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Only-child matching penalty in the marriage market*

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This study explores the marriage matching of only child individuals and the related outcomes. Specifically, we analyze two aspects. First, we investigate the marriage patterns of only children, examining whether people choose mates in a positive or a negative assortative manner regarding only child status. This analysis reveals that, along with being more likely to remain single, only children are also more likely to marry another only child. Second, we measure the premium/penalty by the size of the gap in the partner's socioeconomic status (SES, which is defined herein as years of education) between only child and non-only child individuals. Our estimations confirm that among women who marry an only child husband, only children are penalized in terms of 0.63 years less educational attainment for the partner. Finally, we discuss the potential sources of this penalty along with our set of empirical findings.

Keywords: marriage matching; only children; gender; machine learning
JEL classification codes: J11 J12 J16

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1 Introduction

We have seen a global increase in only child families in many developed countries. For example, in the American and Asian spheres, the percentage of one-child families among those with children has nearly doubled in recent decades.[1] According to Eurostat [2022], the percentage on one-child families in European countries in 2021 was almost half, i.e., 49%, while The Office for National Statistics [2020] reported a figure of 43.7% for one-child families in the UK in 2019. Such social trends are affected by many modern issues, such as economic concerns, older age of becoming a parent, infertility status, marital lives and careers with high pressure, the growing expense of raising children, and the simple desire to have only one child. China's one-child policy has also contributed to the number of only child families worldwide. There is, however, little understanding of only children individuals' marriage outcomes.

Whether one can marry and to whom is hardly a matter of concern only for only children; it also significantly impacts intergenerational relations. One of the major inducements for people to marry is benefitting from a larger family size, such as the provision of public goods, risk sharing and the advantages of economies of scale (Browning et al. [2014]). Many assume that they will either be single or the two of a couple in most cases; however, if we take a larger view of the family, whether one's marriage partner is an only child significantly impacts the size of each natal family. When an only child is young, the parents can devote many resources to this dependent child. However, when parents become old and dependent, they cannot benefit from their family size. Unlike those with siblings, only children face the task of caring for their parents alone, typically after their prime marrying age has passed.[2] While the labor market may work and resolve these intergenerational burden gaps among regions or nations, the marriage market may act on such gaps among families. How does the marriage market affect this disparity between only child and non-only child households?

We expand the existing literature on marriage matching by highlighting sibling structure—particularly only-child status—as a key dimension of partner evaluation. Existing economic studies have emphasized positive assortativity in education and SES and its implications for inequality within households (e.g., Mare, 1991; Pencavel, 1998; Fernández and Rogerson, 2001; Greenwood et al., 2014; Eika et al., 2019). Recent advances in multidimensional matching theory (Chiappori et al., 2012, 2018) provide a framework to evaluate match quality based on observable characteristics. However, these studies have largely overlooked the role of innate family structure.

[1] For instance, the percentage in the US increased from 11% in 1976 to 21% in 2016; that in Canada increased from 12% in 1981 to 26% in 2019; and that in Japan increased from 10% in 2002 to 18.6% in 2015. In Singapore, 19.0% of married women had one child in 2010, while 24% did so in 2020.

[2] Indeed, the literature has shown that strong family ties or customs might negatively impact the younger generation's economic activities, especially in industrialized and urbanized economies [Alesina and Giuliano, 2010]. In families with only children, where externalities cannot occur, children are less likely to leave their parents [Konrad et al., 2002a, Rainer and Siedler, 2009], resulting in fewer opportunities in the labor market [Rainer and Siedler, 2009].

We build on Chiappori et al. [2018]'s framework to examine marriage matching and partner quality through the lens of only-child status. This is particularly relevant in aging societies such as Japan, where caregiving responsibilities often fall disproportionately on individuals without siblings. In such contexts, sibling composition may function not only as a demographic trait but also as a signal of caregiving burdens and familial expectations. Sociological research has begun to explore this dimension, showing that only children face greater difficulty finding partners due to presumed caregiving responsibilities [Yu and Hertog, 2018, Uchikoshi et al., 2023]. Economic studies on this topic, however, remain scarce.[3]

The purpose of this paper is twofold. First, we assess the assortativity in marriage matching with respect to only-child status, by conducting an analysis comprising three components. We first compared observed marriage patterns to those predicted under a counterfactual scenario of random matching. Next, to examine the robustness of these patterns, we statistically evaluated the impact of only-child status on marital outcomes, specifically the likelihood of remaining single and the probability of marrying another only child. Finally, we analyzed marital surplus based on the framework of Choo and Siow [2006] to provide one possible structural interpretation of the observed patterns. As a second component of the study, we estimate only child marriage matching outcomes following Chiappori et al. [2018], where the matching premium/penalty is measured by the difference in the partner's attractiveness. In this analysis, educational attainment served as a proxy for socioeconomic status (SES), and we examined how one's only-child status affects the SES of the marriage partner.

In the first analysis, we identified positive assortative matching with respect to only-child status. However, some mixed couples—pairings between only and non-only children—were nonetheless observed in the data, indicating that the symmetric case proposed by Chiappori et al. [2018]—which predicts complete segregation by only-child status—does not hold in our setting. In addition, statistical analyses revealed that only children are more likely to remain single and more likely to marry another only child. These findings suggest that the marriage market may contribute to reinforcing pre-existing disparities in family size. Our analysis of marital surplus shows that the surplus decreases as the number of only children in the couple increases. This finding suggests that, although positive assortative matching by only-child status is observed, such patterns may not necessarily reflect a true preference among only children to marry one another.

Turning to the second analysis, we confirm the presence of a matching penalty associated with being an only child and find that its magnitude appears to be gender asymmetric and contingent on the partner's only-child status. Specifically, while no significant penalty is observed in the pooled sample, only-child women face a pronounced matching penalty in the

[3]There are only a handful of studies in economics that have directly examined the effect of sibling composition on marriage outcomes. Angrist et al. [2010] found that individuals with many younger siblings are more likely to marry earlier and have more children, though only children were not included in the sample. Vogl [2013] analyzed sibling-related marriage outcomes in Nepal, showing that younger sisters can accelerate marriage timing and reduce partner quality for older sisters. A more detailed discussion of earlier economic and sociological studies on sibling structure is provided in Appendix A.

form of a reduction in their partner's education level—approximately 0.63 years—when they marry a man who is also an only child. This magnitude is substantially larger than the gender gap in education within our sample, which stands at 0.34.

To deepen our analysis, we discuss potential sources of the observed matching penalty, based on our empirical findings and insights from prior literature. In addition, we also conduct two additional analyses. First, we explore heterogeneities based on respondents' birth year, age, and educational attainment, finding that although higher education mitigates assortativity, these characteristics do not alter the main findings regarding partner SES. Second, we examine alternative sibling structures by measuring the matching penalty for heirs defined under patrilineal and primogeniture systems. While heirs under the patrilineal definition consistently experience smaller penalties than only children, this pattern does not hold under the primogeniture definition. Together, these analyses offer further insight into the robustness and contextual variation of the matching patterns we document.

We make several contributions to the literature by investigating only children's marriage matching in Japan. On the one hand, this study explores the role of the marriage market by clarifying the nature of assortativity on sibling composition. If the burden of caring for parents differs between only children and non-only children, then the message that the degree of assortativity sends in the context of aging society is significant. For example, suppose that the marriage market is characterized by negative assortative mating (i.e., only and non-only children are more likely to marry each other). In this case, the burden of family caregiving is moving more toward equalization. In contrast, in the case of positive assortative mating, the marriage market is accelerating inequality in this respect. Therefore, our findings may be meaningful for ascertaining whether the marriage market is driving equalization in family size. Recent sociological studies have shown that sibling composition—such as being an only child or lacking male siblings—affects marriage patterns [Yu and Hertog, 2018, Uchikoshi et al., 2023]. This study contributes from an economic perspective by analyzing the market-level outcomes of one-child marriages, where sibling structure may also reflect underlying familial values and expectations.

In addition, this is the first study to measure marriage quality for only child individuals. As noted earlier, there are few studies on marriage match quality with respect to only child status or sibling status composition, which are innate characteristics. Yu et al. [2012] and Angrist et al. [2010] examined the effects of sibling compostion on marital status and age at first marriage as the marriage outcomes. Despite their insightful findings, these works failed to capture the perspective of the marriage market and matching with a partner. Thus, it remains difficult to discern whether such an individual chooses his or her marital status or is forced to stay single. Vogl [2013] examined women's arranged marriages in Nepal and the impact of certain siblings presence on marriage outcomes and partner quality. Our study complements the literature by shedding light on only child marriages in developed countries with low fertility and aging populations from the marriage market candidates' perspective. Furthermore, the only-child marriage patterns we uncovered reflect both sibling composition

and education level, constituting a successful new application of a two-dimensional partner evaluation model [e.g., Chiappori et al., 2012, 2018].

Exploring the marriage matching of only children in Japan represents more than an exercise of academic curiosity. Many developed countries are experiencing population aging, with declining birth rates being accompanied by an increasing number of only children. These phenomena have become social problems as the burden of caring for elderly individuals, with their longer life spans and extended caregiving periods, falls on their fewer children. Rainer and Siedler [2012] also suggested that the burden on the only child depends on the strength of social security and social expectations for informal family care. Obviously, Japan is one of the countries with the most severely aged population, and it has an established social security system. At the same time, however, the norm of filial obligation toward one's parents tends to be strong in Japan, partly due to the spread of Confucianism in Asia. Therefore, if we can highlight only children's relatively solid bond with their parents as a possible mechanism behind only child marriage matching outcomes, then Japan is an interesting arena to help bring the possible mechanisms of the interdependence of parent–child relationships and marriage to light. Moreover, only children in the Japanese marriage market are also an appealing research population from the perspective of external validity, as only children and children with siblings coexist in the same cohort, allowing cleaner observation of marriage market behavior.[4]

The rest of the paper is organized as follows. First, Section 2 explains Japan's relevant background. Then, Section 3 described in detail the data that we use. Section 4 elaborates on marriage patterns based on only child status, while Section 5 measures the marriage-matching outcomes based on the hypotheses. Section 6 discusses the interpretations for our empirical results. In Section 7, we further demonstrate supplementary analyses, and in Section 8, we conclude the paper.

2 Background

This section provides background on the distinctive character of the Japanese family and the only child.

2.1 Families in Japan

Confucianism has strongly affected the family system in Asian countries, where repaying parents is considered a virtue; the philosophical rationale for strong family ties is traced to Catholicism in Europe (Esping-Andersen [1997]), resulting in a relatively large reliance on families

[4] While China's one-child policy presents an intriguing natural experiment, its uniform application complicates the interpretation of assortative matching patterns within standard theoretical frameworks. Specifically, under the policy in China, incentives such as permitting a second child only when both spouses are only children may distort marriage choices [Lu, 2023]. See also Wen [2023] for sociological evidence.

than society. In Japan, the duty of filial piety remains relatively strong, and caring for elderly parents has traditionally been a family affair. According to a report by the Ministry of Health, Labour and Welfare [2020], in 2019, 28.2% of the primary caregivers for elderly people requiring long-term care (LTC) were coresident couples of the younger generation (the elderly people's children (+) children's partners).[5] This figure is more than double the 12.1% of the care provided formally (by paid caregivers), indicating that the burden of care on the younger generation is still not being shouldered by the market.

Until the end of WWII, the inheritance system in Japan was patrilineal, with the eldest son inheriting the entire estate as the family head. In 1947, the law was amended to allow family members other than the heir (typically the eldest son) to inherit equally. However, for families that have existed for a long time or farm families, there is still a culture of inheritance by and associated heavier obligations on the family head (i.e., eldest son).

Moreover, the burden of care tends to be on a specific child and their spouse, perhaps with the couple living with the specific child's parents. If the child living with his parents is the eldest son and heir, then the woman who will become his wife will make her marriage decision based on the assumption that she will take care of her parents-in-law.

However, it should be mentioned that the masculine norm is slowly fading and that the tendency to care for one's own parents has increased. Thus, the norm of giving priority to parents on the husband's side is fading, although it still exists within society.

2.2 Only children in Japan

A survey that has been conducted since 1940 shows that the percentage of only child families has gradually increased since the 1990s [Cabinet Office, 2021]. The ratio of only child families among those with children increased from 10% in 2002 to 18.6% in 2015. Other trends show that the percentage of mothers who have two children has remained unchanged at more than 50% for almost 40 years. The increase in the share of households with only children can also be attributed to the decrease in households with three or more siblings since the early 2000s.

Given Japan's male-dominated society, where strong family norms remain, and the burden is concentrated on the offspring, especially a specific child, a male or female only child is a unique characteristic in postmarital life (Yu and Hertog [2018]; Uchikoshi et al. [2023]).[6] When an only child reaches adulthood, he or she automatically becomes the parents' heir. If the only child is a male, then he automatically becomes the eldest son. If the only child is female, then there is no eldest son to serve as the typical successor and no other siblings to share the burden within the natal family. As a result, the natal families of only child women have to give up not only intergenerational relations but also their surnames and family lines at the time of their marriage, all of which have been preserved over generations. The trend toward masculine domination is weakening these days (as discussed earlier); however, only children

[5] Comprehensive survey of living conditions, 2019.
[6] Detailed arguments are also found in Yu and Hertog [2018] and Uchikoshi et al. [2023].

still bear the burden of caring for their own parents irrespective of gender, especially in the younger generations.

It should also be noted that an only child has the advantage that they can enjoy transfers from their parents throughout their lives. One prime example of postmarital income transfers is bequests from their parents.[7] Combined with the discussion of investment in education, which will be discussed later, only children seem not only to be at a disadvantage but also to benefit from intergenerational relations.

Finally, in considering the prevalent son preference in Asia, one might find it intriguing that the male-to-female ratio among only children is nearly equal. Typically, the natural sex ratio at birth ranges from 103 to 107 boys for every 100 girls. However, this ratio tends to approach 50:50 as the children grow older. In Japan, for the generation under scrutiny, the sex ratio at birth has consistently hovered around 105, with the highest recorded figure being 107.6 in 1966 (Ministry of Health, Labor and Welfare, 2010). This suggests that the son preference in Japan might not be as pronounced as it is in other Asian countries where the sex ratio at birth is more distorted. Furthermore, families that exhibit a strong son preference often place significant value on upholding traditional family structures. These families are more inclined to pursue having multiple children to ensure the continuation of family leadership or to adhere to the customary norm of having two children. Consequently, one-child families are more likely to reflect family planning based on the desired number of children rather than only on gender preference.

3 Data and summary statistics

3.1 The National Survey on Migration

The National Survey on Migration is a nationally representative survey that takes place in Japan. The data contain information on the sibling configuration, birthplace prefecture, year of birth, and marital status of each family member. The data are collected by the National Institute of Population and Social Security Research through a random sampling method.[8]

[7] According to The Yu-cho Foundation [2023], around 60% of respondents plan to divide their estates equally among their children, while about 10% would leave their entire estate to their only child—suggesting that only children may receive larger inheritances. The Dai-ichi Life Research Institute [2007], based on 715 samples, reports an average inheritance of 21.86 million yen, with 14.05 million yen for the eldest child and 13.03 million yen for younger siblings.

[8] The National Institute of Population and Social Security Research periodically assesses the accuracy of its valid individual data at both the regional block and population levels across 5-year age groups, with those aged 85 years and older comprising one group (The National Institute of Population and Social Security Research 1993, 1998, 2005, 2009, 2013). To validate these data, comparisons are made with the corresponding population estimates from the Ministry of Internal Affairs and Communications' Statistics Bureau. Such comparisons were conducted during the 3rd survey in 1991, the 5th survey in 2001, the 6th survey in 2006, and the 7th survey in 2011. However, the 4th survey in 1996 was compared with census data from 1995. It is important to note that the 7th survey in 2011 excluded the three Tohoku prefectures that were significantly

The surveyors distribute and collect the questionnaires for each household. This study uses the latest available waves from 1991, 1996, 2001, 2006, and 2011.[9] The collection rates for each wave are 89.4%, 95.8%, 85.5%, 74.0%, and 74.7%, respectively. In this study, we use the following information for the analyses.

Only child dummy: The survey asks for the number of surviving older brothers, older sisters, younger brothers, and younger sisters. Those for which none of these are present are assigned a value of 1 for the only child dummy. All others are assigned a value of 0.

Age at the time of the survey: To account for changing trends over five-year intervals, we control for the age of respondents at the time of the survey, along with the information on the year of birth.

Years of schooling: The number of years of schooling for the individual is calculated from the highest school graduated category.

Birth year: The person's year of birth is used.

Regional block: The survey asks for the prefecture where the respondent was born. In the analyses, 47 prefectures are classified into ten blocks and used to account for regional characteristics.[10]

3.2 Sample selection for analysis

Before delving into the data details, it is important to highlight key points regarding the samples used in this study. As will be explained later, this research explores marriage patterns of only children along with surplus analysis following the Choo and Siow [2006]'s framework. Then, we examines spousal socioeconomic status (SES) matching based on the approach of Chiappori et al. [2018].

affected by the Great East Japan Earthquake. As a result, comparisons were not made with these affected prefectures. Across these five surveys, the largest discrepancy at the regional level was observed in the Tokyo area, which showed a difference of -3.3 points out of the 10 blocks surveyed in the seventh survey that was conducted in 2011. Additionally, the largest difference in age distribution was -1.0 points, which was found for the 20-24 age group in the fourth survey conducted in 1996.

[9] The sample size for the 1991 wave is relatively small. This is mainly due to missing values for the place of origin. In addition, the 1991 wave uses slightly different questionnaires, although it does contain our necessary variables, whereas the other waves have been changed to be more uniform.

[10] Specifically, Hokkaido for the "Hokkaido" block; Aomori, Iwate, Miyagi, Akita, Yamagata, and Fukushima for the "Tohoku" block; Saitama, Chiba, Tokyo and Kanagawa for the "Minamikanto" block; Ibaraki, Tochigi, Gunma, Yamanashi, and Nagano for the "Kitakanto and Koshin" block; Niigata, Toyama, Ishikawa, and Fukui for the "Hokuriku" block; Gifu, Shizuoka Aichi, and Mie for the "Tokai" block; Shiga, Kyoto, Osaka, Hyogo, Nara, Osaka and Wakayama for the "Kinki" block; Tottori, Shimane, Okayama, Hiroshima and Yamaguchi for the "Chugoku" block; Tokushima, Kagawa, Ehime, and Kochi for the "Shikoku" block; Fukuoka, Saga, Nagasaki, Kumamoto, Oita, Miyazaki, Kagoshima, and Okinawa for the "Kyushu and Okinawa" block.

For the analyses of marriage patterns, the information and the number of both single and married individuals are utilized. Ideally, the entire sample would be used for this analysis. However, due to data limitations discussed later, certain samples are excluded. Specifically, in the analyses of marriage patterns, while all single individuals from the survey are included, the sample of married individuals is restricted to household heads and their spouses. In other words, married individuals who are not household heads or their spouses are excluded from the analysis.

The issue with the dataset is that while information on household members is available, detailed information about their spouses is not consistently provided. This information, such as sibling composition, is only available for household heads and their spouses. Therefore, cases that do not involve household heads or their spouses must be excluded. [11]

Next, for the analysis of spousal matching characteristics following Chiappori et al. [2018], we use data from household heads and their spouses, for whom all relevant information is available. Consequently, singles and married individuals who are not household heads or their spouses are excluded from this analysis (the former exclusion is due to the definition of the analysis).

Formally, the sample is restricted to individuals aged between 23 and 65 in the survey year, for whom complete educational background information is available. The upper age limit is set due to the definition of the sibling structure variable. In the questionnaire, siblings are limited to those who are still alive; thus, this restriction helps exclude older respondents who may have lost a sibling after marriage. Furthermore, the sample is limited to individuals for whom information on sibling composition, year of birth, and home prefecture is available.

Given these overarching restrictions, the sample of unmarried individuals is restricted to those who have never been married. The sample of married couples is restricted to those for whom information on both spouses is available; specifically, it includes couples where the respondent is either the household head or the spouse of the household head, and who are currently married. Individuals who are divorced, widowed, or separated are excluded. In addition, the sample is limited to couples in which both the respondent and their spouse reside in the same household. To ensure this, the sample is further restricted to households with at least two members. As a result of these sample restrictions, the number of observations decreased from 66,468 to 55,752.

3.3 Summary statistics

Table 1 is around here

[11] The number of excluded cases is 4,144, which accounts for less than 10 percent of the total and is therefore considered a relatively modest proportion. Moreover, since there was no clear difference in the probability of not being a household head or their spouse between only children and non-only children, the main analysis is conducted using information from household heads and their spouses.

Table 1 presents the descriptive statistics for each respondent's gender and only-child status. For continuous variables, the figures indicate the median within each subsample, while percentages or the 25th and 75th percentiles within the subsample are provided in parentheses. For categorical variables, the figures represent the number of samples and the percentage within each group. The following key points can be observed from this data.

First, the sample size of only children is necessarily small. Note that, as discussed in Section 2, there is no gender difference in this value with the percentage of only children being about 7% for men (=2,032/(26,945+2,032)) and about 7% for women (=1,921/(24,854+1,921)). Second, the marital status of only children is more likely to be single than that of non-only children at the descriptive level. Third, the average birth year of only children is later than that of non-only children. This may reflect the increasing prevalence of only-child families over time.

Finally, regarding the key variable of interest—educational background—there is a noticeable difference based on only-child status. Specifically, only children tend to have slightly higher levels of education.[12] When examining years of education by gender, men generally have a higher level of education. More specifically, there is a large proportion of men in the 12-year high school graduate category as well as in the highest 16-year category. Conversely, women are more concentrated in the high school diploma group and the second-highest educational level (14 years of schooling). This suggests that the polarization of educational attainment is more pronounced among men.

4 Marriage patterns for only-child status

This section aims to explore marriage patterns based on three analyses. The first analysis descriptively examines whether the observed marriage patterns related to only-child status exhibit positive or negative assortative matching by comparing them with those generated through random matching. The second analysis formally tests the findings of the first analysis while also investigating the impact on the probability of remaining unmarried. Finally, we conduct supplementary analyses to gain a structural understanding of marriage patterns. Two key discussions emerge from these analyses.

The first key point is to understand the role of the marriage market by examining marriage patterns related to only-child status. Marriage patterns can exhibit either positive or negative assortative mating [Becker, 1991], and different tendencies may be expected when viewed through the lens of only-child status.

[12] Some may argue that using one's own education as a control variable can pose challenges to making accurate causal inferences as it is a post-treatment variable. However, the objective of this study is not to measure causal effects but rather to shed light on how the presence or absence of siblings influences family formation among adults. Therefore, this study incorporates one's own education as a control variable, following the analytical framework of Chiappori et al. [2018]. Furthermore, even if education is not controlled for, it does not significantly alter the main findings based on our specification (see Appendix C.)

The former occurs when individuals select partners who share characteristics. If caregiving responsibilities and economic incentives influence marriage decisions, non-only children, who generally face fewer caregiving burdens, may exit the marriage market first, while only children may be more likely to marry other only children.[13] The latter, by contrast, arises individuals avoid marrying those similar to them. A possible cause of this pattern could be the benefit of trade between providing domestic public goods. For example, an only child with high caregiving responsibilities may avoid marrying another only child, instead preferring a non-only child with lower caregiving burdens.

Additionally, financial resources and dynastic incentives may promote marriages between only and non-only children. Preferences in marriage may be also influenced not only by economic incentives but also by family norms and the intergenerational transmission of values. Recent studies have raised a theoretical question regarding individuals from families with strong norms of filial piety: whether they tend to choose partners who share similar values, or instead prioritize their own family by selecting partners with weaker norms [Cigno et al., 2017, 2021].[14] Such intergenerational normative factors may help explain the observed assortativity based on sibling structure — not because sibling composition is a familial value in itself, but because it can shape expectations about family roles, particularly caregiving responsibilities.

If the analyses reveal that positive assortative mating holds—meaning that when only children marry, they tend to marry other only children rather than non-only children—then, combined with the descriptive statistics showing that only children are more likely to remain unmarried, this suggests that the marriage market functions in a way that exacerbates disparities in the caregiving burden among the working-age population.

The second key point concerns the examination of marriage patterns related to only-child status, as proposed by Chiappori et al. [2018]. According to their framework, if men and women share the same preference regarding only-child status and the number of only children is equal across genders, a symmetric equilibrium should emerge. In this equilibrium, all only children marry other only children, while non-only children marry other non-only children. Since the data indicate that the proportion of only children is the same for both men and women, a symmetric equilibrium is theoretically possible. Through the analysis in this section, we assess the extent to which reality deviates from this theoretical prediction.

[13] If inheritance benefits outweigh caregiving burdens, only children may exit the market first, followed by non-only children. Shared family size preferences may also drive similar sibling structures in marriage.

[14] Recent studies have raised theoretical questions about whom individuals from families with strong norms of filial obligation tend to marry. Unlike other transmitted value factors such as ethnicity, religion, attitudes toward working women, or economic preferences (Bisin and Verdier [2000]; Bisin et al. [2004]; Fernández et al. [2004];Wu and Zhang [2021]), the transmission of strong family norms regarding filial piety can potentially create conflicts within families. According to Cigno et al. [2017] and Cigno et al. [2021], individuals from families with strong filial piety norms may choose to marry partners who also uphold these norms in order to preserve them. On the other hand, it is also possible for them to prioritize their own family by marrying partners with weaker norms. If we consider only children as the group with the strongest parental care norms, assessing assortativity can help us provide some insights into this question. Although we do not directly uncover the underlying mechanism behind these results, our findings on partner choices can offer a certain level of understanding through observable outcomes in the younger generations' adult pairings.

4.1 Comparison with Random Matching

To capture the overall trend in marriage patterns among only children, we first compare the observed marriage patterns based on only-child status with those generated through random matching. For the purpose, we construct a counterfactual sample of randomly matched couples, following the permutation procedure employed by Chiappori et al. [2018]. We assign pseudo-random IDs drawn from a uniform distribution to men and women, rank them accordingly, and match them based on these ranks.

Table 2 presents both the observed and randomly generated patterns. The comparison shows that only children are more likely to marry other only children. Although the percentage difference in marriages between only children may seem small at first glance, it becomes striking when viewed from the perspective of an only child. For example, in the random matching scenario, the share of marriages between only children is 7.3% for men (96/1319) and 7.7% for women (96/1242), whereas in the observed data, it rises to 14.5% for men (191/1319) and 15.4% for women (191/1242).

Despite this positive assortative pattern, mixed marriages between only children and non-only children also occur, indicating that a perfectly symmetric equilibrium, which is proposed by Chiappori et al. [2018], does not hold. Together with the findings in Table 1 of Section 3.3, the data also suggest that a certain proportion of only children remain unmarried, and that they are more likely to do so compared to non-only children.

4.2 Formal alalysis of the marriage patterns

This subsection statistically verifies the two previously observed trends in the marriage patterns of only children. For the purpose, we examine the likelihood of each marriage pattern. Specifically, the estimand is the average values of the following:

$$E[Partner's\ type \mid OnlyChild, X] - E[Partner's\ type \mid NotOnlyChild, X] \tag{1}$$

This equation shows the likelihood that an only child marries a person of type p, where $p \in \{Only\,Child, Not\,Only\,Child, Single\}$.

Then, we present estimates of how marital status differs between only children and non-only children, controlling for gender, year of birth, age, and birthplace, as shown in Eq.(1). In the analysis, we use the augmented inverse probability weighting [Robins and Rotnitzky, 1995, Chernozhukov et al., 2018]. It is known that when OLS estimates a simple linear model, errors in the formulation can lead to large biases. To avoid such bias, double-debiased machine learning (Chernozhukov et al. [2018]) has recently been proposed; thus, we use this method in the paper.

For this purpose, the difference is estimated through double debiased machine learning. In the first stage, the nuisance function is estimated. Specifically, the predictive model of both the

dependent variable and the explanatory variable is estimated. In this stage, machine learning reduces the bias due to incorrect formulation. Specifically, it implements the stacking algorithm (including OLS, random forest, and Bayesian additive regression trees) to estimate conditional means without parametric assumptions. In the second step, we perform an augmented inverse propensity score weight (AIPW) estimation [Robins and Rotnitzky, 1995], substituting these nuisance functions. This method's advantage is that it reduces the risk of misspecification, by utilizing machine learning while improving its convergence. Thus, the asymptotic normality is satisfied, and the approximate computation of confidence intervals is possible.

The estimator requires to estimate the conditional means of Y and $OnlyChild$,

$$E[Y|OnlyChild, X] \; and \; E[OnlyChild|X],$$

where

$$Y = \{Marrige\,with\,OnlyChild, Marrige\,with\,NotOnlyChild, Single\}$$

and $OnlyChild = 1$ if an individual is an only child. X is the control variables including years of one's own schooling, birth year, age, and region of birth. Note that we use robust standard error clustering at the household-level. We estimate this equation for each male and female sample. Technically, it estimates the difference between the average share of people in marital status (married to a p-type partner) or remained single) in the only child population and that in the non-only child population. The coefficient thus shows how one's only child status affects the likelihood associated with each marriage state. The values indicate the gap in the proportion of marriage states in the measure of percentage points.

Figure 1 is around here

Figure 1 presents the estimated coefficients for $OnlyChild$ conditional on the type of marriage partner (as well as single status), which are then sorted by gender. The left panels show the results for single, and the right panels show the results for the marriage with only children. Note that we only indicate the results of two status as the effects of rest group of those marrying non-only children are automatically calculated with these two results.

We can learn four things by comparing the coefficients across the panels. First, looking at the panel as a whole, we can observe similar trends in each panel regardless of gender. Second, when we look at panel of singles, only children are more likely to remain single than non-only children, and this trend is stronger among men than women. The coefficients for only children are higher at 0.07 for men and 0.05 for women. This gender difference may stem from cultural differences in the roles of husband and wife in two families united by marriage, as pointed out by Yu and Hertog [2018]. In Japan, women are used to joining their groom's family upon marriage, and the effect of this assumption is more significant in the case of an only child. If a man's family is given priority even if he marries an only child woman, then the man may not mind if his partner is an only child. However, if a woman is married to an only child man, then she is likely to join the husband's family and concede to its various related obligations. In such a social context, women may avoid marrying only child men. As a result, only child men may be more likely to remain single. Third, only children are more likely to

marry only children partners. The related values are 0.05 for men and 0.06 for women. Finally, inextricably associated with the results above, the only child status reduces the likelihood of marrying a non-only child partner by 0.12 for men and 0.11 for women.

This results suggested two important points. First is that people choose mates in a positive assortative manner regarding only child status.[15] Second, only children are less likely to get married. These two results indicate that family size tends to increase with marriage for non-only children, and a an only child may tend to either marry another only child or remain single. Consequently, the disparities in family size are heightened by dynamics within the marriage market.

4.3 Systematic Returns to Marriage

In this subsection, we supplementarily conduct an analysis to estimate marriage returns, offering a structural perspective on the trends observed in the previous subsections. We first estimate the household-level marriage gain. According to Choo and Siow [2006], the total systematic gain to marriage for a type i male and a type j female can be identified by estimating the logarithm of the following variable:

$$\Pi_{i*j} = \frac{\mu_{ij}}{\sqrt{\mu_{i0} \times \mu_{0j}}} \tag{2}$$

where μ_{ij} represents the number of marriages between type i males and type j females, while μ_{i0} and μ_{0j} denote the number of single males and females of each respective type. The larger this value, the greater the relative return to marriage for type i and type j compared to remaining single. As noted in Choo and Siow [2006], the calculation normalizes by the number of singles, eliminating scale effects.

Additionally, individual-level systematic return can also be computed. The return from marriage for a type i male to a type j female is given by:

$$n_{ij} = \ln\left(\frac{\mu_{ij}}{\mu_{i0}}\right) \tag{3}$$

Similarly, the systematic return from marriage for a type j female to a type i male is:

$$N_{ij} = \ln\left(\frac{\mu_{ij}}{\mu_{0j}}\right) \tag{4}$$

which can be identified through this estimation.

[15] Although we here limit ourselves to likelihood comparisons to intuitively understand the state of the marriage market, we conduct a formal analysis to measure assortativity on only child status in Appendix B, following Chiappori et al. [2021]. Using multiple other indices, we further confirm positive assortative mating on only child status.

Table 3 shows the estimated household-level and individual-level returns to marriage by type ij, specifically focusing on the combinations of the spouses' only-child statuses. Table 3 categorizes marriage patterns by only-child status, naming combinations in the order of male and female. For instance, a marriage between a non-only child male and an only child female is labeled as "Non-Only Child – Only Child Marriage." Each row corresponds to a specific marriage pattern, and the three columns report: the total return to marriage in Eq.(2); the male's individual return in Eq.(3); and the female's individual return in Eq.(4)).

Looking at the total return, the highest return is observed for marriages between non-only children, followed by mixed marriages where the female is an only child, then mixed marriages where the male is an only child. The lowest return is seen in marriages between two only children. This suggests that marriages involving only children tend to have lower returns. Furthermore, a comparison between mixed marriages in which the husband is an only child and those in which the wife is an only child reveals that the surplus size is generally similar. This indicates that the presence of an only child has little gender-based impact on the total household surplus. At the individual level, two main findings emerge: On one hand, in homogeneous marriages concerning only-child status, females generally have higher returns. On the other hand, in mixed marriages, only children tend to obtain higher marriage returns. We can also see that the surplus decline from marrying an only child (rather than a non-only child) is larger for non-only-child men than for non-only-child women.

5 Only-child matching premium/penalty in the marriage market

In this section, we examine whether an individual's being an only child is related to the characteristics of his or her marriage partner. Ideally, we would like to measure the only child matching premium/penalty defined on a utility basis. However, this is impossible because it is unobservable. Thus, we alternatively use the partner's socioeconomic status (years of education) as its approximation. Human capital is likely a monotonic form of attractiveness, and it is practical to link with the arguments on inequality among households [Mare, 1991, Pencavel, 1998, Fernández and Rogerson, 2001, Breen and Salazar, 2011, Greenwood et al., 2014, 2016, Eika et al., 2019]. Here, we apply Chiappori et al. [2018] to estimate the matching premium/penalty regarding partner SES.

5.1 Estimand

This subsection presents the estimands that estimated in the following sections. The estimand in this analysis is the average values of the following:

$$E[Partner's\ SES \mid OnlyChild, X] - E[Partner's\ SES \mid NotOnlyChild, X]. \tag{5}$$

Eqs.(5) shows that only children's partners are likely to be more or less educated than non-only children's partners. Note that if we assume $E[Partner'sSES|OnlyChild, X] = \beta_0 + \beta_1 OnlyChild + \beta X$, we can use exactly the same approach as in Chiappori et al. [2018]. However, the following section proposes a more flexible estimation strategy as opposed to such a linear specification.

In the following analyses, we use SES (years of schooling) as a proxy of a partner's attractiveness other than their only-child status. As in Chiappori et al. [2018], we assume that, holding other conditions constant, individuals want a marriage partner with a higher SES. Thus, when Eq.(5) takes negative values, the SES of the married partner is lower for the only child, suggesting the existence of an only child penalty and vice versa.

5.2 Estimation method

We regress the partner's years of schooling on the only child status and other control variables, as described in the previous subsection for Eq.(5) and its estimand. In this analysis, Y is instead the partner's SES (years of education), which captures attractiveness other than only child status. Sharing with previous analysis, *OnlyChild*, our variable of interest, is a dummy variable that takes the value of one for an only child. X includes own years of schooling, birth year, age, and region of birth. Again, we control for the individual's years of schooling to focus on the disparity in adulthood and to consider positive assortativity on education for couples. Note that the same machine learning procedure is followed as in the previous analysis in Section 4.2.

5.3 Results: Partner's years of schooling (Pooled sample analysis)

Figure 2 is around here

Figure 2 shows the results for the coefficients of *OnlyChild* using the total sample by gender. The panel demonstrates the coefficient of only-child status on the spouse's education. Figure 2 does not show a significant only-child matching premium or penalty in the pooled sample for both men and women.

5.4 Results: Partner's years of schooling (Subsample analysis by partner's status)

As we have seen, the difference is small and unclear in the results of the pooled data. However, considering the possibility of a difference in the benefit of larger family size, the partner's only child status may matter in determining the premium/penalty. Therefore, in this subsection, we analyze the SES penalty using subsamples characterized by the partner's only child status.

Figure 3 is around here.

Figure 3 shows the results for a subsample analysis restricted to gender and the only child status of the marriage partner. While the figure is similar to Figure 2 in the pooled sample analysis, the upper panels are restricted to the male sample, and the lower panels are restricted to the female sample. Furthermore, we demonstrate the results in the left panels with individuals whose marriage partner is a non-only child and in the right panels with individuals whose marriage partner is an only child.

Figure 3 demonstrates that the results vary considerably depending on gender and the only-child status of the partner. In the subsample where the spouse is a non-only child, the coefficients for both men and women are close to zero, suggesting that one's only-child status does not influence their attractiveness in terms of educational background. However, in the subsample where the partner is an only child, gender-specific patterns emerge: the coefficient for men remains near zero (-0.03, not significant at the 5% level), whereas the coefficient for women is notably negative at -0.63 and statistically significant. It is worth mentioning that the coefficient size of female only children status with an only child partner is almost twice as large as the gender gap in education observed in our sample, measured at 0.34.

6 Discussions

In the previous section, it was revealed that when only-child women marry only-child men, their husbands' educational attainment is 0.63 years lower than that of the husbands of non-only-child women. Drawing on the results of our earlier analyses, we now explore possible interpretations of why the outcomes differ depending on the partner's characteristics and whether there are gender-specific differences.

First, let us consider why the only-child penalty is observed particularly when the marriage partner is also an only child. Several interpretations may account for this finding. One possibility is that only children prefer partners who are also only children, for instance, due to shared values or experiences, even if that means compromising on socioeconomic status (SES). However, in Japan, only-child households are less common than in many Western countries, and the ideal family structure is often perceived as having two siblings. Thus, "marriages between only children" may not necessarily be seen as aspirational.

A second interpretation is that only children, who may face disadvantages in the marriage market, end up marrying each other as a form of mutual compromise. This view is supported by prior research. For instance, Yu and Hertog [2018] found that in online matchmaking in Japan, only children tend to be avoided by others—and even among only children, mutual avoidance can occur.

While the surplus analysis presented in Section 4.3 cannot be directly compared to penalty estimations based on the framework of Chiappori et al. [2018], the findings nonetheless partially align with this interpretation. The analysis found that being an only child reduces the couple's surplus, with couples composed of two only children showing the smallest total surplus.

Next, we consider why the matching penalty for only children appears to apply only to women. There are two potential explanations for this gender asymmetry: (1) differences in the distribution of partner characteristics by gender, and (2) differences in how partner characteristics affect marital surplus across genders.

Let us begin with the first factor—gender differences in the distribution of partner characteristics. These can be directly observed from the data. Regarding SES, there is a gender gap in average educational attainment, and as noted in Section 3.3, male educational attainment tends to be more polarized and dispersed. Consequently, the effect of the only-child penalty for women, measured via partners' educational attainments, may be more sensitive to variance in the male distribution. That said, the distribution of educational attainment among women is also fairly diverse, spanning high school, junior college or vocational school, and full university degrees. Therefore, the absence of a penalty among men cannot simply be attributed to a lack of variation on the female side.

We also considered whether the distribution of only-child status differs between men and women. As discussed in Section 3.3, there is no significant gender gap in the proportion of only children. Therefore, regarding the differences in the distribution of partner characteristics, it is likely that only SES—rather than only-child status—is responsible for generating the gender difference in the penalty.

The second factor concerns gender differences in how partner characteristics impact marital surplus. Because our dataset does not contain direct measures of how individuals evaluate surplus, we rely on insights from prior studies. Looking first at the role of partner SES, studies have consistently shown that men's SES is more highly valued in the marriage market than women's (Fisman et al. [2006]; Hitsch et al. [2010]; Low [2014]; Bertrand et al. [2015]). In Japan, Uchikoshi et al. [2024] used a conjoint survey experiment to demonstrate that women are more sensitive to a partner's income than men. Although income is not equivalent to educational attainment, it is a component of SES and thus relevant to understanding partner evaluation. These findings suggest that educational attainment has a different impact on surplus for men and women.

We now turn to gender differences in how only-child status affects surplus. As previously noted, caregiving responsibilities may be a key mechanism. It is generally expected that women are more likely to provide caregiving labor in Japan. In this context, only-child women may be seen as less attractive marriage partners if they are unable to assist in caring for their husbands' parents due to obligations toward their own parents. This caregiving burden is likely to be less relevant for men, as societal expectations for male caregiving are lower.

Finally, Vogl [2013] offers an important comparison. He studied arranged marriage markets in developing countries in an analysis focusing on specific sibling compositions. The study revealed that women with sisters tend to marry earlier, and their spouses tend to have lower educational attainment—a sign of lower search quality or compromise in partner selection.[16]

[16] Vogl [2013]'s findings indicated that when a woman has a younger sibling of the same sex, i.e., a sister, then the quality of the mate tends to be lower. According to the study, this outcome is attributed to the older

In contrast, our study finds that although only children may be slightly more likely to remain single, when they do marry, their spouses tend to have lower levels of educational attainment. This suggests that the mechanism behind our findings differs from one driven primarily by rushed or early marriage, leading to lower-quality matches.

7 Supplementary analyses

Thus far, we have observed that only child individuals incur penalties in terms of lower partner SES. In addition to their heavier burden of caregiving, only child individuals incur a matching penalty, especially when they marry an only child partner, which may cause more considerable inequality. In this section, we attempt to deepen our understanding of the effects on marital outcomes of only children from two perspectives. One is to conduct a heterogeneity analysis, and the other is to analyze based on alternative sibling configurations.

7.1 Heterogeneity of only child penalty

In this subsection, we examine how the one-child matching penalty is affected by heterogeneity. In particular, we focus on two heterogeneities. The first is the demographic variables of birth year and age. The meaning of an only child may change over time, and individuals may change their marriage behaviors depending on their own age. The second is educational background. A higher level of education may increase one's attractiveness and may weaken the effect of being an only child. In addition, if caregiving duties are critical for their attractiveness, one may be able to purchase such services in the market if they can sufficiently afford to do so. To test these issues, we examine the effects of heterogeneity separately for men and women. Specifically, we estimate a linear approximation model of the conditional mean difference in the heterogeneity analysis. Semenova and Chernozhukov [2021] extended the work of Chernozhukov et al. [2018] and proposed a method to estimate a linear approximation model of the mean difference using double-debiased machine learning. This method is expected to reduce misspecification errors and biases, as the estimation of the mean difference does. Asymptotic normality holds for linear application models similar to AIPW estimation, and the approximate computation of confidence intervals is possible. For this reason, we employ this method for the heterogeneity analysis.

Figure 4 is around here.

Figure 4 is the result of the heterogeneity analysis of marriage patterns. Let us first look at the effect of the birth year. We see that the more recently a respondent was born, the stronger the tendency of the main result is. Only children are more likely to remain single (not significant, though), less likely to marry non-only children, and more likely to marry only children. With respect to age, although being older at the time of the survey does not

sister being hurried into marriage to expedite the younger sister's marriage.

appear to have a significant impact on the likelihood of remaining single, it is associated with a stronger tendency for only children to marry other only children. When we look at education, it is seen that the trend in the main result weakens. Now, let us consider only children from the view of economic incentives of forming larger family size and monetary transfer from parents in these results.

Figure 4 shows counterintuitive results for birth year if we account for the circumstances in which Japan has experienced the gradual socialization of elderly care through public policies (and slowly fading social norms on filial obligation).[17] However, this trend of socialization of care may also reflect the trend of women's advancement in society and the decrease in their labor in households. Women who were typically used to care for their parents and the parents-in-law are now more difficult to rely on as caregivers. Consequently, the difficulty of caregiving arrangements within household(s) may lead to the enhanced trend that people choose mates in a positive assortative manner regarding only child status (i.e., only children are less likely to be chosen as a marital partner). In terms of other factors, such as monetary transfer, only children's attractiveness may be weakened by the declining relative value of the monetary transfers from parents than their own economic capabilities.

When analyzing the heterogeneity in age, it becomes evident that the main trend becomes more prominent as respondents get older at the time of the survey. Based on the fact that younger individuals remain single, this result reflects that the trend regarding the choice of marriage partner becomes even stronger when comparing those who are already married and young to those who are older. This suggests that individuals who marry at a later age may be selecting partners with a more realistic understanding of caregiving responsibilities. The results for education level may reflect that only children can overcome their disadvantages if one's educational background is higher, as already discussed.

Figure 5 is around here.

Finally, Figure 5 presents estimates of the matching premium/penalty measured by partner's SES. From the analysis, the main results are not significantly affected by either own birth year or education. In sum, heterogeneity affects the choice of marital partner based only on sibling structure, not partner's SES.

7.2 Excluding Education from Controls

This subsection discusses whether our main result holds without controlling for education. As discussed in the main text, only children tend to be more educated, which may cancel out the penalty. It is also interesting to see how being an only child affects the partner's education overall and its impact after considering the positive assortativity of education. Therefore, in

[17] Historically, children's burden of filial duty has been declining. First, in 1961, Japan enacted a national pension system. Additionally, with the enactment of the Long-Term Care Insurance Law in 2000, a system was put in place for society to support the care of elderly individuals.

Appendix C, we follow the same procedure as in the main text and remove one's own education from the control variables.

According to Appendix C, only children are more likely to remain single and more likely to marry another only child, consistent with the main results obtained without controlling for education. The pattern that the effect on singleness is slightly more prominent for males also holds. However, the results for years of schooling show a modest deviation from the main findings. A clear difference emerges depending on the type of marriage partner: being married to a non-only child significantly increases the partner's education level for only children, although the coefficient is relatively small. In contrast, the partner's education tends to decrease for both male and female only children who marry another only child. As in the main results, this is particularly evident for women, with coefficients that are significant and of similar magnitude.

In sum, although the impact is small, a notable difference from the main result is the presence of a premium for those married to non-only children. This pattern is likely due to the omission of education controls and reflects the well-documented positive correlation in educational attainment between spouses. However, this does not contradict our main finding of a penalty associated with marrying an only child. Taken together with the heterogeneity analysis in the previous subsection—which shows that individuals with lower education levels are more likely to marry an only child—these results suggest that the marriage matching penalty for being an only child is more severe among the less educated.

7.3 The effects of alternative sibling positions

Thus far, we have examined the effect of being an only child on marriage patterns; however, we still need to understand the underlying factors causing these effects. To gain further insights, we conduct an additional analysis considering alternative sibling positions and their interpretation in terms of intergenerational relationships. If these relationships are responsible for the disadvantages experienced by only children in the marriage market, then policy interventions such as promoting the socialization of informal care could help reduce these penalties.

In this context, we explore two alternative sibling positions: the effect of being the eldest son and the effect of being the eldest child. In Japan, the eldest son (and his wife) traditionally bears certain obligations, including caring for his parents. Similarly, the eldest daughter with no male siblings is expected to assume this role. While the influence of the eldest son is widely known, the concept of primogeniture, where inheritance goes to the eldest child, suggests that birth order might be more significant than simply being the eldest son. Recent trends indicate a growing preference for individuals to take care of their own parents, and they also expect their own children to care for them. Additionally, considering the persistent gender gap in the provision of informal care, women may be expected to care for their parents even if they have younger brothers. If there is a significant age difference between the two siblings, the first-born effect may be even more pronounced than that of the eldest son. Taking these two cases

into account, we test whether the effects of these sibling positions exist. To focus on sibling positions, we analyze samples from families with only two siblings. This approach allowed us to extend our main findings on the only child effect and make meaningful comparisons (for the detailed analysis, see Appendix D).

In sum, two key findings emerge. First, patrilineal heiresses who marry only children exhibit effects that, while not statistically significant, are partially consistent with the main results regarding the marriage patterns of only-child women and the educational background of their partners. Specifically, the observed penalty for patrilineal heiresses married to an only child aligns with our main findings, indicating a sizable impact; however, it is not statistically significant. The absence of a partner education penalty for heiresses married to individuals who are non-only children also coincide with our results for only children.

Second, among men expected to bear family responsibilities—especially patrilineal heirs—there are clear tendencies in partner selection. Specifically, they tend to have a higher probability of remaining single and are more likely to avoid marrying only children. It is possible that they themselves are being avoided due to their family responsibilities, which mirrors the patterns observed for only children. Moreover, the tendency of eldest sons with siblings to avoid only children does not contradict the main result of positive assortativity by only-child status. Instead, it may suggest that these eldest sons, who are likely to bear heavier familial duties, are more cautious in choosing a spouse who, as an only child, may prioritize caring for their own parents.

These findings do not dismiss the possibility that the strength of intergenerational relationships plays a role in the penalties faced by only children. Furthermore, the penalty for being an only child is greater than that for being an heir with siblings, as suggested by the analyses based on the two definitions. This highlights the potential challenges faced by only children who lack the support of siblings, in contrast to heirs whose responsibilities can be shared among siblings. However, it is important to note that this study did not establish formal causal effects; therefore, not all of the penalties can be attributed solely to generational relationships.

8 Conclusion

This study investigates marriage matching among only children, with a particular focus on the strength of their intergenerational ties. Specifically, we aimed to investigate the marriage patterns of only children from multiple perspectives by beginning with a comparison between observed marriage patterns and those predicted by random matching. The results indicate that assortative mating based on only-child status is more pronounced in actual marriages than in randomly generated ones. Statistical tests further confirm that positive assortative mating on only-child status is present, and that only children are significantly more likely to remain single.

Second, we measured the matching premium/penalty by applying the framework of Chiappori et al. [2018] to our analysis, finding an only child matching penalty in terms of lower partner SES. Furthermore, we observed that this penalty is more pronounced for female only children who marry male only children, which we attempted to understand in the discussion section by combining data analysis with existing literature.

Moreover, we conducted additional analyses to gain a more profound understanding of the underlying cause of the penalty. Heterogeneity analyses revealed that one's own educational level helps alleviate the disparity in partner choice. Additionally, assortativity based on the only child status becomes more pronounced among respondents born more recently and those who are older. Moreover, the findings of other analyses exploring alternative sibling positions did not refute the possibility that heavier filial obligations influence the marriage patterns of only children.

Several conclusions can be drawn from these findings. First, the composition of siblings, which is an inherent factor beyond an individual's control, tends to disadvantage some individuals in terms of finding a suitable match in the marriage market. Specifically, the results indicate that being an only child leads individuals to compromise on their partners' SES attractiveness in their marriages. Second, the marriage market exacerbates disparities in family sizes. Considering that only children bear a heavier responsibility in caregiving, our results indicating that only children are more likely to remain unmarried or marry other only children imply an increase in the inequality of caregiving burdens through the marriage market. Regarding the penalties faced by only children, socializing the burden of care may be expected to address two negative aspects: the disadvantageous marriages of only children and the widening gap in caregiving burdens among the younger generations.

Before closing our study, we will discuss the limitations of this study and future research directions. The only information that we have on sibling composition is on *surviving* siblings. Since we include in the sample those who have already lost siblings, we may underestimate the penalty for older generations. This issue also prevents us from considering the possibility that only child status may be driven by biological factors (e.g., infertility, low probability of survival of all siblings), as pointed out by Lu and Vogl [2022]. Since families with weak constitutions may also be at a disadvantage in the marriage market, data that include this information would allow other possible interpretations. Considering the data's limitations, it is also important to consider parental information that could impact monetary transfers, such as bequests when examining sibling composition and marital outcomes. However, the dataset utilized in this paper lacks information on parental SES. Including such additional parental information in future research would offer further insights.

Relatedly, this study used data from Japan, which is one of the East Asian countries with the strongest traditions of filial piety, to focus on intergenerational relationships where policy intervention is possible. While the results are somewhat reasonable, other sources of explanation for the only child penalty are possible, as discussed above. It would be interesting to see the effects of variation in policy changes on the marriage patterns, if any, in other economies, a la Bau [2021], who demonstrates that pension policies implemented in societies dominated

by both males and females have had an impact on cultural changes in marriage customs. This study could also be expanded to analyze the impact of alternative sibling structures on marital outcomes. While the current analysis primarily concentrated on the only child status, which is less influenced by specific periods and cultures, a potential avenue for future research is to comprehensively investigate the effects of sibling structure in conjunction with those of masculine culture.

Furthermore, this study is restricted to analyzing marital status and spouse characteristics as dependent variables. However, it does not determine whether individuals are actually experiencing penalties or facing life challenges. Ideally, it would be important to investigate whether sibling composition results in differences in utility levels. If subjective well-being indicators were available, this could open up another avenue for future research, broadening the understanding of our findings and deepening insights into how sibling configurations influence life outcomes.

Finally, we believe that the findings of this study will provide valuable insights into the speed of population decline. Vogl [2020], in their research on the evolutionary process of intergenerational associations in fertility, raised the possibility of marriage assortativity as a mechanism that may contribute to this acceleration. Our discovery of assortativity represents a significant step forward in our understanding of demographics. Thus, it would be meaningful to examine the demographic impact of positive assortativity on sibship size in the marriage market, as it may contribute to the further decline in fertility rates.

Appendix A. Prior Literature on Only Children and Marriage

This appendix concisely reviews prior research related to only children and marriage outcomes. Specifically, we focus on three dimensions: (1) the association between sibling composition and marriage outcomes, (2) educational attainment, and (3) relevant psychosocial mechanisms and other lifetime outcomes.

A.1 Studies on sibling composition and marital outcomes

While not always centered on only children, many sociological studies have explored how family background—including sibship size and birth order—shapes marital behavior. For example, Yu et al. [2012] found that birth order and sibship gender composition affect age at first marriage in gender-asymmetric ways. In Japan, Kojima [1993] discussed marriage arrangements based on sibling structure.

More directly, Yu and Hertog [2018] analyzed online dating behavior in Japan and found that only children receive fewer requests and are more likely to send requests, suggesting a disadvantage in the early stages of mate search. Using representative data from Japan, Uchikoshi et al. [2023] also analyzed the effect of the change in population structure of sibling composition (including only children) on demographic change, using different indicators to show that children who are expected to care for their parents are less likely to marry. Specifically, they calculated the percentage of the male/female population with a particular sibling composition that is actually married to someone with that background.

In economics, Vogl [2013] examined arranged marriages in Nepal and showed that sibling composition—specifically the presence of younger sisters—can pressure women into earlier and lower-quality marriages. These studies suggest that sibling structure may influence not only whether and when individuals marry, but also the quality of their matches.

A.2. Studies on sibling composition and educational outcomes

In our analysis, we use the education of one's partner as a key indicator of marriage quality. Prior work has examined whether being an only child affects educational attainment, a potential confounder in assortative mating. Theoretical frameworks such as the quality–quantity trade-off model suggest that children in smaller families may benefit from more parental investment (Becker and Lewis, 1973, Becker and Tomes, 1976, Galor and Weil, 2000, Hazan and Berdugo, 2002, Moav, 2005).

Empirical findings, however, are mixed. Some studies report educational disadvantages for only children. For instance, Black et al. [2005] and Qian [2009] showed that only children tend to have lower educational outcomes compared to those with siblings.

Conversely, other studies highlight the advantages of being an only child or growing up in a smaller family. For example, Lee [2008] found that only children receive higher per-child expenditures, and Rosenzweig and Zhang [2009] showed that the presence of twin siblings, compared to being an only child, lowers educational outcomes. Further evidence using the one-child policy as a natural experiment suggests that additional siblings reduce educational attainment: Liu [2014] and Li and Zhang [2017] found negative effects of sibling size using one-child policy variation, while Qin et al. [2017] used a regression discontinuity design and reached a similar conclusion.

Taken together, these findings suggest that while some studies emphasize the disadvantages of being an only child, others underscore the benefits of smaller family size. The impact of sibling composition on educational attainment is therefore complex and context-dependent.

A.3. Studies on sibling composition and other outcomes

Psychological studies have long debated whether only children differ from those with siblings in terms of personality and social development. Early stereotypes portrayed only children as spoiled or socially disadvantaged, a view famously summarized by G. Stanley Hall's remark that being an only child is "a disease in itself" [as cited in Fenton, 1928]. While such views have been challenged, they continue to persist in public discourse [Mancillas, 2006, Griffiths et al., 2021].

From a developmental perspective, sibling relationships are seen as early training grounds for emotional regulation and social interaction. As noted by Feinberg et al. [2012], those with siblings may gain interpersonal skills relevant for later romantic relationships. Recent research, however, challenges the negative stereotype of only children and highlights positive traits such as creativity, resilience, and adult success [Blake, 1989, Mellor, 1990, Polit et al., 1980, Polit and Falbo, 1987, 1988, Poston Jr and Falbo, 1990].

Several studies have examined how sibling composition influences labor market outcomes, often treating them as indicators of child quality.

Kessler [1991] found that only children had lower employment rates in adolescence but higher rates in their late twenties compared to middle children. Black et al. [2005] showed that having more siblings reduced full-time employment and earnings, especially for women, while men's incomes declined but their employment status was unaffected. By contrast, Angrist et al. [2010] found no consistent effect of sibling number. Despite mixed findings, socioeconomic success clearly affects marriage decisions, making it a relevant confounder in analyses of only child status.

In addition, many studies have addressed caregiving responsibilities for aging parents. Research across countries shows that only children bear a heavier caregiving burden than those with siblings [Coward and Dwyer, 1990, Dwyer and Coward, 1991, Spitze and Logan, 1991, Rainer and Siedler, 2012]. Economic theory suggests that siblings may free-ride by avoiding

proximity to parents [Konrad et al., 2002b, Rainer and Siedler, 2009]. Using German microdata, Rainer and Siedler [2009] found that only children are less able to move away from parents and face reduced labor market opportunities as a result.

Appendix B. Assortativeness

This appendix formally checks the assortativity of only child status. In the main text, our interest focused on differences in marriage probabilities between two parties (i.e., only children and non-only children). However, we used existing indices for robustness checks on the results of positive assortativity obtained from the difference in their marriage probabilities.

Herein, we use four standard indices introduced in Chiappori et al. [2021]: odds ratio, likelihood ratio, minimum distance, and correlation. The odds ratio and likelihood ratio indices are interpreted as showing positive assortativity when their values exceed one. In our context, the odds ratio index indicates the ratio of marriages between only children to mixed marriages with respect to sibling composition, whereas the likelihood ratio index represents the ratio of the probability of positive assortative matching in terms of sibling structure relative to what would occur randomly.

The remaining two indices, minimum distance and correlation, indicate positive assortativity when their values are positive. The minimum distance index represents the weight of the perfectly assortative component, while the correlation index measures the correlation between the wife's and husband's only child status.

All of the indices show positive assortativity in the pooled data. The values are 1.05 for the odds ratio, 1.01 for the likelihood ratio, 0.09 for the minimum distance, and 0.09 for the correlation. These results suggest a consistent, albeit weak, pattern of positive assortative matching in only child status.

Appendix C. Excluding Education from Controls

This appendix tests whether our main result holds without controlling for education. As discussed in the main text, only children tend to be more educated, which may cancel out the penalty. It is also interesting to see how being an only child affects the partner's education overall and its impact after considering the positive assortativity of education. Therefore, we follow the same procedure as in the main text. and remove one's own education from the control variables. The sibling composition of the marriage partner is indicated by Figure 6, while the educational background of the marriage partner is indicated by Figure 7.

Figure 6 is around here.

Figure 7 is around here.

According to Figure 6, the tendency for only children to remain single and to marry another only child persists, even without accounting for education—confirming the main findings. The gender difference also holds, with the effect on singleness being slightly more pronounced among males. In contrast, the estimates related to years of schooling show some variation from the main result. As shown in Figure 7, the type of spouse plays a key role here: only children who marry non-only children tend to have partners with higher levels of education, though the effect size is modest. By contrast, when both spouses are only children, their partner's education tends to be lower. This pattern is statistically significant for women, with a coefficient of -0.61, which is very close to the main result of -0.63.

Appendix D. The effects of alternative sibling positions

This subsection examines the effects of alternative sibling positions on their marriage matching outcomes. In our analysis with two-sibling respondents, one's position could be determined by the position of the other sibling. For instance, if one is a male and the first-born child, he is considered the heir if the other sibling is a younger brother, an elder sister, or a younger sister. If one is a female, the first-born daughter without a male sibling is considered the heiress. Thus, we define a dummy variable called "Patrilineal" that takes a value of one for males when the other sibling is a younger brother, elder sister, or younger sister, and zero if he has an older brother. For females, the dummy variable takes a value of one if the other sibling is a younger sister, and zero if the other sibling is an elder brother, younger brother, or elder sister. However, if we focus on birth order, then both males and females become heirs if they are first-born children. Hence, we define a dummy variable called "Primogeniture" that takes a value of one when the other sibling is a younger brother or sister, and zero if they have an older brother or sister. Finally, we categorize individuals' marital status into three groups: married to an only child, married to a non-only child, and single. This allows us to compare the results with our main findings.

Figure 8 is around here.

Figure 9 is around here.

Figure 8 shows the results of the effects of heirs on their marital status according to the two definitions. The results indicate that male heirs—under either definition—are more likely to remain single and are less likely to marry only children. In contrast, results differ for women depending on the definition used. Under the definition of a patrilineal heiress, the probability of remaining single increases, and while not statistically significant, there is a slight increase in the likelihood of marrying an only child. Under the definition based on primogeniture, however, no significant effect is observed on the likelihood of remaining single, and the probability of marrying an only child is actually lower.

The difference between these two definitions lies in whether the younger sibling includes a brother. Patrilineal heiresses show disadvantages in marriage similar to those faced by only

children, likely because they are expected to take on family responsibilities. In contrast, primogeniture heiresses may have a younger brother, which allows for the possibility of sharing or delegating caregiving responsibilities.

In this sense, patrilineal heiresses may be expected—much like only children—to take on broader family responsibilities, including the care of elderly parents, within the household or as part of their marital role.

When analyzing the education level of the marriage partner, as shown in Figure 8, no significant effects are observed for either definition. However, in the case of heirs and heiress of the both definitions, the coefficient is larger when the marriage partner is an only child, which aligns with the main finding. Overall, the penalties associated with each dummy variable are not as pronounced as the effect observed for individuals who are only children.

Tables

Table 1: Descriptive statistics of respondents' characteristics by gender and only-child status

Characteristic	Men		Women	
	Not only child N = 26,945[1]	**Only child** N = 2,032[1]	**Not only child** N = 24,854[1]	**Only child** N = 1,921[1]
MarriageStatus				
Married	18,777 (70%)	1,242 (61%)	18,700 (75%)	1,319 (69%)
Single	8,168 (30%)	790 (39%)	6,154 (25%)	602 (31%)
Age	43 (33, 54)	41 (32, 52)	42 (32, 52)	41 (32, 51)
EducationYear				
0	15 (<0.1%)	2 (<0.1%)	18 (<0.1%)	0 (0%)
6	41 (0.2%)	2 (<0.1%)	23 (<0.1%)	1 (<0.1%)
9	3,277 (12%)	214 (11%)	2,386 (9.6%)	132 (6.9%)
12	10,539 (39%)	705 (35%)	10,578 (43%)	744 (39%)
14	3,658 (14%)	332 (16%)	8,264 (33%)	667 (35%)
16	9,415 (35%)	777 (38%)	3,585 (14%)	377 (20%)
BirthYear	1,958 (1,948, 1,969)	1,961 (1,950, 1,970)	1,960 (1,949, 1,970)	1,963 (1,952, 1,971)
RegionalBlock				
Chugoku	1,682 (6.2%)	129 (6.3%)	1,507 (6.1%)	130 (6.8%)
Hokkaido	1,381 (5.1%)	119 (5.9%)	1,239 (5.0%)	109 (5.7%)
Hokuriku	1,444 (5.4%)	121 (6.0%)	1,332 (5.4%)	83 (4.3%)
Kinki	3,920 (15%)	346 (17%)	3,606 (15%)	318 (17%)
Kyusyu & Okinawa	3,985 (15%)	236 (12%)	3,708 (15%)	242 (13%)
Nouth Kanto & Koushin	2,456 (9.1%)	143 (7.0%)	2,219 (8.9%)	144 (7.5%)
Shikoku	1,080 (4.0%)	65 (3.2%)	1,000 (4.0%)	69 (3.6%)
South Kanto	5,643 (21%)	551 (27%)	5,347 (22%)	481 (25%)
Tohoku	2,342 (8.7%)	120 (5.9%)	2,151 (8.7%)	128 (6.7%)
Tokai	3,012 (11%)	202 (9.9%)	2,745 (11%)	217 (11%)

[1] n (%); Median (Q1, Q3)

Table 2: Observed vs. Randomly Matched Marriage Patterns

Characteristic	Husband: Not Only Child N = 18,777[1]	Husband: Only Child N = 1,242[1]
Only Child Status with randomization		
Wife: Not Only Child	17,554 (88%)	1,146 (5.7%)
Wife: Only Child	1,223 (6.1%)	96 (0.5%)
Only Child Status		
Wife: Not Only Child	17,649 (88%)	1,051 (5.3%)
Wife: Only Child	1,128 (5.6%)	191 (1.0%)

[1] n (%)

Notes: This table compares the observed marriage patterns with those generated under random matching. The columns indicate whether the husband is an only child or not, and the rows indicate the same for the wife. Each cell reports the number of couples for each combination, with the proportion relative to the total number of couples shown in parentheses. Random couples are generated by applying a random permutation to the observed married individuals, following the procedure of Chiappori et al. [2018]. Men and women are each assigned IDs drawn from a uniform distribution, ranked accordingly, and then matched based on these ranks.

Table 3: Systematic Returns to Marriage

Men	Women	JointSurplus	Men's Surplus	Women's Surplus
OnlyChild	OnlyChild	-2.57	-1.42	-1.148
Not OnlyChld	Not OnlyChild	1.82	0.77	1.054
OnlyChild	Not OnlyChild	-1.48	0.285	-1.767
Not OnlyChld	OnlyChild	-1.35	-1.98	0.628

Notes: This table reports the estimated household-level and individual-level returns to marriage by spouse-type combination ij, based on the only-child status of each partner. Marriage types are labeled according to the only-child status of the male and female spouse, respectively. For example, a union between a non-only child male and an only child female is labeled as "Non-Only Child – Only Child Marriage." Each row corresponds to a specific marriage pattern, and the three columns report: the total return to marriage in Eq.(2); the male's individual return in Eq.(3); and the female's individual return in Eq.(4).

Figures

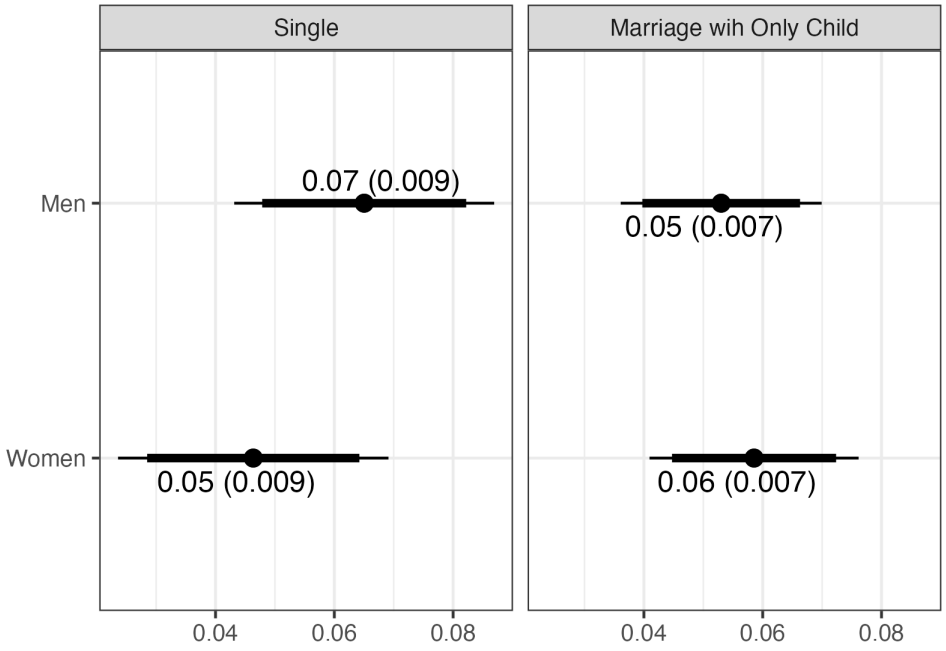

Figure 1: Effect of only child status on partner type

Notes: This figure shows the different marital statuses according to only child status, namely, single (left graph) and married to an only child (right graph), estimated by Eq.(1), along with the 95% confidence interval (bold lines show Bonferroni-corrected confidence intervals). All nuisance functions are estimated using the stacking learner [Wolpert, 1992, Breiman, 1996], which consists of OLS (including squared terms of age, birth year, and years of schooling), random forest [Breiman, 2001], and Bayesian additive regression trees [Chipman et al., 2006, 2010]. Standard errors clustered by each household are in parentheses. We compare groups comprising only children and non-only children, and the coefficients represent the differences in the likelihood of being in each status. Specifically, they indicate the mean values of only children's likelihood of being single minus non-only children's likelihood of being single and only children's likelihood of being married to anther only child minus non-only children's likelihood of being married to an only child, respectively.

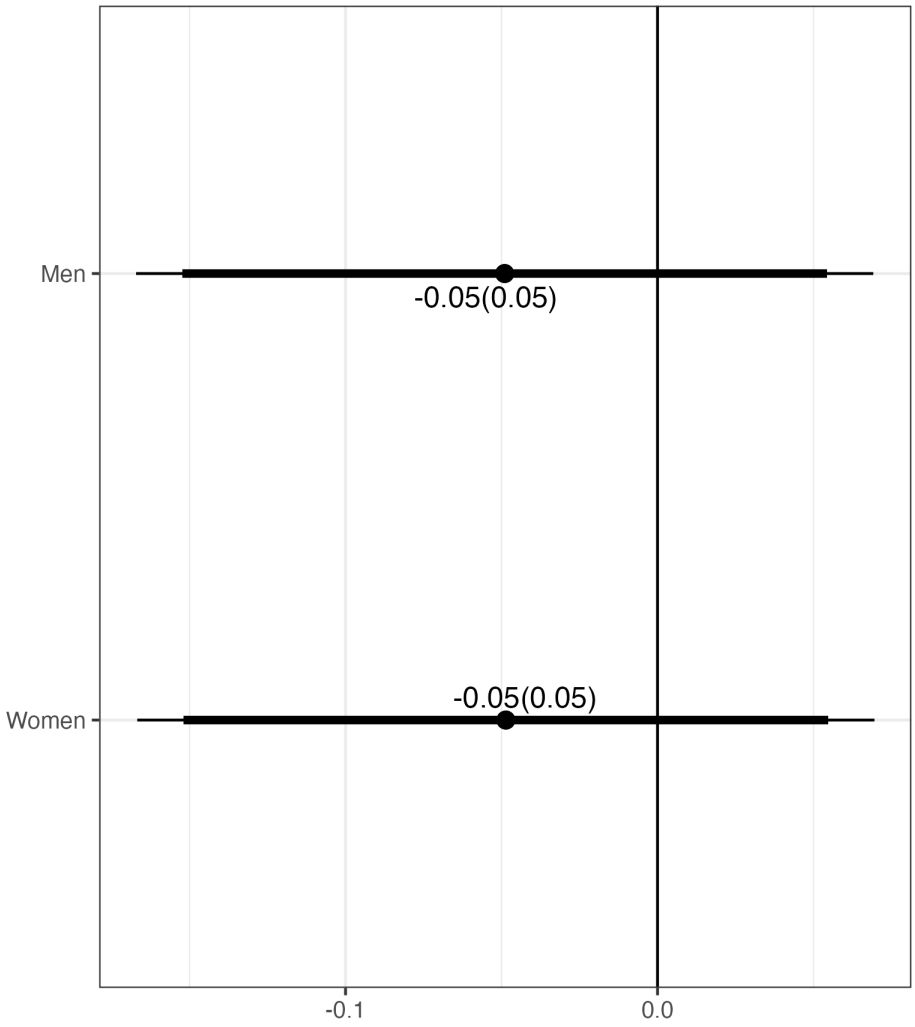

Figure 2: Effects of only-child status on partner's years of schooling (Pooled sample analysis)

Notes: This figure shows the difference in partner's years of schooling according to only child status, estimated by Eq.(5), along with the 95% confidence interval (bold lines show Bonferroni-corrected confidence intervals). All nuisance functions are estimated using the stacking learner [Wolpert, 1992, Breiman, 1996], which consists of OLS (including squared terms of age, birth year, and years of schooling), random forest [Breiman, 2001], and Bayesian additive regression trees [Chipman et al., 2006, 2010]. Standard errors clustered by each household are in parentheses. We compare groups composed of only children and non-only children, and the coefficients represent the differences in their partners' years of education after controlling for other variables. Specifically, they indicate the mean values of the years of schooling of only children's partners minus those of non-only children's partners.

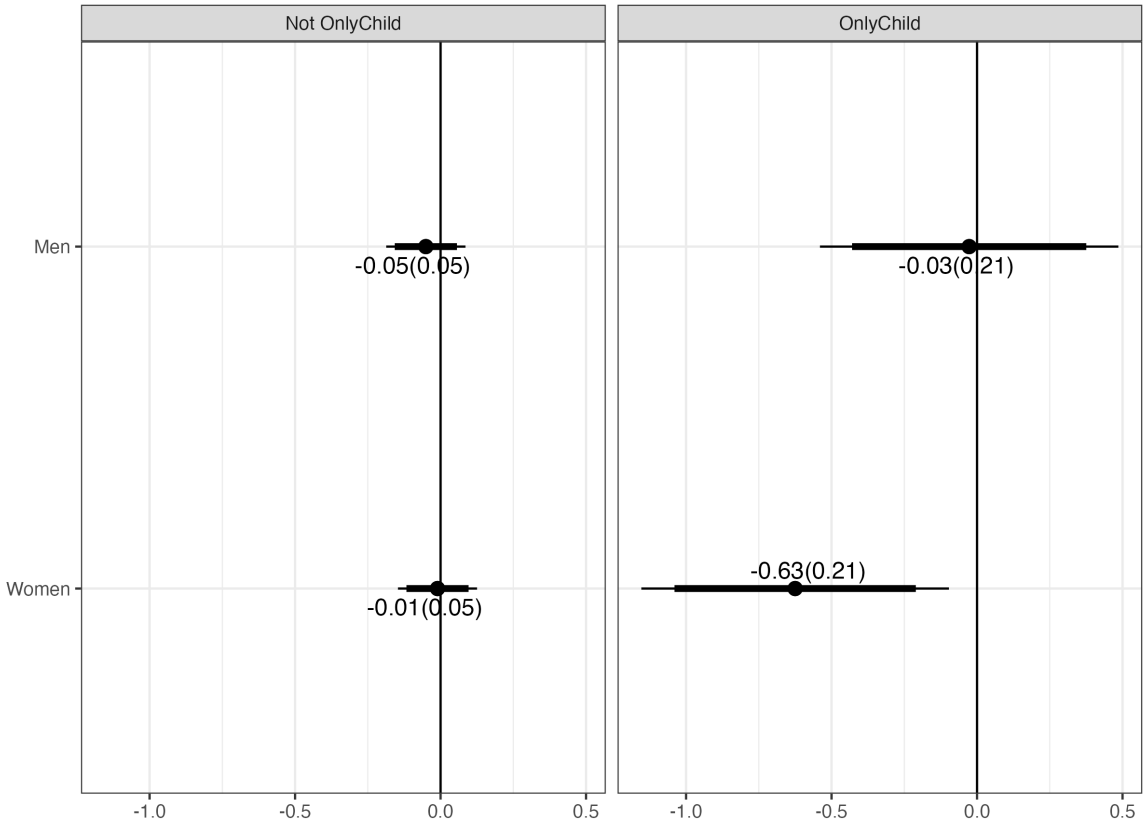

Figure 3: Effects of only-child status on partner's years of schooling (Subsample analysis)

Notes: This figure shows the difference in partner's years of schooling according to only child status by subsamples, namely, married to non-only child (left graph) and married to only child (right graph), estimated by Eq.(5), along with the 95% confidence interval (bold lines show Bonferroni-corrected confidence intervals). All nuisance functions are estimated using the stacking learner [Wolpert, 1992, Breiman, 1996], which consists of OLS (including squared terms of age, birth year, and years of schooling), random forest [Breiman, 2001], and Bayesian additive regression trees [Chipman et al., 2006, 2010]. Standard errors clustered by each household are in parentheses. We compare groups composed of only children and non-only children, and the coefficients represent the differences in their partners' years of schooling after controlling other variables. Specifically, the coefficients indicate the mean values of the years of schooling of only children's partners minus those of non-only children's partners by their partner's type (i.e., only children and non-only children).

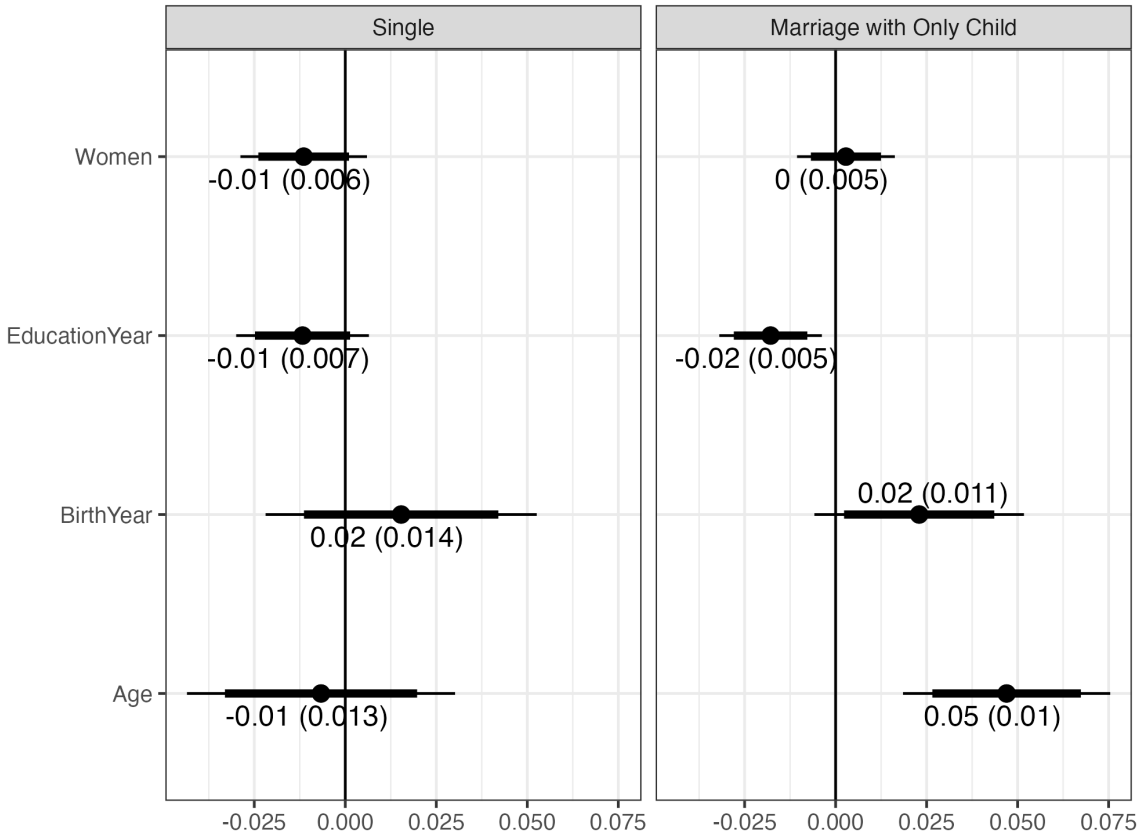

Figure 4: Effect of only child status on partner type (Heterogeneity)

Notes: This figure shows the best linear projection of the conditional difference in the effect of marital status on only child status, namely, single (left graph) and married to only child (right graph), along with 95% confidence interval (bold lines show Bonferroni-corrected confidence intervals). All nuisance functions are estimated using the stacking learner [Wolpert, 1992, Breiman, 1996], which consists of OLS (including squared terms of age, birth year, and years of schooling), random forest [Breiman, 2001], and Bayesian additive regression trees [Chipman et al., 2006, 2010]. Standard errors clustered by each household are in parentheses. We compared groups composed of only children and non-only children. Each variable is interpreted as follows. The coefficient of women is the value based on men. For the partner, the only child coefficient is based on marriages with partners who are non-only children. Years of schooling, birth year, and age estimates represent the correlation between the dependent variable and a one-standard-deviation change from the mean years of schooling, birth year, and age, respectively.

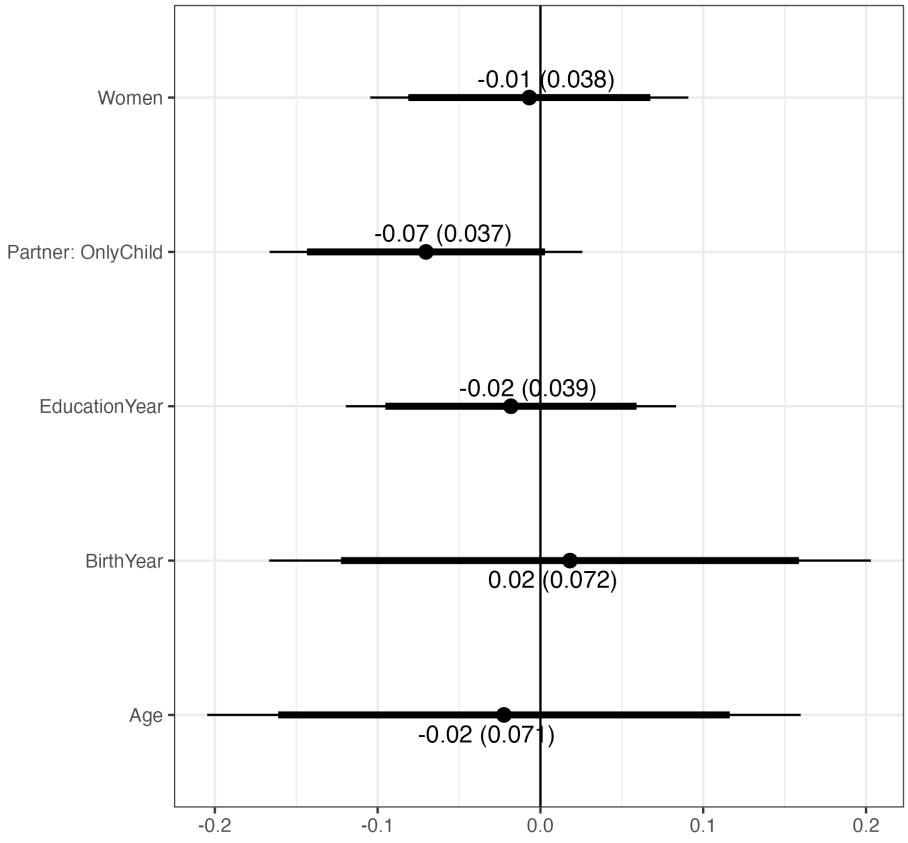

Figure 5: Effect of only child status on partner's years of schooling (Heterogeneity)

Notes: This figure shows the best linear projection of the conditional difference of the partner's years of schooling, along with the 95% confidence intervals (bold lines show Bonferroni-corrected confidence intervals) intervals). All nuisance functions are estimated using the stacking learner [Wolpert, 1992, Breiman, 1996], which consists of OLS (including the squared terms of age, birth year, and years of schooling), random forest [Breiman, 2001], and Bayesian additive regression trees [Chipman et al., 2006, 2010]. Standard errors clustered by each household are in parentheses. We compare groups comprised of only children and non-only children. Each variable is interpreted as follows. The coefficient of women is the value based on men. For the partner, the only child coefficient is based on marriages with partners who are non-only children. Years of schooling, birth year, and age estimates represent the correlation between the dependent variable and a one-standard-deviation change from the mean years of schooling, birth year, and age, respectively.

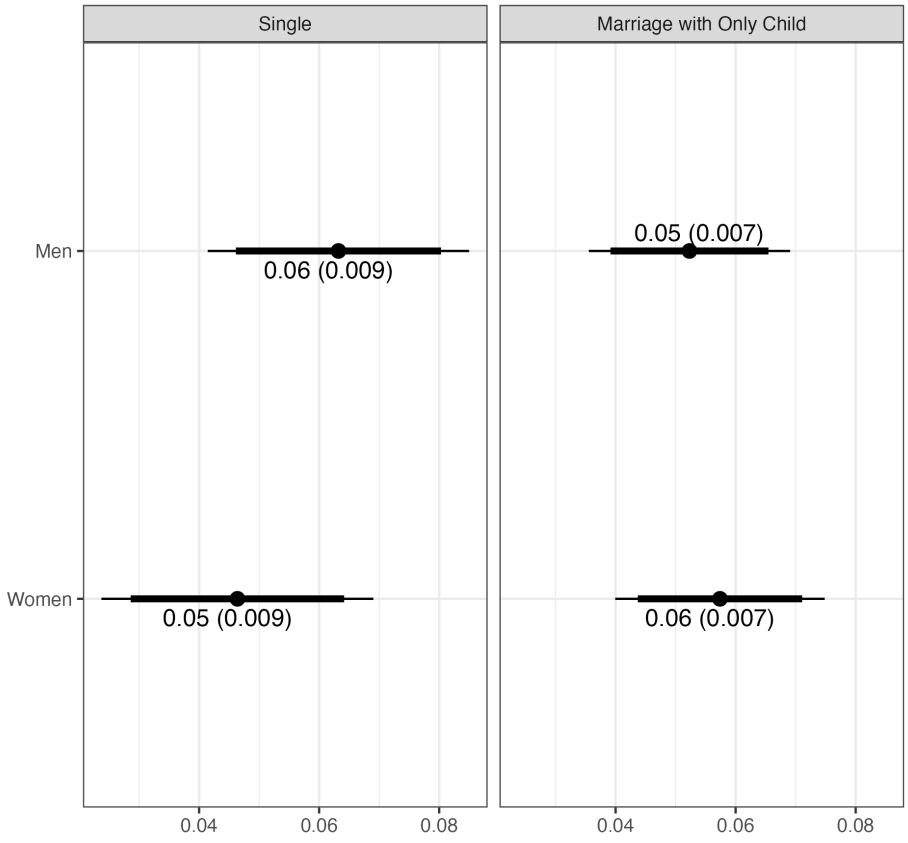

Figure 6: Effect of only child status on partner's type (Without education control)

Notes: This figure shows the different marital statuses according to only child status, namely, single (left graph) and married to only child (right graph), estimated by Eq.(1), along with the 95% confidence interval (bold lines show Bonferroni-corrected confidence intervals). All nuisance functions are estimated using the stacking learner [Wolpert, 1992, Breiman, 1996], which consists of OLS (including the squared terms of age and birth year but NOT years of schooling), random forest [Breiman, 2001], and Bayesian additive regression trees [Chipman et al., 2006, 2010]. Standard errors clustered by each household are in parentheses. We compare groups comprised only children and non-only children, and the coefficients represent the differences in the likelihood of being in each status. Specifically, they indicate the mean values of the only children's likelihood of being a single minus the non-only children's likelihood of being single, and the only children's likelihood of being married to anther only child minus the non-only children's likelihood of being married to an only child, respectively.

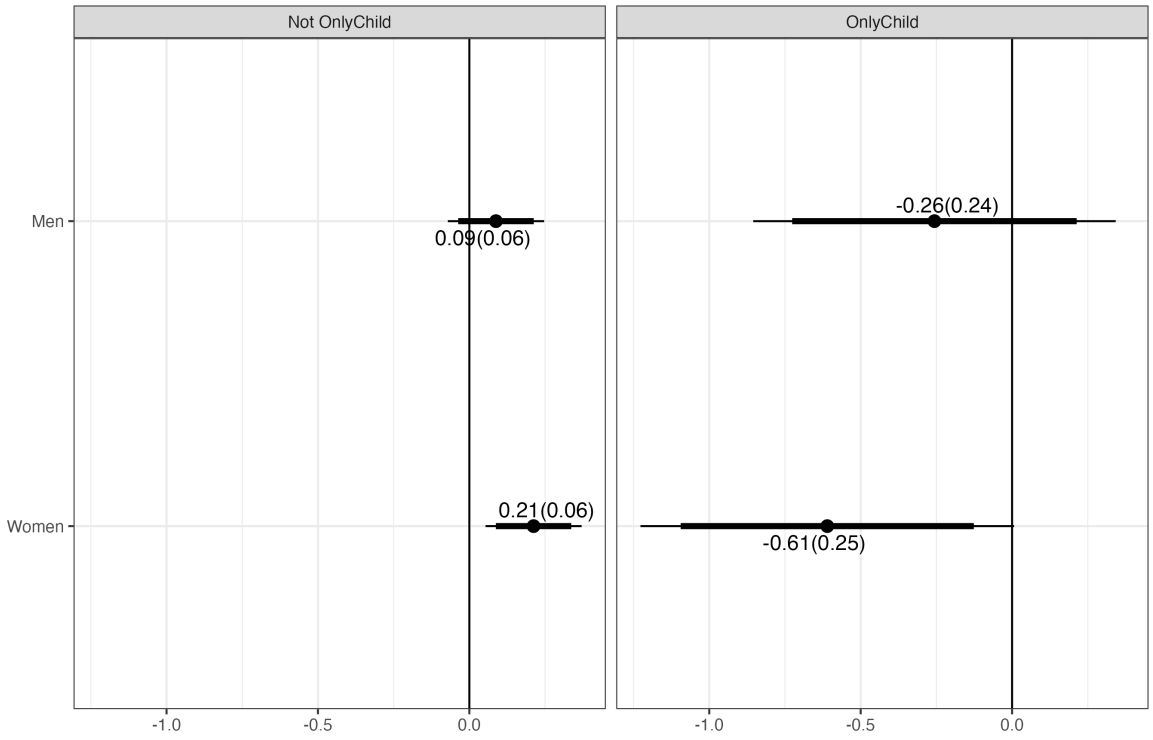

Figure 7: Effects of only-child status on partner's years of schooling (Without education control)

Notes: This figure shows the difference in partner's years of schooling according to only child status by subsamples, namely, married to non-only child (left graph) and only child (right graph), estimated by Eq.(5), along with the 95% confidence interval (bold lines show Bonferroni-corrected confidence intervals). All nuisance functions are estimated using the stacking learner [Wolpert, 1992, Breiman, 1996], which consists of OLS (including the squared terms of age and birth year but NOT years of schooling), random forest [Breiman, 2001], and Bayesian additive regression trees [Chipman et al., 2006, 2010]. Standard errors clustered by each household are in parentheses. We compare groups comprised only children and non-only children, and the coefficients represent the differences in their partners' years of schooling after controlling for other variables. Specifically, they indicate the mean values of the years of schooling of only children's partners minus those of non-only children's partners by their partner's type (i.e., only children and non-only children).

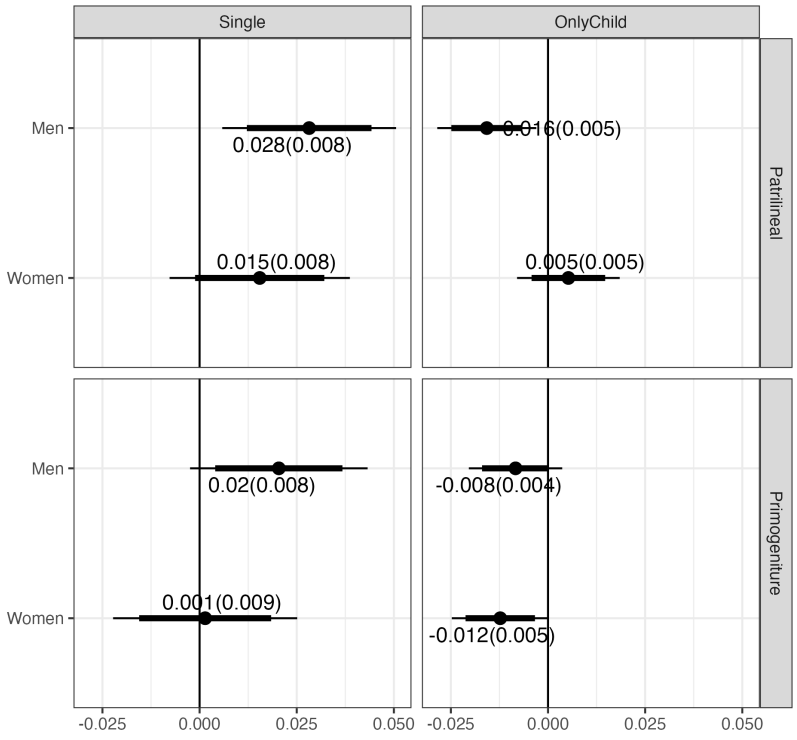

Figure 8: Effects of heir status on partner's type

Notes: This figure shows the different marital statuses according to sibling positions, namely, single (left graph) and married to an only child (right graph), along with the 95% confidence intervals (bold lines show Bonferroni-corrected confidence intervals). The sibling positions are defined by dummy variables called "Patrilineal" (top graph) and "Primogeniture" (bottom graph) among two sibling respondents. The patrilineal variable takes a value of one for males when the other sibling is a younger brother, elder sister, or younger sister, and zero if he has an older brother. For females, the dummy variable takes a value of one if the other sibling is a younger sister and zero if the other sibling is an elder brother, younger brother, or elder sister. Primogeniture takes a value of one when the other sibling is a younger brother or sister and a value of zero if they have an older brother or sister for both males and females. All nuisance functions are estimated using the stacking learner [Wolpert, 1992, Breiman, 1996], which consists of OLS (including the squared terms of age, birth year, and years of schooling), random forest [Breiman, 2001], and Bayesian additive regression trees [Chipman et al., 2006, 2010]. Standard errors clustered by each household are in parentheses. We compare groups comprised of heirs and non-heirs in each definition, and the coefficients represent the differences in the likelihood of being in each status. Specifically, they indicate the mean values of the heirs' likelihood of being a single minus the non-heirs' likelihood of being a single, and heirs' likelihood of marrying an only child minus non-heirs' likelihood of marrying an only child, respectively.

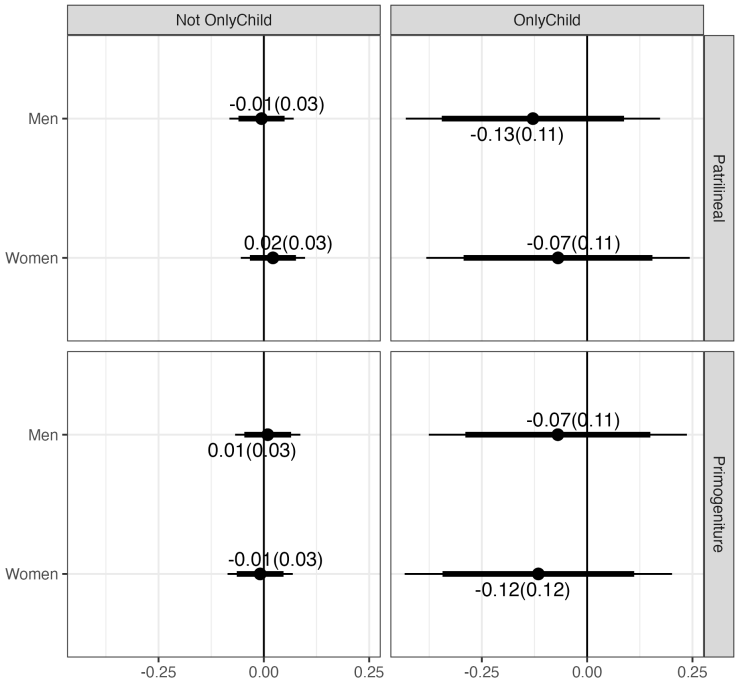

Figure 9: Effects of heir status on on partner's years of schooling (Subsample analysis)

Notes: This figure shows the difference in partner's years of schooling according to alternative sibling position by subsamples, namely, the results among the marriages with a non-only child partner (left graph) and the marriages with an only child partner (right graph), along with the 95% confidence intervals (bold lines show Bonferroni-corrected confidence intervals) intervals). The sibling positions are defined by dummy variables called "Patrilineal" (top graph) and "Primogeniture" (bottom graph) among two sibling respondents. The patrilineal variable takes a value of one for males when the other sibling is a younger brother, elder sister, or younger sister, and zero if he has an older brother. For females, the dummy variable takes a value of one if the other sibling is a younger sister and zero if the other sibling is an elder brother, younger brother, or elder sister. Primogeniture takes a value of one when the other sibling is a younger brother or sister and a value of zero if they have an older brother or sister for both males and females. All nuisance functions are estimated using the stacking learner [Wolpert, 1992, Breiman, 1996], which consists of OLS (including squared terms of age, birth year, and years of schooling), random forest [Breiman, 2001], and Bayesian additive regression trees [Chipman et al., 2006, 2010]. Standard errors clustered by each household are in parentheses. We compare groups composed of heirs and non-heirs in each definition, and the coefficients represent the differences in their partners' years of schooling after controlling for the other variables. Specifically, they indicate the mean values of the years of schooling for heirs' partners minus those of non-heirs' partners by their partner's type (i.e., only children and non-only children).

References

Alberto Alesina and Paola Giuliano. The power of the family. *Journal of Economic growth*, 15(2):93–125, 2010.

Joshua Angrist, Victor Lavy, and Analia Schlosser. Multiple experiments for the causal link between the quantity and quality of children. *Journal of Labor Economics*, 28(4):773–824, 2010.

Natalie Bau. Can policy change culture? government pension plans and traditional kinship practices. *American Economic Review*, 111(6):1880–1917, 2021.

Gary S Becker. *A treatise on the family: Enlarged edition*. Harvard university press, 1991.

Gary S Becker and H Gregg Lewis. On the interaction between the quantity and quality of children. *Journal of political Economy*, 81(2, Part 2):S279–S288, 1973.

Gary S Becker and Nigel Tomes. Child endowments and the quantity and quality of children. *Journal of political Economy*, 84(4, Part 2):S143–S162, 1976.

Marianne Bertrand, Emir Kamenica, and Jessica Pan. Gender identity and relative income within households. *The Quarterly Journal of Economics*, 130(2):571–614, 2015.

Alberto Bisin and Thierry Verdier. "beyond the melting pot": cultural transmission, marriage, and the evolution of ethnic and religious traits. *The Quarterly Journal of Economics*, 115 (3):955–988, 2000.

Alberto Bisin, Giorgio Topa, and Thierry Verdier. Religious intermarriage and socialization in the united states. *Journal of political Economy*, 112(3):615–664, 2004.

Sandra E Black, Paul J Devereux, and Kjell G Salvanes. The more the merrier? the effect of family size and birth order on children's education. *The Quarterly Journal of Economics*, 120(2):669–700, 2005.

Judith Blake. *Family size and achievement*, volume 3. Univ of California Press, 1989.

Richard Breen and Leire Salazar. Educational assortative mating and earnings inequality in the united states. *American Journal of Sociology*, 117(3):808–843, 2011.

Leo Breiman. Bagging predictors. *Machine learning*, 24:123–140, 1996.

Leo Breiman. Random forests. *Machine learning*, 45:5–32, 2001.

Martin Browning, Pierre-André Chiappori, and Yoram Weiss. *Economics of the Family*. Cambridge University Press, 2014.

Cabinet Office. Basic data on marriage and family (kekkon to kazoku wo meguru kiso data). 2021. URL https://www.gender.go.jp/kaigi/kento/Marriage-Family/2nd/pdf/1.pdf(AccessedonJanuary6,2023).

Victor Chernozhukov, Denis Chetverikov, Mert Demirer, Esther Duflo, Christian Hansen, Whitney Newey, and James Robins. Double/debiased machine learning for treatment and structural parameters: Double/debiased machine learning. *The Econometrics Journal*, 21 (1), 2018.

Pierre-André Chiappori, Sonia Oreffice, and Climent Quintana-Domeque. Fatter attraction: anthropometric and socioeconomic matching on the marriage market. *Journal of Political Economy*, 120(4):659–695, 2012.

Pierre-André Chiappori, Sonia Oreffice, and Climent Quintana-Domeque. Bidimensional matching with heterogeneous preferences: education and smoking in the marriage market. *Journal of the European Economic Association*, 16(1):161–198, 2018.

Pierre-Andre Chiappori, Monica Costa Dias, and Costas Meghir. The measuring of assortativeness in marriage: a comment. 2021.

Hugh Chipman, Edward George, and Robert McCulloch. Bayesian ensemble learning. *Advances in neural information processing systems*, 19, 2006.

Hugh A Chipman, Edward I George, and Robert E McCulloch. Bart: Bayesian additive regression trees. *The Annals of applied statistics*, 4(1):266–298, 2010.

Eugene Choo and Aloysius Siow. Who marries whom and why. *Journal of political Economy*, 114(1):175–201, 2006.

Alessandro Cigno, Mizuki Komura, and Annalisa Luporini. Self-enforcing family rules, marriage and the (non) neutrality of public intervention. *Journal of Population Economics*, 30 (3):805–834, 2017.

Alessandro Cigno, Alessandro Gioffré, and Annalisa Luporini. Evolution of individual preferences and persistence of family rules. *Review of Economics of the Household*, 19(4):935–958, 2021.

Raymond T Coward and Jeffrey W Dwyer. The association of gender, sibling network composition, and patterns of parent care by adult children. *Research on Aging*, 12(2):158–181, 1990.

Jeffrey W Dwyer and Raymond T Coward. A multivariate comparison of the involvement of adult sons versus daughters in the care of impaired parents. *Journal of Gerontology*, 46(5): S259–S269, 1991.

Lasse Eika, Magne Mogstad, and Basit Zafar. Educational assortative mating and household income inequality. *Journal of Political Economy*, 127(6):2795–2835, 2019.

Gøsta Esping-Andersen. Hybrid or unique?: The japanese welfare state between europe and america. *Journal of European Social Policy*, 7(3):179–189, 1997.

Eurostat. Household composition statistics. 2022. URL https://ec.europa.eu/eurostat/statistics-explained(AccessedonJanuary6,2023).

Mark E Feinberg, Anna R Solmeyer, and Susan M McHale. The third rail of family systems: Sibling relationships, mental and behavioral health, and preventive intervention in childhood and adolescence. *Clinical child and family psychology review*, 15(1):43–57, 2012.

Norman Fenton. The only child. *The Pedagogical Seminary and Journal of Genetic Psychology*, 35(4):546–556, 1928.

Raquel Fernández and Richard Rogerson. Sorting and long-run inequality. *The Quarterly Journal of Economics*, 116(4):1305–1341, 2001.

Raquel Fernández, Alessandra Fogli, and Claudia Olivetti. Mothers and sons: Preference formation and female labor force dynamics. *The Quarterly Journal of Economics*, 119(4): 1249–1299, 2004.

Raymond Fisman, Sheena S Iyengar, Emir Kamenica, and Itamar Simonson. Gender differences in mate selection: Evidence from a speed dating experiment. *The Quarterly Journal of Economics*, 121(2):673–697, 2006.

Oded Galor and David N Weil. Population, technology, and growth: From malthusian stagnation to the demographic transition and beyond. *American economic review*, 90(4):806–828, 2000.

Jeremy Greenwood, Nezih Guner, Georgi Kocharkov, and Cezar Santos. Marry your like: Assortative mating and income inequality. *American Economic Review*, 104(5):348–53, 2014.

Jeremy Greenwood, Nezih Guner, Georgi Kocharkov, and Cezar Santos. Technology and the changing family: A unified model of marriage, divorce, educational attainment, and married female labor-force participation. *American Economic Journal: Macroeconomics*, 8(1):1–41, 2016.

Neil L Griffiths, Kevin Thomas, Bryce Dyer, Jessica Rea, and Anat Bardi. The values of only-children: Power and benevolence in the spotlight. *Journal of Research in Personality*, 92:104096, 2021.

Moshe Hazan and Binyamin Berdugo. Child labour, fertility, and economic growth. *The Economic Journal*, 112(482):810–828, 2002.

Gunter J Hitsch, Ali Hortaçsu, and Dan Ariely. Matching and sorting in online dating. *American Economic Review*, 100(1):130–63, 2010.

Daniel Kessler. Birth order, family size, and achievement: Family structure and wage determination. *Journal of Labor Economics*, 9(4):413–426, 1991.

Hiroshi Kojima. Sibling configuration and coresidence of married couples with an older mother in japan. *International Journal of Japanese Sociology*, 2(1):1–16, 1993.

Kai A Konrad, Harald Künemund, Kjell Erik Lommerud, and Julio R Robledo. Geography of the family. *American Economic Review*, 92(4):981–998, 2002a.

Kai A Konrad, Harald Künemund, Kjell Erik Lommerud, and Julio R Robledo. Geography of the family. *American Economic Review*, 92(4):981–998, 2002b.

Jungmin Lee. Sibling size and investment in children's education: An asian instrument. *Journal of Population Economics*, 21(4):855–875, 2008.

Bingjing Li and Hongliang Zhang. Does population control lead to better child quality? evidence from china's one-child policy enforcement. *Journal of Comparative Economics*, 45 (2):246–260, 2017.

Haoming Liu. The quality–quantity trade-off: evidence from the relaxation of china's one-child policy. *Journal of Population Economics*, 27(2):565–602, 2014.

Corinne Low. *Essays in gender economics*. PhD thesis, Columbia University, 2014.

Di Lu. The more the merrier? the effect of relaxing birth quotas on marriage outcomes. *Available at SSRN 4439978*, 2023.

Frances R Lu and Tom Vogl. Intergenerational persistence in child mortality. Technical report, National Bureau of Economic Research, 2022.

Adriean Mancillas. Challenging the stereotypes about only children: A review of the literature and implications for practice. *Journal of Counseling & Development*, 84(3):268–275, 2006.

Robert D Mare. Five decades of educational assortative mating. *American sociological review*, pages 15–32, 1991.

Steven Mellor. How do only children differ from other children? *The Journal of Genetic Psychology*, 151(2):221–230, 1990.

Ministry of Health, Labour and Welfare. Summary report of comprehensive survey of living conditions 2019. 2020. URL https://www.mhlw.go.jp/english/database/db-hss/dl/report_gaikyo_2019.pdf(AccessedonJanuary6,2023).

Omer Moav. Cheap children and the persistence of poverty. *The economic journal*, 115(500): 88–110, 2005.

John Pencavel. Assortative mating by schooling and the work behavior of wives and husbands. *The American Economic Review*, 88(2):326–329, 1998.

Denise F Polit and Toni Falbo. Only children and personality development: A quantitative review. *Journal of Marriage and the Family*, pages 309–325, 1987.

Denise F Polit and Toni Falbo. The intellectual achievement of only children. *Journal of Biosocial science*, 20(3):275–286, 1988.

Denise F Polit, Ronald L Nuttall, and Ena V Nuttall. The only child grows up: A look at some characteristics of adult only children. *Family Relations*, pages 99–106, 1980.

Dudley L Poston Jr and Toni Falbo. Academic performance and personality traits of chinese children:" onlies" versus others. *American Journal of Sociology*, 96(2):433–451, 1990.

Nancy Qian. Quantity-quality and the one child policy: The only-child disadvantage in school enrollment in rural china. Technical report, National Bureau of Economic Research, 2009.

Xuezheng Qin, Castiel Chen Zhuang, and Rudai Yang. Does the one-child policy improve children's human capital in urban china? a regression discontinuity design. *Journal of Comparative Economics*, 45(2):287–303, 2017.

Helmut Rainer and Thomas Siedler. O brother, where art thou? the effects of having a sibling on geographic mobility and labour market outcomes. *Economica*, 76(303):528–556, 2009.

Helmut Rainer and Thomas Siedler. Family location and caregiving patterns from an international perspective. *Population and Development Review*, 38(2):337–351, 2012.

James M Robins and Andrea Rotnitzky. Semiparametric efficiency in multivariate regression models with missing data. *Journal of the American Statistical Association*, 90(429):122–129, 1995.

Mark R Rosenzweig and Junsen Zhang. Do population control policies induce more human capital investment? twins, birth weight and china's "one-child" policy. *The Review of Economic Studies*, 76(3):1149–1174, 2009.

Vira Semenova and Victor Chernozhukov. Debiased machine learning of conditional average treatment effects and other causal functions. *The Econometrics Journal*, 24(2):264–289, 2021.

Glenna Spitze and John R Logan. Sibling structure and intergenerational relations. *Journal of Marriage and the Family*, pages 871–884, 1991.

The Dai-ichi Life Research Institute. The summary report on the results of survey on inheritance among middle-aged and older adults in japan, 2005 (japanese). 2007. URL https://www.dlri.co.jp/pdf/ld/01-14/news0701.pdf.

The Office for National Statistics. Number of families by number of dependent children, uk, 1996 to 2019. 2020. URL https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families(AccessedonJanuary6,2023).

The Yu-cho Foundation. The summary report on the results of the 5th survey on household finances and savings in japan, 2022 (japanese). 2023. URL https://www.yu-cho-f.jp/wp-content/uploads/survey_report-9.pdf.

Fumiya Uchikoshi, James M Raymo, and Shohei Yoda. Family norms and declining first-marriage rates: The role of sibship position in the japanese marriage market. *Demography*, page 10741873, 2023.

Fumiya Uchikoshi, Yoshikuni Ono, Hirofumi Miwa, and James M Raymo. Revisiting marriage market mismatch: A conjoint survey experiment approach. 2024.

Tom S Vogl. Marriage institutions and sibling competition: Evidence from south asia. *The Quarterly Journal of Economics*, 128(3):1017–1072, 2013.

Tom S Vogl. Intergenerational associations and the fertility transition. *Journal of the European Economic Association*, 18(6):2972–3005, 2020.

Fangqi Wen. Assortative mating on only-child status and accumulation of economic advantages in contemporary china. *Available at SSRN 4519501*, 2023.

David H Wolpert. Stacked generalization. *Neural networks*, 5(2):241–259, 1992.

Jiabin Wu and Hanzhe Zhang. Preference evolution in different matching markets. *European Economic Review*, 137:103804, 2021.

Wei-hsin Yu and Ekaterina Hertog. Family characteristics and mate selection: Evidence from computer-assisted dating in japan. *Journal of Marriage and Family*, 80(3):589–606, 2018.

Wei-hsin Yu, Kuo-hsien Su, and Chi-Tsun Chiu. Sibship characteristics and transition to first marriage in taiwan: Explaining gender asymmetries. *Population Research and Policy Review*, 31(4):609–636, 2012.