Dissecting Educational Assortative Marriage in Japan:
The Role of Institutional Changes in Higher Education

July 25, 2019

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This research was conducted at the Center for Demography and Ecology at the University of Wisconsin-Madison which is supported by a center grant from the Eunice Kennedy Shriver National Institute of Child Health and Human Development (P2C HD047873). Please direct correspondence to Fumiya Uchikoshi at: Department of Sociology, University of Wisconsin-Madison, 1180 Observatory Dr., Madison, WI 537056. e: uchikoshi@wisc.edu, t: 608-648-8750, f: 608-262-8400.
Abstract

A robust literature on educational assortative marriage has suggested that educational expansion is one institutional mechanism that potentially explains trends in educational assortative marriage. This perspective, however, does not take into consideration that expansion in higher education could potentially be concomitant with increasing gaps between high- and low-tier institutions. In this study, I hypothesize that part of the changes in spouse pairing patterns is due to growing gaps between the quality of education in high- and low-tier institutions. Applying log-linear and log-multiplicative layer effects models to data from the Japanese Panel Survey of Consumers (JPSC) and Keio Household Panel Study (KHPS), I compared the trends of association between husbands’ and wives’ educational attainment by conventional categorization with that of detailed categorization of university graduates. An explicit categorization of university graduates is made by institutional selectivity (a social boundary between national/public and private universities and field of study). In terms of patterns, results revealed that, conditional on the composition of educational attainment and cohort, graduates from the most selective universities are more likely to experience educational homogamy than their counterparts from less prestigious institutions. As of trends, results that did not distinguish universities based on institutional selectivity suggest that educational assortative marriage has decreased continuously since 1950s. However, the evidence of declining trend was weak. Rather, results with detailed categorization of university graduates show that there has been a diverging trend between national/public university graduates and private university graduates. Therefore, results suggest that a decline in educational assortative marriage was observed in previous studies partly because they did not distinguish between university graduates by institutional selectivity. A potential implication and application of this study are discussed.

Keywords: Educational Assortative Marriage, Higher Education, Japan
1. Introduction

The question of who marries whom is one of great interest to demographers and stratification researchers. Research on assortative mating suggests there has been an increase in educational homogamy at the top of educational gradients (Schwartz and Mare 2005), which has potential impacts on economic inequality (Burtless 1999; Schwartz 2010) and intergenerational transmission of advantages (Breen and Andersen 2012; Breen and Salazar 2010; Esping-Andersen 2007; Torche 2010). A large literature in sociology and economics has examined patterns of assortative mating by education (Blossfeld 2009; Kalmijn 1998; Schwartz 2013), since education is one of the most crucial aspects for status attainment in many industrial nations, particularly at ages when marriage is most likely to occur. Among various possible hypotheses proposed, one theory has suggested that educational expansion is one institutional mechanism that potentially explains trends in educational assortative marriage (Blossfeld 2009; Mare 1991; Smits 2003; Smits and Park 2009). This theory, however, does not take into consideration that expansion in higher education could potentially be concomitant with institutional differentiation, i.e., the growth of institutional heterogeneity through an increase in lower-tier institutions (Arum et al. 2007). This is an important omission in the assortative mating literature given that there has been an accumulation of studies that examined effects of horizontal stratification (heterogeneity within the same years of education) on a range of outcomes such as earnings (Brewer et al. 1999; Ge et al. 2018; Li et al. 2012; but see Dale and Krueger 2002, 2011), women’s labor force participation (Hersch 2013; Ge et al. 2018), health (Fletcher and Frisvold 2014; Montez et al. 2018), and marriage (Ge et al. 2018).

The main aim of this paper is to propose a new look at the role of educational expansion and differentiation, focusing on growing heterogeneity of selectivity in higher education, and to apply this perspective to explore trends in educational assortative marriage using the Japanese case. A focus on perspective on the growing heterogeneity of higher education by selectively provides a potentially important contribution for understanding diverging trends in educational assortative marriage depending on institutional contexts. Studies
have suggested that the trend in educational homogamy in Japan has declined at a relatively constant rate since 1950s (Fujihara and Uchikoshi 2019; Fukuda, Yoda, and Mogi 2019; Miwa 2007) in contrast to the trend observed in the United States or other counties. A focus on institutional differentiation is relevant to explain the declining trend in educational assortative marriage in Japan, because increased post-secondary educational attainment in Japan has been promoted through a growth of private institutions which are thought to be located in a lower tier of hierarchy in terms of selectivity (Fujihara and Ishida 2016; Ishida 2007), which has resulted in growing heterogeneity of university graduates. If there has been a relative increase in private universities and a relative value for private universities has declined, graduates from these institutions are increasingly more likely to intermarry spouses without university degrees, while the strength of educational homogamy among prestigious university graduates remain or even increases. Thus, by comparing trends in homogamy among university graduates from conventional models with results from models that distinguish within university differences, I answer the following question: previous studies may have ignored a potentially important aspect of changes in spouse paring patterns by education – growing heterogeneity of higher education. Understanding the mechanism through which educational assortative marriage in Japan has potential implications to other contexts, where the educational expansion is also characterized by its stratifying processes in higher education through a growth of lower-tier institutions (Roksa et al. 2007).

In this study, I address two questions. First, I ask whether the strength of homogamy differs within university graduates from different types of universities, depending on their institutional prestige and selectivity? I hypothesize that educational homogamy will be stronger for the most selective group, and the other second or third tier groups follow. Second, I examine whether the decline in educational homogamy among those with high educational attainment is explained by a growth in the institutional heterogeneity of graduates and a growth of intermarriage with non-university graduates. In Japan, educational expansion occurs with institutional differentiation, especially through an increase in lower-tier private university
graduates. I hypothesize that these newly created private institutions have more in common with other, lower levels of education, than they do with the prestigious institutions, which may partially explain why graduates from the lower-tier universities have less educational homogamy than their prestigious counterparts.

This article is divided into six sections, with this introduction as the first section. In the second section, I review the theoretical background for this study, focusing the role of expansion in higher education. In the third section, I propose research questions and three possible hypotheses regarding the impact of higher education expansion on educational assortative marriage. The fourth section presents the method and data used. The results are discussed in the fifth section. In the final section, I present the discussion, limitations, future developments, and conclusion.

2. Theoretical background

Mixed findings of trends in educational assortative marriage

There are mixed empirical evidence on temporal changes in educational assortative marriage despite the theoretical efforts to explain the global trend in educational assortative marriage. Smits et al. (1998) proposed that the relationship between educational homogamy and level of economic development follows an inverted U-shape. This hypothesis was supported by using cross-sectional data across countries (Smits et al. 1998), but no study has found an inverted U-shape trend in a single society (Birkeland and Heldal 2003; Halpin and Chan 2003; Hou and Myles 2008; Miwa 2007; Raymo and Xie 2000; Schwartz and Mare 2005; Wong 2003).

In contrast, there has been an increase in educational homogamy in some countries in recent cohorts. Schwartz and Mare (2005) explain the rise in educational homogamy in the United States, focusing on the role of positive assortative mating (Oppenheimer 1988). This means that men’s and women’s preferences for partners have become more symmetric over time, because there has been an increase in access to both higher education and the labor market. This results in a positive association between education and earning potential among women. This
hypothesis has been supported in other countries where women’s access to education and labor market have both improved in the 20th century (Han 2010; Ravazzini et al. 2017; Wong 2003).

However, this hypothesis is not able to explain cases where women’s labor force participation is still not strongly linked to their educational attainment, such as Japan (Brinton and Lee 2001; Shambaugh et al. 2017). Moreover, the trend in educational homogamy in Japan has even declined constantly since 1950s (Fujihara and Uchikoshi 2019; Fukuda, Yoda, and Mogi 2019; Miwa 2007). Importantly, Japan is not the only country which has seen a decline in educational homogamy. Rather, other countries, such as France, Denmark or East Asian countries, share similar trends (Andrade and Thomsen 2018; Bouchet-Valat 2014; Smits and Park 2009).

Although there has been an accumulation of empirical knowledge about the trends in educational assortative marriage, and multiple hypotheses have been proposed to explain this (Song et al. 2017), some scholars have argued that the trends are so heterogeneous across countries that no theories could explain all of the variation in educational assortative marriage (Blossfeld 2009; Hout and DiPrete 2006). That being said, the results from previous studies suggest two possible patterns of changes in educational homogamy over time in different countries. One possibility is that multiple mechanisms have brought about diverging trends in educational homogamy differently depending on contexts. Another possibility is that one important mechanism is working but it has been ignored in previous studies. The latter point is particularly relevant to countries where educational homogamy has declined, because theories to explain the declining trend have been limited compared with studies theorizing an increase in assortative mating.

One well-known hypothesis argued that the time gap between school completion and marriage may lead to changes in educational assortative marriage (Mare 1991; Schwartz and Mare 2005). At any given average age at marriage, an increase in average educational attainment shortens the period for seeking a potential partner; therefore, individuals are more likely to meet their partners in school. In contrast, an increase in the average age at marriage extends the gap,
and this prolonged period for seeking potential partners gives individuals opportunities to meet their partners outside school.

Although some studies supported this hypothesis (Halpin and Chan 2003; Hou and Myles 2008), this hypothesis does not fit with countries where there has been a rapid educational expansion and an increase in average age at marriage simultaneously, such as Japan (Fujihara and Uchikoshi 2019) or other East and Southeast Asian countries (Smits and Park 2009). Moreover, this time gap hypothesis assumes that the prolonged period for seeking a partner affects all the educational groups homogeneously. However, this is not necessarily the case. As Andrade and Thomsen (2018) argued, trends in the odds of homogamy differ by fields of study within the same education level. This suggests that trends in homogamy differs within the same group defined by the same years of education. Rather, it is heterogeneous depending on other characteristics. Therefore, in this study, I propose that ignoring a growth of within group variation complicates our efforts to evaluate and understand any of the other posited mechanisms – that is, a new perspective on the declining trend, that focuses on a growing heterogeneity within university graduate by selectivity, is a fundamental issue rather than just another possible mechanism.

The role of expansion and differentiation in higher education institutions on educational assortative marriage

As Blossfeld and Timm (2003) summarized, past studies revealed that changes in educational assortative marriage depend on institutional contexts, which is also emphasized in recent work by Rauscher (2015). Among possible institutional mechanisms which may explain the mixed finding on trends in educational assortative marriage, particularly relevant are changes in educational attainment across cohorts. In fact, prior studies on this topic, either implicitly or explicitly, assumed that educational expansion, i.e. an increase in the number of people with higher education, may affect the trends in educational assortative marriage, although their focus
on changes in educational composition did not distinguish expansion from institutional differentiation.

Status attainment hypothesis, for instance, predicts that socio-economic development brings about a change from ascriptive to universalistic achievement criteria, which replace social origins with educational attainment as the main factor predicting one’s future socio-economic status (Blossfeld and Timm 2003; Kalmijn 1998; Treiman 1970). Individuals who attempt to achieve the highest possible socio-economic status tend to take educational level into account when selecting their partners (Smits et al. 1998). Thus, this hypothesis predicts that the level of educational homogamy will increase as modernization proceeds. Indeed, the hypothesis has been supported in multiple contexts. In the United States, education has been an important criteria for marriage (Kalmijn 1991b), while educational expansion is positively associated with educational homogamy in many European countries (Blossfeld and Timm 2003).

Schwartz and Mare (2005), on the other hand, emphasized the role of educational expansion by focusing on changing women’s labor force participation. According to them, men and women’s preferences for partners have become more symmetric than before as women with higher education increase their access to the labor market, which results in a positive association between education and earning potential (Oppenheimer 1988). Schwartz and Mare (2005) hypothesized that an increase in educational homogamy is driven by the greater symmetry between men and women because men increase their motivation to marry highly educated women. Although implicitly, these theories posit that educational expansion will lead to an increase in educational homogamy.

Structural theory (Blau et al. 1982: Blau and Schwartz 1984) assumes that educational expansion will increase educational homogamy more explicitly. This theory posits that group size plays a key role to explain inter/intra group relations. According to this theory, “as group size increases, the probable rate of outgroup relations decreases” (Blau and Schwartz 1984: 31) and a relative groups size per se determines a possible contact to meet spouses in the same of different social groups. Specifically, this predicts that a larger groups size enables individuals to
find a partner in their group, and thus couples are more likely to be homogamous if the group size is larger. In a context of educational assortative marriage, educational expansion in higher education, for instance, is expected to increase educational homogamy among college graduates, because the expansion increases contact to meet equally educated spouses at ages when marriage is most likely to occur (Blossfeld 2009; Mare 1991). This hypothesis was supported by Hu and Qian (2016), who examined the role of educational expansion on trends in educational assortative marriage in urban China. Their detailed analysis of marriages in 1980s revealed that educational expansion was associated with an increase in educational homogamy, through increasing availability of highly educated individuals.

In contrast to these studies which have supported the positive influence of educational expansion for educational homogamy, Smits (2003) and Smits and Park (2009) predict an opposite consequence of educational expansion. According to what they call exclusivity hypothesis, educational homogamy among college graduates is stronger when its group size is small. The theoretical expectation comes from a theory on status closure, that posits that elite small groups are aware of their advantages, which may increase their motivation to maintain the social boundary and exclude outgroups (Parkin 1971; Weber 2008). If the group size increases, however, the relative value of higher education reduces and barriers to mating with elite groups should decrease. Therefore, this hypothesis predicts that educational expansion promotes intermarriage between educational elites and others. The declining trends in educational assortative marriage in Japan (Fujihara and Uchikoshi 2019; Fukuda, Yoda, and Mogi 2019) fit with the theoretical expectation.

The abovementioned literature, however, largely have treated educational expansion as homogeneous. In other words, it assumes that increased access to higher education occurs uniformly. This assumption is not necessarily the case when expansion in higher education (more highly educated individuals) accompanies institutional differentiation (more variation within higher education) (Arum et al. 2007; Ayalon et al. 2008). Although previous studies on trends in educational assortative marriage have assumed that educational expansion may affect the trends
in educational assortative marriage (Blossfeld 2009), they were not able to distinguish between educational expansion and differentiation in higher education. This distinction is particularly relevant if the increase in people with higher education is promoted through an uneven differentiation, i.e., a growth of institutional heterogeneity based on the selectivity through an increase in lower-tier institutions, as previous studies on stratification in higher education argued that differentiation is often driven by an increase in lower-tier institutions (Arum et al. 2007: 5).

In a sense that these lower tier institutions often have been established as a compromise between popular demand for higher education from below and elite reluctant response (Brint and Karabel 1989), the exclusivity hypothesis fits more with a thesis on co-occurrence of expansion and differentiation by stratification scholars. Even this hypothesis, however, defines university graduates as elite group and treated them as homogeneous.

Although indirect, a study by Arum and his associates examined the role of college selectivity in marriage market, which argued that college graduates in the United States tend to marry spouses from institutions with similar characteristics (Arum et al. 2008). Also, college graduates of prestigious schools are also more likely to marry spouses with a college degree than graduates of low prestigious schools (Arum and Roska 2014). These results suggest that graduates from prestigious institutions are more likely to seek similar college graduates to maintain social boundaries, which resonates with exclusivity hypothesis. Related to this finding, Schwartz and Mare (2005: 640) argued that there has been a growth of intermarriage between people with “some college” (13-15 years of education) and high school graduates (12 years of education) in the United States. Moreover, using the 2003 National Survey of College Graduates, Hersch (2013: 483-484) pointed out that female graduates of elite institutions are more likely to marry male spouses whose jobs are requiring a BA or higher.

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1 Arum et al. (2007: 5) defines the distinction between lower versus higher tier postsecondary education by “prestige, resources, and selectivity of both faculty and students”. A notable example is American postsecondary education, which consists of a mix of research universities, second-tier universities, two-year community colleges, and for-profit colleges.
Arguably, the perspective on educational expansion and growing heterogeneity within higher education that may increase or decrease educational homogamy is not new in research in social stratification. In particular, “Effectively Maintained Inequality” (EMI) hypothesis is relevant to our question in this study. This hypothesis was proposed by Lucas (2001) as a theoretical response to the “Maximally Maintained Inequality” (MMI) hypothesis, which posits that educational inequality between two groups is persistent until the access to a given level of education among the advantaged group reaches a saturation through educational expansion (Raftery and Hout 1993). In contrast to the MMI hypothesis, EMI hypothesis posits that educational inequality is maintained even when a vertical inequality in educational attainment decreases through an improved access to higher education, because privileged groups seek qualitative advantages within a given level of education to maintain their positions. In the context of educational expansion in Japan, as discussed below, the importance of prestige within higher education has been constant or has increased relative to the increase in lower-tier private institutions. Therefore, I apply the EMI hypothesis to changes in educational assortative marriage, and posit that the strength of homogamy among prestigious university graduates remains (or increases), while private university graduates are increasingly more likely to intermarry with spouses without university degrees.

Japanese context

Educational expansion through differentiation is also applicable to the Japanese case, where expansion in higher education was mainly promoted through the contribution of the lower tier private universities (Fujihara and Ishida 2016; Ishida 2007). National/public universities are often perceived to be more prestigious, selective, and provide a better quality of education, while

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2 Attempts to link MMI or EMI hypothesis to studies on educational assortative mating is not new. Andrade and Thomsen (2018: 4-5), for instance, also mentioned an impact of differentiation of higher education on patterns of educational assortative marriage by citing Raftery and Hout (1993) and Lucas (2001), but their focus is more on horizontal differentiation, i.e., diversification of field of study, in higher education, while my main focus in this paper is on vertical aspect of differentiation (years of education or levels of education).
private universities, except for a few schools, are generally thought to be in a lower tier (Ishida 1998; Ono 2008). Also, compared with other countries, beliefs about the university hierarchy has been stable and publicly shared (Yonezawa et al. 2002).

Figure 1 shows trends in male and female entrance rates to four-year university and trends in proportion of students enrolled in private universities by sex. During the first stage of private university expansion, from the late 1950s to the late 1970s, the proportion of student enrollment at the university level in private universities continuously increased for both men and women, although men’s enrolment rate has increased more rapidly in this period than women’s one. According to Ishida (2007), the first stage of expansion was caused by demographic (an increase in the 18 years old population) and economic (the demand for a skillful human resource for the new technology) circumstances. Since newly founded institutions are mostly located around the lower ranks of the hierarchy (Ishida 2007), the expansion of higher education results in an increase in the heterogeneity of university graduates.

The second stage of expansion of higher education started after the Ministry of Education’s announcement in 1984 that its restrictions on establishing new institutions would be relaxed to meet the demand of a growing younger population (Ishida 2007). The expansion in this stage was also provided through newly-established private universities. Although the proportion of students enrolled in private institutions slightly decreased in between the two expansion periods, it has been stable since 1995. In this stage, not only male, but also female, students were more likely to enter universities than other institutions. As in the first stage of expansion, private universities, which were motivated to recruit more students in order to expand their budgets, played a major role in contributing to the expansion of higher education, and they are still located at lower prestige in the hierarchy in terms of selectivity (Ishida 2007). Thus, educational expansion in Japan has resulted in growing heterogeneity in higher education through an increase in lower-tier private institutions. Importantly, during this period, the growth of the proportion of private university students is larger for women than men. As a result, while less than 60% of male students are enrolled in private institutions (lower than that of male
students) during the first period of expansion, about 80% of female university students are enrolled in private institutions in recent years (a larger proportion than male students).

Moreover, another mechanism through which the growth of heterogeneity within universities operates is the upgrading of junior colleges to private universities. Junior colleges offer associate degrees, are mostly established by private institutions, and are frequently characterized by their concentration of female students. As shown in Figure 1, female representation in four-year universities had been limited until recently. Instead, a large amount of female students were enrolled in junior colleges, which accounts for almost 90% of students enrolled. Brinton (1989) suggests that this gender segregation in higher education occurred because obtaining higher education has been thought not to offer substantial benefits to women’s opportunities for occupational careers and transition to marriage (Brinton 1989). Another gendered aspect in these junior colleges is found in the subjects that women have majored in, which are mostly humanities, home economics, and education (Fujiwara-Fanselow 1995). While more than 500,000 students (mostly female) were enrolled in these junior colleges in the early 1990s, they started to suffer from a shortage of female applicants after that. This is largely because opportunities for occupational careers have been more opened to women after the Equal Employment Opportunity Law was enacted in 1985, which led to more female students aspiring to study at four-year universities.

As a result, some junior colleges attempted to recruit female students by specifically catering to female student’s emerging educational needs. These schools changed from providing associate degrees (i.e., junior colleges) to providing bachelor degrees (i.e., four-year universities). The number of junior colleges in Japan was 596 in 1995 (and the percentage of private institutions was 83.9%), but it decreased to 488 in 2005, 395 in 2010, and 337 in 2017 (Ministry of Education, Culture Sports, Science and Technology 2018). Instead, the number of
private four-year universities increased from 415 in 1995 to 553 in 2005, 597 in 2010, and 604 in 2017. Importantly, these upgraded institutions are located around the lower ranks of the hierarchy because that employ less selectivity to recruit more students. These institutional shifts suggest that the heterogeneity across universities in Japan, as a result of reduced selectivity at the 4-year university level, has grown through an increase in the prevalence of junior colleges that have been converted to private universities, especially for women. Additionally, these converted junior colleges mostly offered non-technical majors such as humanities or home economics (i.e. Non-STEM majors) - because of this gendered division, it is worth examining whether or not the strength of educational homogamy differs between Non-STEM and STEM students and whether these patterns have changed over time.

Figure 2 show the distributions of male and female educational attainment separately using the Japanese Panel Survey of Consumers (JPSC) and Keio Household Panel Study (KHPS). Although somewhat stalled during 1955 to 1975 birth cohorts for men, both men and women are more likely to enter four-year universities in recent cohorts relative to previous cohorts.3 Despite the general rise in access to education among women, gender differences persist in educational attainment for younger cohorts. In terms of university heterogeneity by selectivity, the proportion of national/public university graduates remains largely the same across cohorts, while the proportion of private institution graduates, especially in non-STEM fields, has increased. This is consistent with the fact that women’s access to higher education has been promoted through an increase in private institutions including upgraded school from junior colleges.

[Figure 2 is about here]

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3 Although not shown, these trends are comparable to married population as well.
Educational assortative mating in Japan is characterized as a persistent structure of gender asymmetric spouse pairing patterns (Fujihara and Uchikoshi 2019). In Japan, studies have argued that many women are willing to marry up (female hypergamy) while men desire to marry less educated women (Raymo and Iwasawa 2005). Related to the first point, education has been an important criteria in the marriage market, but preference for partner's education is also asymmetric between men and women. According to National Fertility Survey conducted by the National Institute of Population and Social Security Research (2016), more than half (55%) of single women aged from 18 to 50 in 2015 answered they take partner's education into consideration for prospective partners, while only 30.5% of single men answered they consider partner's education in seeking a partner. The gender asymmetric structure has been persistent (National Institute of Population and Social Security Research 2016).

Previous studies have also suggested that that educational homogamy has declined in Japan (Fujihara and Uchikoshi 2019; Fukuda, Yoda, and Mogi 2019; Miwa 2007; Raymo and Xie 2000). Despite their attempts to explain this declining trend, however, they have treated university degrees and their granting institutions as homogeneous. Therefore, little is known about the plausible impacts of the growing heterogeneity in higher education on the formation of educational assortative marriage. Importantly, however, a few studies suggest that a closer look at a growth of heterogeneity within higher education is needed to fully understand declining trends in educational assortative marriage in Japan (Fukuda, Yoda, and Mogi 2019; Fukuda, Raymo, and Yoda 2019). Based on their analysis on trends in educational assortative marriage in Japan between 1990 and 2013, Fukuda, Raymo and Yoda (2019) found that there has been an increase in hypogamy while an increase in homogamy among university educated women. Given that the expansion of higher education in Japan has been driven by an increase in lower-ranked universities (Fujihara and Ishida 2016), they interpreted this result as an evidence that “the social and economic boundaries between lower-ranked universities and technical colleges may be declining among younger cohorts” (Fukuda, Raymo and Yoda 2019: 29).
3. Research questions and hypothesis

A focus on institutional differentiation in higher education has an important implication for studies on trends in educational assortative marriage, because it provides several testable hypotheses to explain the declining trend of educational homogamy in high-income countries. First, relying on the exclusivity hypothesis, we can expect there is a qualitative difference in the strength of homogamy within university graduates, depending on the boundaries represented by the prestige and selectivity of their institutions. Specifically, I expect educational homogamy to be stronger for the most selective group, and for the strength of homogamy ties to weaken within lower tiered groups. Second, I expect that the decline in educational homogamy among highly educated is explained by a growth in heterogeneity of graduates from private institutions and a growth in intermarriage with non-university graduates. In Japan, the educational expansion occurs with institutional differentiation, especially through an increase in lower-tier private university graduates. These newly created institutions are more similar to lower levels of the educational system than to the highly prestigious national universities; less homogamy occurs among private institutional attendees because these graduates are more likely to marry with the less educated individuals.

Based on these theoretical expectations, I propose the following hypotheses. First, I expect strength of homogamy among university graduates to vary by levels of selectivity, net of compositional differences in husband’s and wife’s education and marriage cohorts.

\[ H1: \text{Conditional on the composition of educational attainments and cohorts, the odds ratio of homogamy is the strongest for national and public university graduates; this is followed by private university graduates (STEM) and private university graduates (non-STEM)} \] (Exclusivity hypothesis)

A rationale to classify university graduates into these groups follows. First, there is a social boundary between national/public universities and private universities, as I argued above.
Second, in addition to this boundary, I also posit that private universities with STEM fields are perceived separately from private universities with non-STEM major. Private universities with STEM major, such as engineering or medicine, are often more selective and expensive than non-STEM private institutions. In contrast, private universities that offer non-STEM majors, such as humanities, social sciences, or education, are less selective and their tuition is lower than the STEM institutions. Moreover, as I discussed, recent upgrades of junior colleges, where female students have been dominant and majored in subjects on humanities, to four-year universities, enables me to argue that a distinction between STEM and Non-STEM fields among private university graduates is reasonable.

It might be problematic to use STEM majors as a separate category, given that the proportion of STEM majors is thought to differ greatly between men and women. However, in contrast to intuition, women with STEM majors are not a quantitative minority in Japan, especially for private university graduates. Figure 3 shows the trends in the proportion of STEM and non-STEM students by gender. Although the proportion of female students with STEM majors from national/public university is small, i.e., less than 5% during 1970s, the proportion of private STEM accounts for about 10%. Importantly, the proportion increased dramatically among women during 2000s, from 12% to 21%. This indicates that women increasingly major in STEM fields, and this is especially the case for private sectors.

[Figure 3 is about here]

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4 Although studies that clearly show the divide between STEM and non-STEM institutions in private sector universities in Japan are limited, cross-national comparison in European countries argued that a growing access to higher education is associated with a decline in mean ability among non-STEM students (Reimer et al. 2008). Also, relative returns on education has increased among STEM majors (engineer and hard sciences) in Spain (Ortiz and Rodriguez-Menés 2016). Most importantly, studies suggest on horizontal stratification have argued that STEM majors receive higher occupational returns than other majors (Gerber and Cheung 2008), EMI hypothesis suggests that STEM majors are more advantaged than non-STEM majors, and thus STEM majors will be perceived as more prestigious.

5 Ideally it would be interesting to see results that separates STEM national/public university graduates from Non-STEM group, but a small sample size of national/public university graduates makes a comparison difficult.
Second, I test whether findings on trends in educational assortative marriage in Japan from previous studies are supported in this dataset as well. Previous studies did not take the heterogeneity of university graduates by their institutional selectivity into account. Thus, I expect the association of educational attainments between husbands and wives, which does not distinguish between university graduates based on their institutional selectivity, to decline over the cohorts.

H2: Conditional on composition of educational attainments and cohorts, the association of educational attainment between spouses decreases over cohorts. (Declining association hypothesis)

Last, I test whether distinguishing between university graduates based on their institutional selectivity explains a decline in the educational assortative marriage in Japan. In particular, I test whether the direction of changes in assortative mating differs by university prestige and selectivity.

H3: Conditional on composition of educational attainments and cohorts, the association of educational attainment between spouses decreases over cohorts among private university graduates but national/public university graduates. (Institutional differentiation hypothesis)

4. Data and method

Data

Previous literature on trends in educational assortative marriage ignored the role of institutional differentiation in higher education on educational homogamy. One reason for the absence of considerations of institutional differentiation arises from data limitations. Most surveys do not ask respondents about the institutional characteristics of their universities. Even when such
questions were asked, those surveys did not ask spouse’s college characteristics (Arum et al. 2008: 110, but see Andrade and Thomsen 2018 for an exception).

In order to fill in the research gap, this study used two related panel surveys: Japanese Panel Survey of Consumers (JPSC) and Keio Household Panel Study (KHPS). JPSC is the first nationally represented longitudinal survey in Japan that targets young and middle-aged women (aged 24 to 34) in 1993. It added additional cohorts, women aged 24-27 in 1997, 24-29 in 2003, 24-28 in 2008, and 24-28 in 2013, and is conducted annually. KHPS is conducted by Keio University, Japan and has similar questions as the JPSC. KHPS started in 2004 and the respondents are a nationally representative sample of 4,000 households. 1,400 households were added in 2007 and 2012.

Variables
I used six categories of the husband’s and wife’s educational attainment: 1 = junior high school (chugakko, Level 2 of the International Standardized Classification of Education [ISCED], United Nations Educational, Scientific and Cultural Organization [UNESCO] Institute for Statistics, 2012), 2 = high school (koutou gakkō, Level 3 of the ISCED), 3 = junior college, college of technology, and professional training college (tanki daigaku, koutou senmon gakko, and senmon gakko, Level 5 of the ISCED, hereafter junior college), 4 = private university with humanities and social sciences major (shiritsu daigaku bunkei, Level 6 of the ISCED, hereafter junior college), 5 = private university with STEM major (shiritsu daigaku rikei, Level 6 of the ISCED), and 6 = national or public university (kokkoritsu daigaku, Level 6 of the ISCED).

Given my focus on exclusivity and institutional differentiation, this study does not consider educational attainment beyond a university undergraduate degree. In my sample of university graduates, there are some respondents who also obtained their Master’s or PhD

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6 STEM/non-STEM distinction is created by the information about respondent’s and their spouse’s major in undergraduate education. Categories are Science, Engineering, Agriculture, Medicine or dentistry, Pharmacology, Humanities, Social science, Education, Home economics, and Other. I aggregated the first 5 majors into STEM majors and the other 5 majors into non-STEM majors.
degrees. Although important, I used their university degree in analysis. I took this approach because there are too few cases in these samples to make the distinction meaningful. I use information about year of marriage and educational attainment of married couples. Given that additional educational attainment after marriage is uncommon in Japan, I used respondent’s and spouse’s education at the time of first interview. If respondents married after the first interview, spouse’s education when they married was added to the dataset.

After omitting cases with missing educational information, 7,091 couples remained.⁷ There are several possible biases to examine the trends of assortative marriage from cross-sectional data, such as divorce, remarriage, mortality, and cohabitation (Birkeland and Heldal 2003; Schwartz and Mare 2012). For example, studies show that heterogamous couples are positively associated with marital dissolution both among married (Tzeng 1992) and cohabiting couples (Mäenpää and Jalovaara 2014).⁸ Use of cross-sectional data includes both younger and older cohorts; thus, homogamous couples could be more overestimated for the latter cohort (Kalmijn 1991a: 500).

Method

This study is interested in educational homogamy net of margins rather than its descriptive trends. This means that I control compositional changes in educational attainments between men and women. I then examine changes in odds ratio of homogamy conditional on composition of educational attainments. To capture these odds ratios and their changes, I apply log-linear and log-multiplicative models to three-way tables of the husband’s educational attainment $H(i =

⁷ 31 cases were omitted because their or spouse’s education are based on the old educational system before World War II. Also, 286 cases are omitted because either their or spouse’s education is missing.
⁸ According to the National Fertility Surveys, the cross-sectional proportion of non-married cohabiting couples has been marginal and stable. Among couples in which women are under age 50, the proportion of non-married cohabiting population was 0.9% in 1987 and 0.4% in 2015 (National Institute of Population and Social Security Research, 2016). Considering this trend, I expect that an increase in cohabitation would not lead to serious bias in this analysis.
First, I estimate six log-linear models to elucidate patterns of educational assortative marriage conditional on composition. To illustrate, the conditional independence model assumes independence of wives and husbands educational achievement.

\[ \ln F_{ijk} = \lambda + \lambda_i^H + \lambda_j^W + \lambda_k^C + \lambda_{ik}^{HC} + \lambda_{jk}^{WC} \] (Model 1: Independence)

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 \( k \). I set this model as a baseline, and specify this by adding other parameters. Each value for education and cohort corresponds to the categories I defined previously. For example, \( F_{123} \) indicates a frequency of couples in which husbands are junior high school graduates, wives are high school graduates, and they married in a year in 1996-2016.

Models 2 to 4 capture different patterns of educational homogamy. Model 4, for instance, represents the quasi-independence model of homogamy.

\[ \ln F_{ijk} = \lambda + \lambda_i^H + \lambda_j^W + \lambda_k^C + \lambda_{ik}^{HC} + \lambda_{jk}^{WC} + \delta_{ij}^{HW}, \text{where } \delta_{ij}^{HW} = 0 \text{ for } i \neq j \] (Model 4: Homogamy)

This model estimates a single homogamy effect that is consistent across levels of education. This model captures the strength of association in each cell on the main diagonal, in comparison to the off-diagonal cells. Although the main focus in this paper is a heterogeneity within higher education in terms of their likelihood of educational homogamy, analysis is performed to explain a constant decline in educational homogamy across all educational groups by focusing on a growth of heterogeneity within higher education. Thus, following the prior studies on educational homogamy, I distinguish between homogamy across all educational groups from other patterns of marriage (heterogamy).

Other than this model, this study also examines a model that treats marriage between university graduates equally regardless of their selectivity (Model 2) and a model that assumes distinct diagonal parameters among university graduates but treats off-diagonal cells among the
graduates equally (Model 3). Models 2, 3, and 4 used the design matrix shown in the Appendix Table 1.

While Models 2-4 examine homogamy within educational groups, Model 5 reflected the permeability of barriers to marriage across educational barriers between spouses. The equation is defined as follows:

\[
\ln F_{ijk} = \lambda + \lambda^H_i + \lambda^W_j + \lambda^C_k + \lambda^{HC}_{ik} + \lambda^{WC}_{ik} + \gamma^{HW}_{ij},
\]

where \( \gamma^{HW}_{ij} = \sum_{q=j}^{i-1} \gamma_q \) for \( i > j \), \( \gamma^{HW}_{ij} = \sum_{q=i}^{j-1} \gamma_q \) for \( i < j \), and \( \gamma^{HW}_{ij} = 0 \) for \( i = j \)

(Model 5: Crossing)

For example, the odds ratios for a husband with junior high school education to marry a wife with high school education is expressed as \( \gamma^{HW}_{12} = \gamma_1 \). This parameter is additive, and thus odds ratios for husbands with university education to cross barriers to marry wives with high school education is \( \gamma^{HW}_{52} = \gamma_2 + \gamma_3 + \gamma_4 \).

Model 6 allows for saturated association between wives and husbands educational achievement (\( \psi^{HW}_{ij} \)), but restricts the association to be the same across marriage cohorts. This model is used for an illustration purpose to see baseline differences in parameters of educational assortative marriage.

\[
\ln F_{ijk} = \lambda + \lambda^H_i + \lambda^W_j + \lambda^C_k + \lambda^{HC}_{ik} + \lambda^{WC}_{ik} + \psi^{HW}_{ij}
\]

(Model 6: Saturated)

Next, I examine whether a degree of educational assortative marriage varies by marriage cohorts. In order to investigate the trends in educational assortative marriage, I applied the model based on Schwartz and Mare (2005). Model 9 (changing homogamy), for instance, can be written as:

\[
\ln F_{ijk} = \lambda + \lambda^H_i + \lambda^W_j + \lambda^C_k + \lambda^{HC}_{ik} + \lambda^{WC}_{ik} + \lambda^{HW}_{ij} + \delta^{HW^C}_{ijk}, \text{ where } \delta^{HW^C}_{ijk} = 0 \text{ for } i \neq j.
\]

(Model 9: Changing homogamy)

I also applied the log-multiplicative layer effects models (Xie 1992), which allows us to estimate changes in the strength of the associations over time while assuming the overall
patterns constant. The log-multiplicative layer effects model for saturated association (Model 15), for instance, is expressed as follows:

\[
\ln F_{ijk} = \lambda_i + \lambda_j^H + \lambda_{ik}^C + \lambda_{jk}^{HC} + \lambda_{jk}^{WC} + \beta_k \psi_{ij}^{HW}
\]

(Model 15: Saturated)

where \( \psi_{ij}^{HW} \) indicates the saturated association between wives and husbands educational achievement and \( \beta_k \) is the log-multiplicative parameter. This model produces a parsimonious estimation of changes in the strength of the association (Powers and Xie 2008; Xie 1992). The \( \beta \) parameter is set to be 1, with the oldest cohort as a reference, and I evaluate the changes in the association by a percent change of this parameter from the reference cohort.

5. Results

Descriptive results: observed and expected rates of educational assortative marriage

Figure 4 presents changes in observed rates of educational homogamy, hypergamy (women marrying up), and hypogamy (women marrying down) on the left and expected under independence on the right. Expected rates are calculated under an assumption that the husband’s and wife’s education levels are independent from each other. For observed rates, more than 50% of marriages were homogamous in the pre-war cohort, and homogamy still accounts for more than 35% of the latest cohort. In contrast, both educational hypergamy and educational hypogamy have slightly increased from the oldest cohort to the latest cohort. Expected rates (right), on the other hand, show that trends are similar to those from observed rates. The rate of homogamy decreased, while the trend has increased for hypergamy and hypogamy. One interesting finding is that educational homogamy decreased even further than in observed rates. Intuitively, it is reasonable to assume that educational expansion leads to an increase in educational homogamy as distributions of men’s and women’s education become more similar. However, the figure shows this is not the case in Japan. Also, although the trends are the same

---

9 Expected rates are calculated under an assumption that the husband’s and wife’s education levels are independent from each other.
between observed and expected rates, results suggest that much of the observed trend are explained by changes in the compositions of men’s and women’s educational attainment.

[Figure 4 is about here]

Log-linear and log-multiplicative models

To investigate the relative association between wives and husbands educational achievement, the log-linear and log-multiplicative layer effects models were employed. Table 1 provides goodness of fit 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 ($BIC$).\(^{10}\) One the one hand, the $ID$ is the proportion of misclassified cases in a given model. Thus, the smaller $ID$, the better the model fit. $BIC$ adds a penalty for the number of parameters to $G^2$ in a given model, so the more negative $BIC$, the better model fit.\(^{11}\) One advantage to refer to $BIC$ is that the $BIC$ for fully saturated model should be 0 (Raftery 1995). Thus, we expect to see models with $BIC$ lower than 0 to be a much preferred one compared with models with positive $BIC$.

Model 1 (conditional independence ) shows that 23.10% of cases are misclassified in this model, which suggests a poorer fit as expected. By adding homogamy parameters, Model 2-4 improves the model fit compared with Model 1. Among these models, Model 3, that used the matrix 3 in the Appendix is the best fitted. This result suggests that the association of educational attainment between husbands and wives is heterogeneous by the levels of selectivity, and the off-diagonal associations among university graduates are distinguishable from other marriages.

\(^{10}\) $ID$ was defined as $\sum |F_{ijk} - f_{ijk}| / 2n$, where $f_{ijk}$ denotes the observed frequencies of the $(i,j,k)$ cell.

\(^{11}\) $BIC$ was defined as $G^2 - \log n \times df$.

Given the number of sample, the contingency tables could be sparse. In 6 by 6 table shown in Table 3, a cell that represents husband with junior high school and wife with private STEM university has no observation. Although it is possible to compare model fit statistics across models if the degrees of freedom are largely the similar (Fienberg 1980: 176), my estimates could be biased, especially for estimated parameters. Thus, I added constant of 1/108 to each cell count ($F_{ijk}$) in this model to make each row and column total increase by one as Hout (1988) attempted.
Model 5 added crossing parameters, which improved the fit relative to all the prior models both the \textit{BIC} and \textit{ID}. Notably, the \textit{BIC} is smaller than that of Model 6, which assumes that the full interaction of husbands and wives education without cohort change. In this sense, the crossing model is enough to capture patterns of assortative marriage parsimoniously.

For a descriptive purpose, Table 2 presents the parameters estimated by Model 3, Model 5, and Model 6 shown in Table 1. As of Model 3, parameters on the lower diagonal cells (PNS, PST, and NPU) tend to be larger (2.131, 2.431, 3.228) than those on the upper diagonal cells except for homogamy of junior high school graduates (2.227). Also, reading this parameter as strength of homogamy, homogamy is the strongest for national/public university graduates (NPU), then PST and PNS follow. Thus, the strength of homogamy among university graduates differs by their selectivity and supports the exclusivity hypothesis.

For Model 5, as expected, crossing each educational attainment status for marriage is less likely to occur. Interestingly, however, the crossing parameter is relatively lower for a barrier between private non-STEM university (PNS) and private STEM university (PST) than other barriers of crossing adjacent educational attainment. Since larger crossing parameters refer to a higher odds of intermarriage, this result suggests that the difficulty of crossing the education boundary is smaller between these private university graduates and they are more likely to intermarry with each other compared with other pairs of adjacent education groups.

For Model 6, as with Model 3, marriage tends to be homogamous and educational homogamy among university graduates is more likely to occur than among high school or junior college graduates. A somewhat unexpected result was that the strength of homogamy is stronger for private university graduates with STEM degree than national/public university graduates, although their coefficients are quite similar.

[Table 2 is about here]
Models 7-10 add parameters to estimate changes in each of educational assortative marriage types articulated in Model 6. Although their BIC is lower than 0 across the models, all the model fits were poorer than the Model 5 or 6, which suggests that there is no cohort change in assortative marriage. Although we need to interpret results cautiously due to the relatively worse fit, Figure 5 presents changes in each of the homogamy scenarios for Models 7, 8, and 9 and changes in crossing parameters of Model 10. These models assumed that the strength of educational homogamy differs by cohorts. First, compared with the reference cohort, results from Model 7 indicate that homogamy is increasingly less likely to occur over time, across educational attainment levels, except for junior high school graduates married between 1983 and 1995. This result is consistent with previous studies that argued that educational homogamy has consistently declined in Japan (Fujihara and Uchikoshi 2019; Fukuda, Yoda, and Mogi 2019; Miwa 2007; Raymo and Xie 2000). The results of Model 9, which distinguish between universities by selectivity, presents a different picture. Although trends in homogamy among junior high school, high school, and junior college graduates are comparable to that of Model 7, the trend is more divergent in university graduates. Specifically, while national/public university graduates are increasingly more likely to marry similarly educated spouses, private university graduates, both STEM and Non-STEM degrees, are less likely to marry homogenously in recent years. To see where the increase in educational homogamy among prestigious university graduates and decrease among private university graduates occur, panel (c) of Figure 5 presents selected changes in crossing parameters. Given that crossing coefficients are generally negative, positive coefficients in the cohort interaction means more intermarriage in recent cohorts, while negative coefficients are less intermarriage. Results show that the difficulty to cross educational attainment boundaries between private STEM and national and public university graduates has increased by 36.6%. In contrast, crossing boundaries between other adjunct educations has declined.

[Figure 5 is about here]
These results suggest that educational homogamy generally has declined, but distinguishing between university graduates by institutional selectivity provides a more nuanced picture of these trends. To see a trend in educational assortative marriage using more parsimonious models, I applied a log-multiplicative models (Models 11-15). Among these models, Model 14 and Model 15 fit the best by the BIC. BIC for these models are slightly worse than their hierarchical models, that is Model 5 or Model 6, but chi-square test of $G^2$ statistic between Model 5 and Model 14 shows that the null hypothesis that these models are the same is rejected at 1% level of statistical significance ($G^2=11.308, \text{df}=2$). Thus, I selected Model 14 as the best fitted model. The log-multiplicative parameters $\beta_k^C$ estimated by Model 14 presents that the difficulties to cross boundaries between the husband’s and wife’s educational attainment in terms of the log-odds ratios declined by 14.1% point over the three cohorts. In contrast, a chi-square test of $G^2$ statistic between Model 6 and Model 15 does not reject a null hypothesis at 5% level but 10% level ($G^2=5.4193, \text{df}=2$). Thus, as for the association in general, it is weakly supported that Model 13 is selected as the best fitted model.

This weak support for decline in educational assortative marriage in Japan is somewhat in opposition to previous studies (Fujihara and Uchikoshi 2019; Fukuda, Yoda, and Mogi 2019; Miwa 2007) that clearly argued that educational assortative marriage has continuously declined since 1950s. One methodological difference between this study and past studies is an explicit categorization of university graduates by institutional selectivity. In contrast to past studies that treated university graduates as a homogeneous groups, this study categorized university graduates into three groups from the outset. This means that we, by definition, controlled for changes in the composition of these university graduates ($\lambda_i^H, \lambda_j^W, \lambda_{ik}^{HC}$, and $\lambda_{jk}^{WC}$), while past studies on educational assortative marriage did not. Thus, the different results between them might be due to different levels of categorization (Wong 2003). Table 3 examines trends in educational assortative marriage using the same modeling but different definition of educational attainment, that is, to treat university graduates as homogeneous, in order to compare these results to previous studies. The results indicate that a log-multiplicative saturated model (Model
9) was selected as the best fitted.\textsuperscript{12} As the coefficients $\beta_9$ show, educational assortative marriage has declined by 22.9%. Combined with results from Table 2, we can conclude that a decline in educational assortative marriage was observed in previous studies partly because they did not distinguish between university graduates by institutional selectivity. If controlled as this study examined, models that assume stable trends in assortative mating (Model 5 and 6) could be selected. Also, the strength of educational homogamy is lower among private non-STEM graduates than national/public university graduates, and the former group has increased in its proportion in recent years. These private university graduates have declined their tendency to marry similarly-educated spouses while there has been a growth in homogamy among national/public university graduates. Given this evidence, the decline in educational homogamy among university graduates reported in previous studies was observed because there has been a relative increase in private university graduates and the strength of homogamy among these graduates has also declined as well over the cohorts.

\textit{Robustness check using different categorizations}

Wong (2003) argued that results of log-linear analysis differs by levels of aggregation. In the context of this study, I used three categories of cohorts, but lack enough observations in a few cells may cause bias. Therefore, I also used the 2-category version of marriage cohort. Results are shown in Appendix Table 2, which are similar to the main results that use 3-category of marriage cohorts. Specifically, both log-multiplicative models with crossing parameters and saturated association are selected as the best fitted ones.\textsuperscript{13} Although selected models are the same, magnitude of change in the association differs by levels of aggregation. Results from 2-category version indicate that the association declines by about 12.4\% over the cohorts.

\textsuperscript{12} The second best fitted model was Model 4 which assumes there is not cohort change, but statistical test using G2 statistics reject a null hypothesis at 1\% level (G2=24.7849, d.f.=2). Also, BIC for Model 9 is lower than that of Model 4.

\textsuperscript{13} Although BIC for Model 15 was not lower than that of Model 6, chi-square test shows that a null hypothesis was rejected at 1\% level of statistical significance (G2=6.3146, df=2).
6. Discussion

This paper investigated the patterns of educational assortative marriage in Japan over time, focusing the role of expansion and institutional differentiation in higher education. As expected, results demonstrated that the strength of educational homogamy differs by the levels of institutional selectivity (support for the exclusivity hypothesis (H1)). Also, in general, educational homogamy has decreased. The log-multiplicative layer effects model estimated that the association between the husband’s and wife’s education decreased by about 20% between the two cohorts defined by the respondent’s year of marriage, which supports the declining association hypothesis (H2).

However, the evidence of declining trend was weak. Rather, results from the contingency tables to which I applied the log-linear and log-multiplicative models also indicate that the trends in educational assortative marriage are constant across marriage cohorts. This weak support for declining trends, which is contrast to the past studies on assortative marriage in Japan, is related to this study’s original contribution, that is, a finer categorization of university graduates by school selectivity and prestige. In addition to the initial difference in strength of homogamy across these groups, there has been a diverging trend. Specifically, national/public university graduates have increased their tendency to marry similarly educated spouses, while the opposite is true for private university graduates. Rather, these graduates, especially private university graduates with STEM majors, have seen a decline in educational homogamy. Without accounting for the increasing differentiation within higher education, previous studies on trends in educational assortative marriage are not able to identify diverging trends in homogamy among university graduates, which in turn contribute to a general trends in quite different ways. These results support the institutional differentiation hypothesis (H3) that posits that a relative increase in private university graduates, accompanied by a growing heterogeneity in higher educational institutions, contributes to a decline in educational homogamy.
Although the results indicated that the expansion in higher education is associated with a decline in educational assortative marriage, because expansion causes not only a *compositional* shift in educational distribution but also institutional *differentiation*, a couple of limitations and future steps should be noted. Since this study used a cross-sectional information about spouse’s pairing patterns, a potential bias was not omitted. In particular, given that older cohorts are more likely to be martially homogeneous than younger cohorts using cross-sectional data, we may have overestimated the declining trend of educational assortative marriage. Also, a relatively small sample size makes the contingency table sparse, especially for marriage between university graduates and non-university graduates. Small sample size also makes it difficult to examine trends in assortative mating using a finer cohort categorization. For a consistent and reliable estimates, the results should be re-analyzed conducting a survey using a larger dataset.

Lastly, the findings in this study could also extend to comparative perspectives. The facilitation of higher educational expansion by an institutional differentiation has been also found in the United States where the expansion is characterized by its stratifying processes in higher education through an increase in lower-tier institutions (Roksa et al. 2007). A growth of institutional differentiation is not only limited to Japan (Ishida 2007) but also observed in East Asian countries in general for various mechanisms (Hannum et al. 2019), such as, China (Li et al. 2012), South Korea (Park 2007) or Taiwan (Lo 2014). Thus, future research should also examine whether a growth of institutional heterogeneity within higher education is associated with changes in educational assortative mating in these countries. Analyzing how spouse pairing patterns is influenced by educational expansion and differentiation would provide new insights into understanding of how higher education creates social stratification.

**Acknowledgements**

Japanese Panel Survey of Consumers and Keio Household Panel Study were provided by the Panel Data Research Center at Keio University. I thank Sho Fujihara, Kohei Toyonaga (the University of Tokyo), Ryota Mugiyma (Hitotsubashi University), Akira Igarashi (Rikkyo
University), Christine Schwartz, Jim Raymo, Eric Grodsky, Leafia Zi Ye, Kelsey Wright, and Mikki Ruo-Fan Liu (University of Wisconsin-Madison) for their helpful comments and suggestions.

References


Figure 1. Trends in university enrollment in Japan
Figure 2. Proportion of respondents’ educational attainment by sex and birth cohorts (excluding non-married)

Figure 3. Trends in STEM/Non-STEM students by gender and institution
Figure 4. Observed and expected distributions of homogamy, hypergamy, and hypogamy by marriage cohorts
Figure 5. Changes in the homogamy and crossing parameters by marriage cohorts, estimated by Model 7, Model 9, and Model 10

Note: JHS = junior high school, HS = high school, JC = junior college, college of technology, or professional training college, UNI = university, PNS = private university with Non-STEM, PST = private university with STEM, NPU = national/public university
Table 1 Goodness of fit for the models and log-multiplicative layer coefficients (6 categories / 3 cohorts)

<table>
<thead>
<tr>
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<td></td>
<td>G²</td>
<td>d.f.</td>
<td>ID</td>
<td>BIC</td>
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<td>1 [HC WC]</td>
<td>Conditional independence</td>
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<td>75</td>
<td>20.31%</td>
<td>1529.959</td>
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<td>2 [HC WC δ²HW]</td>
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<td>6 [HC WC ψ²HW]</td>
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<td>46.6171</td>
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<td>2.29%</td>
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<td>7 [HC WC HW δ²HWC]</td>
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<td>9 [HC WC HW δ²HWC]</td>
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<td>10 [HC WC HW γ²HWC]</td>
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<td>40</td>
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<td>15 [HC WC ψ²HWβC]</td>
<td>Saturated</td>
<td>41.1978</td>
<td>48</td>
<td>2.02%</td>
<td>-384.4048</td>
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Table 2 Parameters of association between husband’s and wife’s educational attainment, estimated by Model 3, Model 5, and Model 6

<table>
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<tr>
<th>Husband’s education</th>
<th>Wife’s education</th>
<th>(a) Homogamy (Model 3)</th>
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<td>HS</td>
<td>PTC</td>
<td>PNS</td>
<td>PST</td>
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<tr>
<td>JH</td>
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<td>2.227</td>
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<td>1.701</td>
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<td>PST</td>
<td></td>
<td>1.701</td>
<td>2.431</td>
<td>1.701</td>
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<tr>
<td>NPU</td>
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<td>1.701</td>
<td>1.701</td>
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(b) Crossing (Model 5)

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<td>-1.850</td>
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<td>-1.037</td>
<td>-1.689</td>
</tr>
<tr>
<td>PNS</td>
<td>-2.622</td>
<td>-1.415</td>
<td>-0.772</td>
<td>-0.265</td>
<td>-0.917</td>
</tr>
<tr>
<td>PST</td>
<td>-2.887</td>
<td>-1.680</td>
<td>-1.037</td>
<td>-0.265</td>
<td>-0.652</td>
</tr>
<tr>
<td>NPU</td>
<td>-3.539</td>
<td>-2.332</td>
<td>-1.689</td>
<td>-0.917</td>
<td>-0.652</td>
</tr>
</tbody>
</table>

(c) Saturated (Model 6)

<table>
<thead>
<tr>
<th>JH</th>
<th>HS</th>
<th>PTC</th>
<th>PNS</th>
<th>PST</th>
<th>NPU</th>
</tr>
</thead>
<tbody>
<tr>
<td>JH</td>
<td>3.900</td>
<td>1.271</td>
<td>0.402</td>
<td>-1.555</td>
<td>-1.628</td>
</tr>
<tr>
<td>HS</td>
<td>1.308</td>
<td>0.816</td>
<td>0.042</td>
<td>-0.392</td>
<td>-0.804</td>
</tr>
<tr>
<td>PTC</td>
<td>0.149</td>
<td>0.042</td>
<td>0.119</td>
<td>0.036</td>
<td>-0.099</td>
</tr>
<tr>
<td>PNS</td>
<td>-0.835</td>
<td>-0.870</td>
<td>-0.500</td>
<td>1.124</td>
<td>0.529</td>
</tr>
<tr>
<td>PST</td>
<td>-3.904</td>
<td>-0.300</td>
<td>0.449</td>
<td>0.606</td>
<td>1.753</td>
</tr>
</tbody>
</table>
Note: JH = junior high school, HS = high school, JC = junior college, college of technology, or professional training college, PNS = private university with non-STEM, PST = private university with STEM, and NPU = national and public universities. For Model 6, I used effect coding (ANOVA-type coding) ($\sum_{i=1}^{6} \Psi_{ij}^{HW} = \sum_{j=1}^{6} \Psi_{ij}^{HW} = 0$).

Table 3 Goodness of fit for the models and log-multiplicative layer coefficients (4 categories / 3 cohorts)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>G^2</td>
<td>d.f.</td>
<td>ID</td>
<td>BIC</td>
</tr>
<tr>
<td>Log-linear models</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 [HC WC]</td>
<td>Conditional independence</td>
<td>2006.1</td>
<td>27</td>
<td>20.12%</td>
<td>1766.7</td>
</tr>
<tr>
<td>2 [HC WC $\delta^{HW}$]</td>
<td>Homogamy</td>
<td>360.06</td>
<td>23</td>
<td>5.76%</td>
<td>156.13</td>
</tr>
<tr>
<td>3 [HC WC $\gamma^{HW}$]</td>
<td>Crossing</td>
<td>106.61</td>
<td>24</td>
<td>3.63%</td>
<td>-106.2</td>
</tr>
<tr>
<td>4 [HC WC $\psi^{HW}$]</td>
<td>Saturated</td>
<td>36.52</td>
<td>18</td>
<td>2.09%</td>
<td>-122.6</td>
</tr>
<tr>
<td>Models for changing homogamy and crossing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 [HC WC HW $\delta^{HWC}$]</td>
<td>Homogamy</td>
<td>7.0201</td>
<td>10</td>
<td>0.39%</td>
<td>-81.65</td>
</tr>
<tr>
<td>6 [HC WC HW $\gamma^{HWC}$]</td>
<td>Crossing</td>
<td>8.2524</td>
<td>12</td>
<td>0.60%</td>
<td>-98.15</td>
</tr>
<tr>
<td>Log-multiplicative layer effect models</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 [HC WC $\delta^{HWC}\beta^{c}$]</td>
<td>Homogamy</td>
<td>359.21</td>
<td>21</td>
<td>0.0569</td>
<td>173.01</td>
</tr>
<tr>
<td>8 [HC WC $\gamma^{HW}\beta^{c}$]</td>
<td>Crossing</td>
<td>95.72</td>
<td>22</td>
<td>3.43%</td>
<td>-99.35</td>
</tr>
<tr>
<td>9 [HC WC $\psi^{HW}\beta^{c}$]</td>
<td>Saturated</td>
<td>11.735</td>
<td>16</td>
<td>0.98%</td>
<td>-130.1</td>
</tr>
</tbody>
</table>
Appendix

Table 1 Design matrix

<table>
<thead>
<tr>
<th>Models</th>
<th>Goodness of fit of models</th>
<th>$\beta^C$</th>
</tr>
</thead>
</table>

Note Row and Column number corresponds to the following educational attainment. 1 = junior high school, 2 = high school, 3 = junior college, college of technology, or professional training college, 4 = private university with non-STEM, 5 = private university with STEM, and 6 = national and public universities.

Table 2 Goodness of fit for the models and log-multiplicative layer coefficients (6 categories / 2 cohorts)

<table>
<thead>
<tr>
<th>Models</th>
<th>Goodness of fit of models</th>
<th>$\beta^C$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 [HC WC]</td>
<td>Conditional independence</td>
<td>2335.841 50 21.10% 1892.54</td>
</tr>
<tr>
<td>2 [HC WC δ^{HW}]</td>
<td>Homogamy (matrix 1)</td>
<td>568.1034 46 7.86% 160.2666</td>
</tr>
<tr>
<td>3 [HC WC δ^{HW}]</td>
<td>Homogamy (matrix 2)</td>
<td>441.0574 43 6.49% 59.8186</td>
</tr>
<tr>
<td>4 [HC WC δ^{HW}]</td>
<td>Homogamy (matrix 3)</td>
<td>759.8447 44 8.56% 369.7399</td>
</tr>
<tr>
<td>5 [HC WC γ^{HW}]</td>
<td>Crossing</td>
<td>166.5101 45 4.90% -232.461</td>
</tr>
<tr>
<td></td>
<td>Model Description</td>
<td>Degrees of Freedom</td>
</tr>
<tr>
<td>---</td>
<td>----------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>6</td>
<td>[HC WC ψ^{HWC}] Saturated</td>
<td>20.1444</td>
</tr>
<tr>
<td>7</td>
<td>[HC WC HW δ^{HWC}] Homogamy (matrix 1)</td>
<td>8.8767</td>
</tr>
<tr>
<td>8</td>
<td>[HC WC HW δ^{HWC}] Homogamy (matrix 2)</td>
<td>7.9806</td>
</tr>
<tr>
<td>9</td>
<td>[HC WC HW δ^{HWC}] Homogamy (matrix 3)</td>
<td>8.8832</td>
</tr>
<tr>
<td>10</td>
<td>[HC WC HW γ^{HWC}] Crossing</td>
<td>9.4646</td>
</tr>
</tbody>
</table>

**Models for changing homogamy and crossing**

<table>
<thead>
<tr>
<th></th>
<th>Model Description</th>
<th>Degrees of Freedom</th>
<th>G² or χ²</th>
<th>df</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>[HC WC δ^{HWC}β^C] Homogamy (matrix 1)</td>
<td>566.631</td>
<td>45</td>
<td>7.95%</td>
<td>-167.6602</td>
</tr>
<tr>
<td>12</td>
<td>[HC WC δ^{HWC}β^C] Homogamy (matrix 2)</td>
<td>439.8807</td>
<td>42</td>
<td>6.60%</td>
<td>67.5079</td>
</tr>
<tr>
<td>13</td>
<td>[HC WC δ^{HWC}β^C] Homogamy (matrix 3)</td>
<td>759.8276</td>
<td>43</td>
<td>8.57%</td>
<td>378.5889</td>
</tr>
<tr>
<td>14</td>
<td>[HC WC γ^{HWC}β^C] Crossing</td>
<td>152.7159</td>
<td>44</td>
<td>4.70%</td>
<td>-237.389</td>
</tr>
<tr>
<td>15</td>
<td>[HC WC ψ^{HWC}β^C] Saturated</td>
<td>13.8298</td>
<td>24</td>
<td>1.29%</td>
<td>-198.955</td>
</tr>
</tbody>
</table>

**Log-multiplicative layer effect models**