/0895904818802106).
- Savage, Jeanne E., Philip R. Jansen, Sven Stringer, Kyoko Watanabe, Julien Bryois, Christiaan A. De Leeuw, Mats Nagel, Swapnil Awasthi, Peter B. Barr, Jonathan R. I. Coleman, Katrina L. Grasby, Anke R. Hammerschlag, Jakob A. Kaminski, Robert Karlsson, Eva Krapohl, Max Lam, Marianne Nygaard, Chandra A. Reynolds, Joey W. Trampush, Hannah Young, Delilah Zabaneh, Sara Hägg, Narelle K. Hansell, Ida K. Karlsson, Sten Linnarsson,

Grant W. Montgomery, Ana B. Muñoz-Manchado, Erin B. Quinlan, Gunter Schumann, Nathan G. Skene, Bradley T. Webb, Tonya White, Dan E. Arking, Dimitrios Avramopoulos, Robert M. Bilder, Panos Bitsios, Katherine E. Burdick, Tyrone D. Cannon, Ornit Chiba-Falek, Andrea Christoforou, Elizabeth T. Cirulli, Eliza Congdon, Aiden Corvin, Gail Davies, Ian J. Deary, Pamela DeRosse, Dwight Dickinson, Srdjan Djurovic, Gary Donohoe, Emily Drabant Conley, Johan G. Eriksson, Thomas Espeseth, Nelson A. Freimer, Stella Giakoumaki, Ina Giegling, Michael Gill, David C. Glahn, Ahmad R. Hariri, Alex Hatzimanolis, Matthew C. Keller, Emma Knowles, Deborah Koltai, Bettina Konte, Jari Lahti, Stephanie Le Hellard, Todd Lencz, David C. Liewald, Edythe London, Astri J. Lundervold, Anil K. Malhotra, Ingrid Melle, Derek Morris, Anna C. Need, William Ollier, Aarno Palotie, Antony Payton, Neil Pendleton, Russell A. Poldrack, Katri Räikkönen, Ivar Reinvang, Panos Roussos, Dan Rujescu, Fred W. Sabb, Matthew A. Scult, Olav B. Smeland, Nikolaos Smyrnis, John M. Starr, Vidar M. Steen, Nikos C. Stefanis, Richard E. Straub, Kjetil Sundet, Henning Tiemeier, Aristotle N. Voineskos, Daniel R. Weinberger, Elisabeth Widen, Jin Yu, Goncalo Abecasis, Ole A. Andreassen, Jerome Breen, Lene Christiansen, Birgit Debrabant, Danielle M. Dick, Andreas Heinz, Jens Hjerling-Leffler, M. Arfan Ikram, Kenneth S. Kendler, Nicholas G. Martin, Sarah E. Medland, Nancy L. Pedersen, Robert Plomin, Tinca J. C. Polderman, Stephan Ripke, Sophie Van Der Sluis, Patrick F. Sullivan, Scott I. Vrieze, Margaret J. Wright, and Danielle Posthuma. 2018. "Genome-Wide Association Meta-Analysis in 269,867 Individuals Identifies New Genetic and Functional Links to Intelligence." *Nature Genetics* 50(7):912–19. doi: [10.1038/s41588-018-0152-6](https://doi.org/10.1038/s41588-018-0152-6).

Saygin, Perihan Ozge. 2016. "Gender Differences in Preferences for Taking Risk in College Applications." *Economics of Education Review* 52:120–33. doi: [10.1016/j.econedurev.2016.02.002](https://doi.org/10.1016/j.econedurev.2016.02.002).

Scarr-Salapatek, Sandra. 1971. "Race, Social Class, and IQ." *Science* 174(4016):1285–95. doi: [10.1126/science.174.4016.1285](https://doi.org/10.1126/science.174.4016.1285).

Schubert, Renate, and Ioana Marinica. 2018. *Gender Attainment Gaps Literature Review and Empirical Evidence from IARU Universities*.

Schwartz, Christine R. 2010. "Earnings Inequality and the Changing Association between Spouses' Earnings." *American Journal of Sociology* 115(5):1524–57. doi: <https://doi.org/10.1086/651373>.

Schwartz, Christine R. 2013. "Trends and Variation in Assortative Mating: Causes and Consequences." *Annual Review of Sociology* 39(1):451–70. doi: [10.1146/annurev-soc-071312-145544](https://doi.org/10.1146/annurev-soc-071312-145544).

Schwartz, Christine R., and Robert D. Mare. 2005. "Trends in Educational Assortative Marriage from 1940 to 2003." *Demography* 42(4):621–46.

- Sekhri, Sheetal. 2020. "Prestige Matters: Wage Premium and Value Addition in Elite Colleges." *American Economic Journal: Applied Economics* 12(3):207–25. doi: [10.1257/app.20140105](https://doi.org/10.1257/app.20140105).
- Sewell, William H., and Vimal Shah. 1967. "Socioeconomic Status, Intelligence, and the Attainment of Higher Education." Pp. 197–215 in *Power and Ideology in Education*, edited by J. Karabel and A. H. Halsey.
- Shen, Yifan. 2021. "The Nonlinear Linkage Between Earnings Homogamy and Earnings Inequality Among Married Couples." *Demography* 58(2):527–50. doi: [10.1215/00703370-8996374](https://doi.org/10.1215/00703370-8996374).
- Shirakawa, Toshiyuki. 2020. "Mechanisms of Gender Major Segregation in Higher Education: Focusing on Gender Differences in STEM Orientation." *Hiroshima Papers on Society and Culture* 16(127-158. (in Japanese)).
- Shurchkov, Olga. 2012. "Under Pressure: Gender Differences in Output Quality and Quantity under Competition and Time Constraints." *Journal of the European Economic Association* 10(5):1189–1213. doi: [10.1111/j.1542-4774.2012.01084.x](https://doi.org/10.1111/j.1542-4774.2012.01084.x).
- Smith, Herbert L., and Brian Powell. 1990. "Great Expectations: Variations in Income Expectations Among College Seniors." *Sociology of Education* 63(3):194. doi: [10.2307/2112837](https://doi.org/10.2307/2112837).
- Smits, Jeroen. 2003. "Social Closure among The Higher Educated: Trends in Educational Homogamy in 55 Countries." *Social Science Research* 32(2):251–77. doi: [10.1016/S0049-089X\(02\)00049-2](https://doi.org/10.1016/S0049-089X(02)00049-2).
- Smits, Jeroen, and Hyunjoon Park. 2009. "Five Decades of Educational Assortative Mating in 10 East Asian Societies." *Social Forces* 88(1):227–55.
- Soll, Jack B., and Joshua Klayman. 2004. "Overconfidence in Interval Estimates." *Journal of Experimental Psychology: Learning, Memory, and Cognition* 30(2):299–314. doi: [10.1037/0278-7393.30.2.299](https://doi.org/10.1037/0278-7393.30.2.299).
- Spinath, Birgit, Christine Eckert, and Ricarda Steinmayr. 2014. "Gender Differences in School Success: What Are the Roles of Students' Intelligence, Personality and Motivation?" *Educational Research* 56(2):230–43. doi: [10.1080/00131881.2014.898917](https://doi.org/10.1080/00131881.2014.898917).
- Stevenson, David Lee, and David P. Baker. 1992. "Shadow Education and Allocation in Formal Schooling: Transition to University in Japan." *American Journal of Sociology* 97(6):1639–57. doi: [10.1086/229942](https://doi.org/10.1086/229942).
- Takeuchi, Yo. 1997. "The Self-Activating Entrance Examination System: Its Hidden Agenda and Its Correspondence with the Japanese 'Salary Man.'" *Higher Education* 34(2):183–98.
- The JoongAng Ilbo. 2019. "Admission Rate to Seoul National University Is Three Times Higher for Men than for Women... It Was Different from Susi (Holistic Review)." January 30.

- Thomas, Scott L. 2003. "Longer-Term Economic Effects of College Selectivity and Control." *Research in Higher Education*, 44(3):263–99.
- Thomas, Scott L., and Liang Zhang. 2005. "Post-Baccalaureate Wage Growth within Four Years of Graduation: The Effects of College Quality and College Major." *Research in Higher Education* 46(4):437–59. doi: [10.1007/s11162-005-2969-y](https://doi.org/10.1007/s11162-005-2969-y).
- Thompson, Jason. 2019. "Mobility in the Middle: Bachelor's Degree Selectivity and the Intergenerational Association in Status in the United States." *Research in Social Stratification and Mobility* 60:16–28. doi: [10.1016/j.rssm.2019.02.001](https://doi.org/10.1016/j.rssm.2019.02.001).
- Torche, Florencia. 2010. "Educational Assortative Mating and Economic Inequality: A Comparative Analysis of Three Latin American Countries." *Demography* 47(2):481–502. doi: [10.1353/dem.0.0109](https://doi.org/10.1353/dem.0.0109).
- Torche, Florencia. 2011. "Is a College Degree Still the Great Equalizer? Intergenerational Mobility across Levels of Schooling in the United States." *American Journal of Sociology* 117(3):763–807. doi: [10.1086/661904](https://doi.org/10.1086/661904).
- Toyonaga, Kohei. 2022. "Processing of School Name Codes in SSM Surveys." *Journal of Applied Sociology* 64:67–82.
- Treiman, D. J., and HBG Ganzeboom. 2000. "The Fourth Generation of Comparative Stratification Research." Pp. 123–50 in *International Handbook of Sociology*, edited by S. R. Quah and A. Sales. SAGE.
- Tsukada, Mamoru. 1991. *Yobiko Life: A Study of the Legitimation Process of Social Stratification in Japan*. Institute of East Asian Studies, University of California.
- Tucker-Drob, Elliot M., and Timothy C. Bates. 2016. "Large Cross-National Differences in Gene $\times$ Socioeconomic Status Interaction on Intelligence." *Psychological Science* 27(2):138–49. doi: [10.1177/0956797615612727](https://doi.org/10.1177/0956797615612727).
- Turkheimer, Eric. 1991. "Individual and Group Differences in Adoption Studies of IQ." *Psychological Bulletin* 110(3):392–405.
- Turkheimer, Eric, Andreana Haley, Mary Waldron, Brian D'Onofrio, and Irving I. Gottesman. 2003. "Socioeconomic Status Modifies Heritability of IQ in Young Children." *Psychological Science* 14(6):623–28. doi: [10.1046/j.0956-7976.2003.psci_1475.x](https://doi.org/10.1046/j.0956-7976.2003.psci_1475.x).
- Turley, Ruth N. López, Martín Santos, and Cecilia Ceja. 2007. "Social Origin and College Opportunity Expectations across Cohorts." *Social Science Research* 36(3):1200–1218. doi: [10.1016/j.ssresearch.2006.09.004](https://doi.org/10.1016/j.ssresearch.2006.09.004).
- Tzeng, J. M. 1992. "The Effects of Socioeconomic Heterogamy and Changes on Marital Dissolution for First Marriages." *Journal of Marriage and Family* 54(3):609–19.
- Uchikoshi, Fumiya. 2018. "Assortative Mating in the Age of Marriage Decline." *Sociological Theory and Methods* 33(1):15–31 (in Japanese).

- Uchikoshi, Fumiya, and James M. Raymo. 2021. *Educational Assortative Mating in Japan: Insights into Social Change and Stratification*. Springer.
- Vallet, Louis-André. 2004. "The Dynamics of Inequality of Educational Opportunity in France: Change in the Association Between Social Background and Education in Thirteen Five-Year Birth Cohorts (1908-1972)." *Paper Presented at ISA RC28 (Social Stratification and Mobility), Spring Meeting 2004* 1–54.
- Van Bavel, Jan. 2012. "The Reversal of the Gender Gap in Education and Female Breadwinners in Europe" edited by W. Lutz, K. S. James, V. Skirbekk, and J. Van Bavel. *Vienna Yearbook of Population Research* 10:127–54. doi: [10.1553/populationyearbook2012s127](https://doi.org/10.1553/populationyearbook2012s127).
- Van Bavel, Jan, Christine R. Schwartz, and Albert Esteve. 2018. "The Reversal of the Gender Gap in Education and Its Consequences for Family Life." *Annual Review of Sociology* 44(1):341–60. doi: [10.1146/annurev-soc-073117-041215](https://doi.org/10.1146/annurev-soc-073117-041215).
- Van Houtte, Mieke. 2005. "Global Self-Esteem in Technical/Vocational Versus General Secondary School Tracks: A Matter of Gender?" *Sex Roles* 53(9–10):753–61. doi: [10.1007/s11199-005-7739-y](https://doi.org/10.1007/s11199-005-7739-y).
- Verger, Antoni, Lluís Parcerisa, and Clara Fontdevila. 2019. "The Growth and Spread of Large-Scale Assessments and Test-Based Accountabilities: A Political Sociology of Global Education Reforms." *Educational Review* 71(1):5–30. doi: [10.1080/00131911.2019.1522045](https://doi.org/10.1080/00131911.2019.1522045).
- Vigdor, Jacob L., and Charles T. Clotfelter. 2003. "Retaking the SAT." *The Journal of Human Resources* 38(1):1–33. doi: [10.2307/1558754](https://doi.org/10.2307/1558754).
- Watt, Helen M. G., Jennifer D. Shapka, Zoe A. Morris, Amanda M. Durik, Daniel P. Keating, and Jacquelynne S. Eccles. 2012. "Gendered Motivational Processes Affecting High School Mathematics Participation, Educational Aspirations, and Career Plans: A Comparison of Samples from Australia, Canada, and the United States." *Developmental Psychology* 48(6):1594–1611. doi: [10.1037/a0027838](https://doi.org/10.1037/a0027838).
- Wertz, Jasmin, Jay Belsky, Terrie E. Moffitt, Daniel W. Belsky, HonaLee Harrington, Reut Avinun, Richie Poulton, Sandhya Ramrakha, and Avshalom Caspi. 2019. "Genetics of Nurture: A Test of the Hypothesis That Parents' Genetics Predict Their Observed Caregiving." *Developmental Psychology* 55(7):1461–72. doi: [10.1037/dev0000709](https://doi.org/10.1037/dev0000709).
- Wikström, Christina, and Magnus Wikström. 2020. "Merit-Based Admissions in Higher Education." Pp. 34–50 in *Higher Education Admissions Practices*, edited by M. E. Oliveri and C. Wendler. Cambridge University Press.
- Witteveen, Dirk, and Paul Attewell. 2020. "Reconsidering the 'Meritocratic Power of a College Degree.'" *Research in Social Stratification and Mobility* 66:100479. doi: [10.1016/j.rssm.2020.100479](https://doi.org/10.1016/j.rssm.2020.100479).

- Wong, Raymond Sin-Kwok. 2003. "To See or Not To See: Another Look at Research on Temporal Trends and Cross-National Differences in Educational Homogamy." *Taiwanese Journal of Sociology* 31:45–88.
- Woźny, Anna. 2022. "Herbivorous Men, Carnivorous Women: Doing Masculinity and Femininity in Japanese 'Marriage Hunting.'" *Signs: Journal of Women in Culture and Society* 47(3):715–40. doi: [10.1086/717703](https://doi.org/10.1086/717703).
- Xie, Yu. 1992. "The Log-Multiplicative Layer Effect Model for Comparing Mobility Tables." *American Sociological Review* 57(3):380–95.
- Yamamoto, Yoko. 2016. "Gender and Social Class Differences in Japanese Mothers' Beliefs about Children's Education and Socialisation." *Gender and Education* 28(1):72–88. doi: [10.1080/09540253.2015.1091917](https://doi.org/10.1080/09540253.2015.1091917).
- Yonezawa, Akiyoshi, Izumi Nakatsui, and Tetsuo Kobayashi. 2002. "University Rankings in Japan." *Higher Education in Europe* 27:373–82.
- Yoshida, Wataru. 2020. "How Large Japanese Firms Regard College Selectivity When Hiring New Graduates: The Quantitative Analysis of Firm-Level Data on New Hires." *Kyoiku Shakaigaku Kenkyu (The Journal of Educational Sociology)* 107:89–109.
- Yoshihara, Keiko Nakashima. 1998. "Gender Differentiation in the Process of the Selection of Universities: An Analysis of 'Tracks' Embedded in the Entrance Examination System." *Journal of Educational Sociology* 62:43–67.
- Young, Alexander I., Stefania Benonisdottir, Molly Przeworski, and Augustine Kong. 2019. "Deconstructing the Sources of Genotype-Phenotype Associations in Humans." *Science* 365(6460):1396–1400. doi: [10.1126/science.aax3710](https://doi.org/10.1126/science.aax3710).
- Young, Alexander I., Seyed Moeen Nehzati, Stefania Benonisdottir, Aysu Okbay, Hariharan Jayashankar, Chanwook Lee, David Cesarini, Daniel J. Benjamin, Patrick Turley, and Augustine Kong. 2022. "Mendelian Imputation of Parental Genotypes Improves Estimates of Direct Genetic Effects." *Nature Genetics* 54(6):897–905. doi: [10.1038/s41588-022-01085-0](https://doi.org/10.1038/s41588-022-01085-0).
- Yu, Wei-Hsin. 2009. "Higher Education and Gender Inequality." Pp. 147–77 in *Gendered Trajectories: Women, Work, and Social Change in Japan and Taiwan*. Stanford University Press.
- Yu, Wei-hsin, and Kuo-hsien Su. 2024. "Who Benefits from Elite Colleges' Decreased Reliance on High-Stakes Standardized Tests? Evidence from a Quasi-Field Experiment." *Research in Social Stratification and Mobility* 89:100871. doi: [10.1016/j.rssm.2023.100871](https://doi.org/10.1016/j.rssm.2023.100871).
- Zafar, Basit. 2013. "College Major Choice and the Gender Gap." *Journal of Human Resources* 48(3):545–95. doi: [10.1353/jhr.2013.0022](https://doi.org/10.1353/jhr.2013.0022).
- Zeng, Kanming. 1999. *Dragon Gate: Competitive Examinations and Their Consequences*. Cassell.

- Zhou, Xiang. 2019. "Equalization or Selection? Reassessing the 'Meritocratic Power' of a College Degree in Intergenerational Income Mobility." *American Sociological Review* 84(3):459–85. doi: [10.1177/0003122419844992](https://doi.org/10.1177/0003122419844992).
- Zwick, Rebecca. 2017. *Who Gets in? Strategies for Fair and Effective College Admissions*. Harvard University Press.