DEMOGRAPHIC RESEARCH
A peer-reviewed, open-access journal of population sciences

DEMOGRAPHIC RESEARCH

VOLUME 37, ARTICLE 43, PAGES 1383- 1412
PUBLISHED 9 NOVEMBER 2017
http://www.demographic-research.org/Volumes/Vol37/43/
DOI: 10.4054/DemRes.2017.37.43

Research Article

Postmarital residence and child sex selection: Evidence from northeastern Japan, 1716–1870

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This publication is part of the Special Collection on "The Power of the Family," organized by Guest Editors Hilde A.J. Bras and Rebecca Sear.

Contents

Demographic Research: Volume 36, Article 43
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Abstract

BACKGROUND
Child sex is often 'selected' due to parental preference, especially in historical East Asia. Postmarital residence shapes coresident kin availability and conjugal power hierarchies, which may influence the couple's preference and selection on child sex. Empirical evidence, however, remains limited.

OBJECTIVE
We examine whether postmarital residence influences the sex of births and how such influence interacts with coresident kin, sex composition of surviving children, household landholding, and local economic fluctuation.

METHODS
We analyze annual panel data of 1,045 wives, transcribed from household registers recording the entire population of two villages between 1716 and 1870 in northeastern Japan, where both virilocal and uxorilocal residence were common. We use discrete-time event-history models via binary and multinomial logistic regressions, with either clustered standard errors or random effects at individual level, to examine the effects of selected factors on the probability of having a male, female, or no birth in the next year.

RESULTS
Compared with virilocal marriages, uxorilocal marriages are more likely to have a first birth in the next year, especially a female first birth when the household is wealthy. As for second and later births, uxorilocal marriages are less likely to reproduce males in the next year when surviving children are all females, but more likely to reproduce females when surviving children are all males.

CONCLUSIONS
This study is among the first to provide systemic evidence on how postmarital residence

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shapes child sex selection. Unlike the common perception of 'missing girls' in East Asia, shaped by specific reproductive context, both girls and boys can be missing in early modern Japan.

1. Introduction

While, in principle, the chances of having male and female births are about equal in the human population (Fisher 1930), in reality, the sex of children is often 'selected' depending on parental preferences for specific parity and sex composition of surviving children (Drixler 2013; Lee and Wang 1999; Lee, Wang, and Campbell 1994; Choe, Hao, and Wang 1995; Smith 1977; Tsuya et al. 2010; Sandström and Vikström 2015; Hank 2007; Anderson et al. 2006; Drixler and Kok 2016; Reher et al. 2017; Manfredini, Breschi, and Fornasin 2013). The observed sex ratio of young children is particularly skewed among many contemporary and historical Asian populations (Zeng et al. 1993; Tsuya et al. 2010; Sen 1992; Das Gupta 1987; Coale and Banister 1996; Park and Cho 1995). With modern contraception and sex detection techniques, child sex selection is primarily prenatal, but in the past it was mostly postnatal, through infanticide and neglect (Hrdy 1987; Lee and Wang 1999; Lynch 2011).

Explanations of the skewed offspring sex ratio from an evolutionary perspective emphasize biased investment of parents in accordance with their conditions, probably best exemplified by the Trivers–Willard hypothesis (Trivers and Willard 1973). When applied to humans, the theoretical expectation is that due to the different reproductive payoffs of sons and daughters, parents of advantageous socioeconomic status and favorable living environment tend to produce boys, while those in poor conditions are prone to produce girls. However, empirical studies of selected human populations provide inconsistent evidence (Kolk and Schnettler 2016; Cronk 2007; Freese and Powell 1999; Gaulin and Robbins 1991). Moreover, sex selection is found across socioeconomic strata (e.g., Lee and Wang 1999). Thus, in addition to general evolutionary and biological mechanisms we may need to consider specific social and cultural contexts.

Existing research from a social perspective indeed suggests considerable complexity and agency of human reproduction in response to various contexts. Increasing evidence reveals the importance of family structure and kin availability (Sear and Coall 2011). The influence of socioeconomic characteristics on reproduction has also been commonly recognized (Voland 1984; Low 1990; Chen, Lee, and Campbell 2010; Tsuya et al. 2010). Meanwhile, as suggested by a systematic comparison of selected Eurasian populations in 1700–1900, contexts that matter the most to

reproduction may differ between populations (Tsuya et al. 2010). In northwestern Europe, socioeconomic status – often reflected in individual occupation and household property – played a critical role in shaping reproduction. In East Asia, social power – an individual's position within the family hierarchy and local society – was particularly important.

This paper focuses on how postmarital residence, as an important family context, influences child sex selection and whether its influence varies by other contexts such as coresident kin, household land wealth, sex composition of surviving children, and local economic fluctuations. Virilocal/patrilocal marriages (wife living with husband and his kin), uxorilocal/matrilocal marriages (husband living with wife and her kin), and neolocal marriages (the couple living independently) often differentiate the conjugal power hierarchy of the couple and their social standing in the family and kin group.[3] The main reason is that postmarital residence defines not only whether the couple coresides with a natal kin group but also with whose natal kin group they coreside, interact, pool resource, share risks, and fulfill familial obligations. On the one hand, for the husband, although the degree may vary according to local norms, uxorilocal marriage in East Asia often implies 'status exchange' (e.g., Davis 1941; Merton 1941). A socioeconomically disadvantaged man marries a woman from a better-off family at the cost of leaving his kin group and giving up the succession of patrilineal family, which is a central familial duty for males in Asian culture. Being 'selected' by the wife's family, he has productive and reproductive obligations to the interests of his in-law family. On the other hand, for the wife, uxorilocal marriage generates empowerment in domestic life and provides support from her natal kin living under the same roof or nearby. In strongly patriarchal societies, uxorilocally married wives are often the first if not the only child, which may imply established acceptance of and preference for girls in the family. This may further shape sex preference and selection in reproducing the next generation. Hence, all else being equal, we expect that uxorilocal marriages are more likely to favor and produce girls than virilocal marriages.

However, little empirical evidence exists in the literature concerning the relationship between postmarital residence and child sex selection, let alone consideration of the confounding roles played by other contexts such as coresident kin, household wealth, sex composition of surviving children, and local economic conditions. This is not surprising considering that in Western populations, where postmarital residence is relatively diverse, sex preference and sex-selective reproduction control are atypical, while in most Asian populations, where son preference and sex-selective reproduction control are common, postmarital residence is

[3] Existing studies tend to use 'virilocal' and 'patrilocal,' as well as 'uxorilocal' and 'matrilocal,' interchangeably. We use 'virilocal' and 'uxorilocal' hereafter.

predominantly virilocal. To our knowledge, in a historical East Asian context, only Wolf and Huang (1980) and Drixler (2013) discuss marital residence types and their reproduction differentials using quantitative data. From an anthropological perspective and based on tabulations of early-20th-century population registration data from Taiwan, Wolf and Huang find that children's marriages had much lower fertility levels than uxorilocal and virilocal marriages because "the intimate childhood association aroused a marked, sustained aversion" (1980: 176), resulting in low fertility. However, they neither compare reproduction in virilocal and uxorilocal marriages nor do they study sex selection. Drixler (2013: 95) provides a tabulation based on cross-sectional data from historical population registers, suggesting that Japanese uxorilocal marriages have a greater preference for a daughter as the first child than virilocal marriages, but provides no further explanation nor systematic examination (details are discussed in the next section). In contemporary rural China, Jin, Li, and Feldman (2006) find no difference in fertility between virilocal and uxorilocal marriages, but child sex selection is not the focus of their study.

Tokugawa Japan provides a unique opportunity to compare differences in reproduction between virilocal and uxorilocal marriages. Like other historical East Asian populations, in Tokugawa Japan virilocal marriages dominated, and postnatal sex-selective reproduction control was widely practiced (Drixler 2013; Saito 1992). Meanwhile, the Tokugawa Japanese population included a nontrivial proportion of uxorilocal marriages (more details in the next section). Moreover, individual-level panel data, consisting of annual observations of more than 6,000 individuals living in two northeastern Japanese villages between 1716 and 1870, further allows for a longitudinal analysis of the interaction between child sex selection and selected characteristics of individuals, couples, households, and communities.

Thus, this study provides new empirical evidence of not only differential sex preferences and sex-selective reproduction controls between virilocal and uxorilocal marriages but also their associations with coresident kin and household wealth. Compared with virilocal marriages, we find that uxorilocal marriages are more likely to record a female first birth as opposed to no birth in the next year, especially among wealthy households. Moreover, regarding second and later births, uxorilocal marriages are less likely than virilocal marriages to have an additional male birth in the next year when surviving children are all females but more likely to have an additional female birth in the next year when surviving children are all males.

Our empirical findings on the influence of postmarital residence on child sex selection also help us understand different strategies of family organization and succession across generations and, in particular, distinguish uxorilocal marriage as a long-term rather than a short-term family strategy. It is conventionally assumed that uxorilocal marriage is a temporary strategy to meet the practical needs of daughter-only

families and low-status males. If that were the case, given the prevailing patriarchal culture, the wife's family would want male descendants in the next generation to carry on the family line. Thus, we would expect to observe a similar, if not stronger, son preference in uxorilocal marriages than in virilocal marriages. By contrast, we find uxorilocal marriages tend to favor daughters more than virilocal marriages. Consequently, the next generation of uxorilocal marriages is also more likely to be uxorilocal. In other words, intergenerational transmission of uxorilocal marriage may exist along the matrilineal line. In this regard, uxorilocal marriage represents a long-term strategy for family organization and continuity adopted by a subpopulation, which persistently differs from the virilocal majority in patriarchal societies.

2. Background

2.1 Marriage and stem family norms in Tokugawa Japan

Early modern Japan is known for its regional diversity in population and family patterns. The northeastern region demonstrates a strong adherence to the stem family principle (i.e., only one couple in each generation) (Oto 1996; Cornell 1987). Rural villagers actively controlled household size and sex balance of members via marriage, divorce, remarriage, adoption, service migration, and even infanticide. Marriage was pivotal in recomposing the family. In stem family households, inheriting children brought in the new spouse, and noninheriting siblings left home (Smith 1977; Cornell 1987; Kurosu 1996). This rule kept "the family farm and other property intact from one generation to the next, assuring as nearly as possible that the family would continue in the village" (Smith 1977: 134–135). Moreover, this rule resulted in different life course options and power structures within the family. In both uxorilocal and virilocal marriages, inheriting daughters in the former and inheriting sons in the latter were more autonomous and had easier access to resources in their natal households (e.g., Oto 2001: 367). The husbands and wives who married into their households had to obey the practices and rules of the new marital residence. Divorce occurred frequently in early modern Japan (Kurosu 2011). If couples divorced, husbands and wives who had married in had to leave the marital household, while inheriting daughters and sons stayed in their natal households and often remarried.

While uxorilocal marriage was not uncommon in various parts of Japan, it was especially popular in regions known to have practiced succession by the eldest daughter (*ane-katoku* in folk terms) (Maeda 1976). This was a form of uxorilocal marriage where

upon marriage the husband came to live with the wife's family.[4] Alternatively, this is considered a form of adoption, called 'adoption of sons-in-law' (*muko-yoshi*). This custom is said to have been common in northeastern Japan, where per-capita landholding is large (particularly of rice paddies) and families needed to recruit manpower (or sons-in-law) for labor-intensive field work (Oto 1996: 265). The environment in northeastern Japan was harsh, and mortality was relatively high, making early succession necessary (Hayami 2009: 585–586).

Frequent practice of uxorilocal marriage or son-in-law adoption together with daughter-first preference might facilitate a peasant strategy for swift and successful transition of headship in villages with a high mortality risk (Kurosu 2013). The idea that couples deliberately had daughters in order to find capable sons-in-law is often discussed as a strategy for the families of merchants and medical doctors (Otake, Takeda, and Hasegawa 1988). Similarly, in postwar Japan, Mehrotra et al. (2010) find that such adult adoption strategy makes family firms unusually competitive. For the interest of this study, it is important to note that inheriting women who married uxorilocally generally retained higher social status and power even after marriage (Mori 1999; Maeda 1992: 71–74).[5]

2.2 Infanticide and sex preference in Tokugawa Japan

Infanticide has been a central topic in the discussion of recorded low fertility and population stagnation in 18th-century Japan. Findings are mixed as to whether poor peasants practiced infanticide due to economic hardship, as suggested by conventional prewar historians, or, regardless of social status, used infanticide as a form of postpartum birth control or family planning to limit family size and improve household income (e.g., Hanley 1972; Smith 1977). While most historical demographers agree that it was a practice embedded deeply in cultural and historical contexts, its regional variation, persistence, and spread and its importance to population patterns and other demographic behaviors are yet to be fully examined. Some studies claim that what appears as infanticide could be attributed to miscarriages induced by overwork and

[4] While *ane-katoku* is the equivalent of primogeniture (succession by the eldest child), succession by the eldest daughter is emphasized here, as succession by the eldest son was the majority and common pattern in early modern Tokugawa (Yamamoto 2006).

[5] Two pieces of evidence point to the fact that sons-in-law were fairly powerless in uxorilocal marriages and that the family heads (wives' fathers) were influential in determining their marriage continuity and transfer of headship. First, the risk of divorce was higher among uxorilocal than virilocal marriages in the two villages; i.e., sons-in-law were often divorced and left (were kicked out or ran away) the marital household (Kurosu 2011). Second, a study of adoption in Shimomoriya found that becoming sons-in-law was not a promise of future headship; even if they became the head, their average length of headship was much shorter than that of natural sons (Kurosu 1998).

sexually transmitted disease (Tomobe 2001). Other factors related to exposure to the risk of conception (e.g., age at marriage, sexual networking, spousal separation, breastfeeding) need to be investigated, making infanticide only one of "multiple components of demography" (Cornell 1996: 44). Recent studies try to place infanticide in the wider context of the history of parenting, childhood, and reproduction, as well as astrology and cultural beliefs (Ota 2007; Sawayama 2005; Kawaguchi 2002).

Existing literature also suggests a complicated relationship between infanticide and sex preference in Tokugawa Japan. Drixler's work (2013), based on large cross-sectional data collected from Eastern Japan, brings infanticide back to the center as an explanation of population changes in early modern Japan. Based on the own-children method of backward projection of fertility, Drixler places the proportion of infanticides and abortions close to 40% during the decades when they were most frequent (2013: 18). While the precise estimate may be debatable, his work empirically supports the wider use of infanticide among peasants and, more importantly, shows that, "unlike other systems of infanticide, eastern Japan's logic of infant selection did not consistently reject baby girls" (Drixler 2013: 91). This is in line with studies that show that sex-balanced offspring were desired in Tokugawa society in order to ensure the family line and for gendered labor (Ota 1991). The number of surviving siblings and their sequence influenced infanticide choices (Drixler 2013: 92). Tsuya and Kurosu (2010) argue that the preference for a daughter (especially having a daughter first) prevailed particularly in the eastern part of Japan, as a daughter could help the mother by looking after her younger sibling(s) (Hanley and Yamamura 1975; Skinner 1987). In addition, the girl–boy(s) sequence served the interests of fathers (and mothers) who married at a young age by reducing the potential for intergenerational power conflicts between the father as household head and his eldest son as heir presumptive (Skinner 1988). Regarding our study, another finding of Drixler (2013: 92) is especially worth noting: The male-to-female sex ratio of children appeared to be lower among uxorilocal marriages than among virilocal marriages. This finding is based on a tabulation that does not account for confounding factors and is not accompanied by detailed explanation, but it is nevertheless in line with our findings, reported later.

2.3 Settings of our study population

Our study population is from two northeastern Japanese villages, Shimomoriya and Niita, located in today's Fukushima prefecture. The villages were almost exclusively agricultural. Shimomoriya, situated at the foot of a mountain range, was susceptible to cold summers and poor harvests resulting from chilly gusts off the mountains (Narimatsu 1985: 1–3). Niita, situated on flat land on the banks of the Gohyaku River,

had less severe winter weather (Narimatsu 1992: 4–6) but was vulnerable to frequent flooding. In other words, the two villages were often at the mercy of fluctuations in agricultural output.

Despite or partly due to the environmental hardship,[6] the peasants appear to have actively adjusted household size and composition for the integrity and continuity of the family (Kurosu 2013). Studies based on the same village records as this study reveal survival strategies of the farm households based upon economic and demographic constraints, including using marriage (Tsuya and Kurosu 2014), adoption (Kurosu 2013), divorce (Kurosu 2011), and remarriage (Kurosu 2007), and controlling the timing of siblings' departures in relation to the heir's marriage and first birth (Kurosu 1996). Being the head or an immediate member of the stem family reduced mortality risk (Tsuya and Kurosu 2004). Thus, the individual life course was tightly bound to and stratified by stem family rules (Saito 2000). Tsuya and Kurosu (2004, 2010) suggest that the mortality level of the two villages was at the higher end and the fertility level was at the extremely low end of the distribution observed for villages of the same period. Strong reproductive control was prevalent, not only through parity-specific efforts (stopping) but also from behaviors not related to limitation of family size, such as birth spacing and spousal separation due to frequent labor migration. While women married very young, they did not start to have children until three to four years after marriage, had the next child five years after the previous one, and stopped having children by age 33 to 34. The mean number of births recorded was one of the lowest ever observed in 18th- and 19th-century rural Japan. There is clear indication of extensive and sophisticated use of sex-selective and parity-specific infanticide with the aim of achieving a relatively small and sex-balanced offspring set (a daughter was preferred first). This confirms the normative understanding of the general sex preference and infanticide practices in historical Japanese populations. Our study develops these previous works further by examining the relationship between postmarital residence and reproduction.

[6] The population trends of the two villages reflect the economic hardship of peasant life. At the beginning of the registers the population of Niita was 538 and of Shimomoriya 419, and they remained stable for the first 35 years. However, both villages suffered population decline, losing a total of 30%–40% from the initial period. The populations started a gradual upturn only after 1840, with a general improvement in the climate resulting in less frequent famines and the development of agricultural techniques improving living standards in the two villages. The number of households also declined from the mid-1770s and became stable in the 1840s at 30%–40% below the number of households in the early 18th century. The average size of households was stable at around four members, which was small for a preindustrial population, and increased only after the Tempo famine in the 1830s, to around six persons in both villages.

3. Methodology

3.1 Data

This study takes advantage of individual-level panel data from the local population registers – *ninbetsu-aratame-cho* – in Shimomoriya and Niita (NAC-SN). These NAC records cover a period of about 150 years, 1716–1869 for Shimomoriya and 1720–1870 for Niita, with only a small number of intermittent years missing. The registers record vital events, including birth, death, marriage, and migration, for all individuals residing in the villages. In addition, exits from and entry to the household, including movements within and outside the village, were recorded in detail. Exits for unknown reasons were rare, accounting for less than 1% of all recorded exits in the NAC registers in both villages. Thus, their quality and length make these NAC registers some of the best documentation of historical populations in Japan, and possibly in East Asia (Tsuya and Kurosu 2004; Dong et al. 2015).

To compare marital reproduction in virilocal and uxorilocal marriages, we define our population at risk as currently married females aged 10–49. Unlike in many other East Asian populations, in the past divorce and remarriage were relatively common in Japanese populations. We therefore further restrict our analysis to those who are recorded as getting married in the NAC and have neither own children ever recorded nor coresiding children resulting from their husbands' previous marriages or adoptions. By so doing, although we have no information on women's marriage and reproductive histories outside the village, if any, we assure that all observed births and their parities are exactly measured for each marriage under study. Only observations linked to another observation of the same individual in the following year are eligible for analysis. This restriction ensures that our estimated coefficients represent the effect on the probability of having a birth in the next year. Attrition is not a substantial concern in the NAC-SN data since the average rate of linking individual observations between registers is around 95%, the highest among comparable historical population panel data in East Asia (Dong et al. 2015). After the above-mentioned data restrictions, our analytical sample comprises 13,888 annual observations of 1,045 wives, of whom 978 have a first birth and 700 have second and later births.

3.2 Methods and measures

The panel structure of our data facilitates a discrete-time event history approach. It has been widely used by previous studies on reproduction and child mortality using these Japanese and similar East Asian panel data (e.g., Tsuya et al. 2010; Dong et al. 2017).

We begin by applying logit models and examine effects of selected factors on the overall probability of having a recorded birth in the next year, regardless of the child's sex. We then apply multinomial logit models and distinguish the differential probability of three mutually exclusive competing outcomes: male, female, or no birth.[7] In addition, considering possible unobserved heterogeneity among wives or couples, we employ two methods to confirm the findings. One is a multinomial logit model with clustered standard errors at the individual level to account for possibly correlated errors of observations of the same individual. The other is a two-level random intercept (or, in other words, random-effect) multinomial logit model, with observations as the first level and unique individuals as the second level, which takes account of time-invariant unobserved characteristics that have consequences for reproduction, like fecundity, health, and other reproductive traits (Campbell and Lee 2010).

We study first births and later births separately. As discussed before, sex preference in Japanese culture varies by parity and sex composition of surviving children. It is therefore important to differentiate the pattern by parity, and to include measures for previous births and surviving children when studying later births.

We have two outcome variables. The first is a dummy variable indicating whether the woman has a new recorded birth in the next year, which serves to estimate the overall probability of reproduction. The second is a categorical variable indicating whether the woman has no, a male, or a female birth(s) in the next year, which concerns the differential probability of reproduction by child's sex. We find no women with both male and female births recorded in the same year. Thus, the three categories are mutually exclusive.

Our key explanatory variable is an indicator of the type of postmarital residence: virilocal or uxorilocal. We also include variables for wife's age and its squared term, wife's age at the current marriage, and whether the current marriage is a remarriage. In addition, following previous research (Tsuya et al. 2010; Skinner 1993), we include a measure for conjugal power hierarchy, that is, the age difference between wife and husband – whether the husband is six and more years older, zero to five years older, or younger than the wife. To study later births we include three measures regarding characteristics of previous births: years from last birth, cumulative number of recorded

[7] This approach has methodological advantages over previous studies on the differential probability of having male and female births. Although also differentiating, the East Asian part of the analysis in Tsuya et al. (2010) only uses simple logit models with two separate binary outcome variables, having a recorded male birth or not, and having a recorded female birth or not. Such an estimation strategy mixes the two reference outcomes – having a recorded birth of the opposite sex and having no birth – and thus may produce biased estimated effects of the explanatory variables. Moreover, compared with a set of separate logit models, multinomial logit models enable us to conduct statistical tests of coefficients between different outcomes, which is the focus of our study of sex selection behavior.

births up to the current year, and whether there are no surviving children, only males, only females, or both males and females.

For coresident kin and other household- and community-level contexts, we first have a categorical variable measuring the presence or absence of parents or parents-in-law in the household: no parents, only mother, only father, both parents. We also have a set of dummy variables indicating the sibling or sibling-in-law coresidence of older brothers, older sisters, younger brothers, and younger sisters. To measure the size effect of household we have not only the number of kin but also the number of non-kin in the household. The number of coresident kin allows us to examine the scale effect of coresident kin, be it negative due to elevated resource competition or positive because of increased domestic help. Because the non-kin in the household are predominantly servants and laborers, the number of coresident non-kin further enables us to examine the beneficial effect of extra labor provided by those not competing for household resources. Moreover, we have detailed annual household landholding information, measured by household land taxation, *koku*, a rare and valuable kind of time-variant household socioeconomic information for historical demographic research. We include annual rice prices to measure the short-term economic fluctuations of the village, lagged by one year and in logarithm. Finally, to account for time-invariant unobserved characteristics of specific villages and periods, although not reported in our result tables, we follow previous studies (Tsuya et al. 2010) and control for the fixed effects of the two villages and four periods: 1716–1759, 1760–1779, 1780–1839, and 1840–1870.

We report the descriptive statistics of the variables mentioned above in our analytical sample in the Appendix, Table A-1.

4. Results

4.1 Descriptive patterns

The sex ratio of recorded births in our Japanese study population is skewed, but the direction of skewness changes between first and later births. As suggested in Table 1, while wives in virilocal marriages appear to be slightly older when they marry and reproduce, they have relatively more male births than their counterparts in uxorilocal marriages. For first births, more female first births are registered, and the sex ratios of the two types of marriage also differ: 94.0 and 68.1 males per 100 females for virilocal and uxorilocal marriages respectively. By contrast, for second births more males are recorded than females: 123.3 males and 116.4 males per 100 females for virilocal and uxorilocal marriages respectively. For third and later births the sex ratios in virilocal

and uxorilocal marriages are similar, at around 109. While the absolute levels of sex ratios may be subject to specific data, region, and period, the patterns observed here are in line with Drixler's (2013) finding based on concurrent Japanese population cross-sectional data with a much broader geographic coverage.

Table 1: Reproductive age patterns and male-to-female sex ratio of recorded births by parity in virilocal and uxorilocal families

	Wife's age		First birth		Second birth		Third and later births	
Marital residence	First marriage	First birth	Sex ratio	N	Sex ratio	N	Sex ratio	N
Virilocal	15.5	19.9	94.0	487	123.3	364	109.0	489
Uxorilocal	13.9	19.1	68.1	190	116.4	132	109.9	170

To sum up, if we assume that the biological probability of giving birth to either sex is about equal, what we observe reflects deliberate sex selection.[8] However, unlike other East Asian historical populations in which 'missing girls' were predominant, the Japanese population under study has not only 'missing girls' but also 'missing boys.' Also, Table 1 suggests that the extent of child sex selection may differ between types of postmarital residence, which we will study further in the next section.

4.2 Event history analysis

4.2.1 First birth

Overall, uxorilocal marriages have a higher probability of recording a first birth in the next year than virilocal marriages. As suggested by Model 1 of Table 2, the odds of uxorilocal marriages having a first birth in the next year are 47% more than the odds for virilocal marriages. Models 2 and 3 yield similar results concerning the differential probability of having a male or female first birth by postmarital residence type.

[8] These patterns are unlikely to be an artifact of household registration. Our Japanese annual registers omit infants who were born after the current registration and died before the next registration. However, records of children are balanced between sexes and are relatively complete overall in the Japanese data. In comparison to similar household registration data in East Asia, and unlike the common omission of child records in some other Chinese and Korean historical population registration data, this argues against the systematic omission of children of either sex in the Japanese registration (Dong et al. 2015). Moreover, remaining documents of the basic law and ordinance of the Nihonmatsu domain to which these two villages belonged also demonstrate the completeness and thoroughness of the registration (*Goryounai ninbetu aratame no oboe*, transcribed in Nihonmatsu-han Shi Kanko-kai 1992: 518–519). Previous studies based on this data have yielded many plausible findings on mortality, marriage, and reproductive behavior in comparison with other East Asian and European populations.

Uxorilocal marriages have a 40% or 60% higher relative risk of having a male first birth as opposed to no birth in the next year than virilocal marriages. The relative risk for uxorilocal marriages of having a female first birth as opposed to no birth in the next year is 52% or 71% more than for virilocal marriages. While not reported in Table 2, the effect of postmarital residence on the probability of having a male as opposed to female first birth in the next year is not statistically significant. This suggests that uxorilocal and virilocal marriages do not have different sex selection practices regarding first birth.

Table 2: Effects of marital residence, kin coresidence, household landholding and other selected factors on the probability of having a recorded male or female first birth in the next year

	(1) Logit model, clustered SE		(2) Multinomial logit model, clustered SE (ref.: no birth)				(3) Two-level random-intercept multinomial logit model (ref.: no birth)			
	Either sex birth		Male birth		Female birth		Male birth		Female birth	
Variable	exp(b)	p	exp(b)	p	exp(b)	p	exp(b)	p	exp(b)	P
Age	3.436	0.000	3.538	0.000	3.381	0.000	4.429	0.000	4.159	0.000
Age^2	0.972	0.000	0.972	0.000	0.973	0.000	0.969	0.000	0.970	0.000
Age at marriage	1.033	0.075	1.048	0.066	1.018	0.440	0.999	0.984	0.971	0.383
Remarried	0.746	0.094	0.468	0.004	1.033	0.874	0.510	0.018	1.112	0.646
Couple age difference (ref.: husband 0–5 yrs older)										
Wife is older	0.737	0.178	0.843	0.589	0.651	0.158	0.745	0.399	0.605	0.144
Husband 6+ yrs older	1.123	0.274	1.109	0.484	1.132	0.354	1.091	0.597	1.117	0.467
Postmarital residence (ref.: virilocal)										
Uxorilocal	1.470	0.002	1.409	0.039	1.518	0.005	1.600	0.013	1.711	0.002
Coresidence of parents (ref.: none)										
Only mother(/-in-law)	1.038	0.830	0.956	0.843	1.112	0.654	1.042	0.877	1.194	0.505
Only father(/-in-law)	0.704	0.113	0.497	0.021	0.929	0.789	0.537	0.054	1.017	0.954
Both parents(/-in-law)	0.866	0.354	0.650	0.045	1.108	0.619	0.673	0.109	1.135	0.602
Coresidence of older brother(s)	0.946	0.785	0.840	0.564	1.038	0.885	0.807	0.533	1.010	0.973
Coresidence of older sister(s)	0.920	0.686	0.741	0.349	1.074	0.776	0.719	0.353	1.021	0.947
Coresidence of younger brother(s)	0.863	0.250	0.940	0.725	0.802	0.190	0.902	0.597	0.765	0.149
Coresidence of younger sister(s)	0.719	0.013	0.784	0.188	0.666	0.022	0.716	0.103	0.612	0.011
Number of kin in the household	1.003	0.950	1.029	0.684	0.985	0.818	1.042	0.592	0.997	0.966
Number of non-kin in the household	0.985	0.630	1.008	0.848	0.958	0.384	1.002	0.971	0.950	0.340
Household landholding (in *koku*)	1.010	0.204	1.012	0.267	1.008	0.438	1.012	0.290	1.008	0.498
Logged rice price last year	0.850	0.334	0.709	0.171	0.981	0.929	0.670	0.134	0.933	0.773
Village fixed effects	Yes		Yes		Yes		Yes		Yes	
Period fixed effects	Yes		Yes		Yes		Yes		Yes	
Constant	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Level-2 (individual-level) parameters										
b	–		–				1 (constrained)			
Variance (s.e.)	–		–				0.674 (0.350)			
Log (pseudo)likelihood	–1,493.876		–1,879.477				–1,875.817			
Individuals	978		978				978			
Observations	4,142		4,142				4,142			

Note: In Model 1 and 2, standard errors are adjusted for individual clusters. In Model 3, annual observations are the first level and unique individuals are the second level.

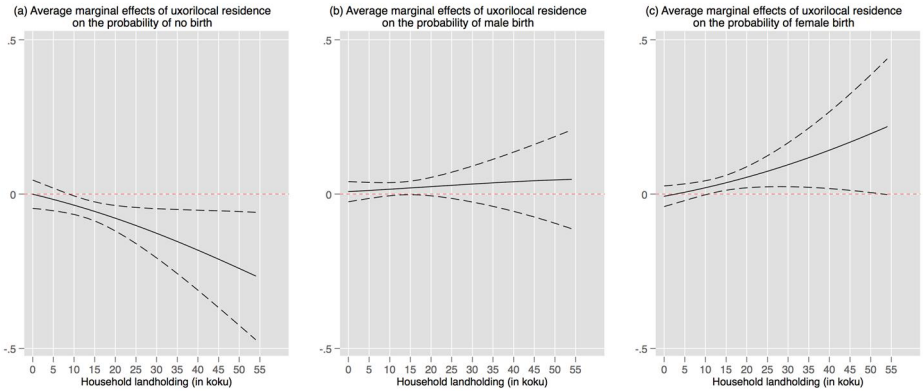
Postmarital residence having been taken into account, we find other selected marriage characteristics, including the conventional conjugal power hierarchy measure, (i.e., the age difference of the couple), are not associated with the probability of having a first birth in the next year. The only exception is that remarried wives are around 50% less likely to have a male first birth than wives in their first marriage, but there is no difference regarding female first births.[9] However, while not reported in detail due to limited space, we find no interaction effect between the wife's remarriage status and postmarital residence, suggesting similar behavioral patterns of remarried wives in virilocal and uxorilocal marriages. Moreover, the influence of postmarital residence on having a first birth remains if we only study wives in their first marriage.

Nor does strong evidence exist for the effects of coresident kin, except that living with at least one younger sister or sister-in-law lowers the probability of having a female birth. The negative association implies a substitution effect – both a young sister and a first-born daughter could meet the need for a young female member in the household who may later help care for the elderly and children.

However, interestingly, we find that the favoring effect of uxorilocal marriages on female first births varies by household socioeconomic status, measured by landholding. We estimate a model specified the same as Model 2 in Table 2 but with an additional interaction term of postmarital residence and household landholding. We plot in Figure 1 the average marginal effect (with 95% confidence interval) of uxorilocal versus virilocal marriages on the probability of having no birth, a male first birth, and a female first birth, in the next year, along with change in household landholdings. When household landholding increases, uxorilocal and virilocal marriages do not differ in the predicted probability of having a male first birth in the next year, but uxorilocal marriages are less likely to have no birth and more likely to have a female birth in the next year. In other words, instead of resuming virilocal marriages in the next generation by preferring a son, land-rich uxorilocally married couples have a particularly strong preference to have a daughter as the first child.

[9] There are 66 first births born to the remarried wives in our analytic sample. The sex ratio is even more skewed than the overall pattern: 78.6 in virilocal marriages and 32.3 in uxorilocal marriages.

Figure 1: Average marginal effects of uxorilocal vs. virilocal postmarital residence, along with change in household landholding, on the predicted probability of having no first birth (a), a male first birth (b), and a female first birth (c) in the next year



Note: Black dashed lines indicate 95% confidence intervals. The solid black line indicates the predicted probability for uxorilocal marriages. The red dashed reference line (y = 0) indicates the predicted probability for virilocal marriages.

We also find no direct effect of logged rice price in the previous year or of its interaction with postmarital residence. This suggests that the influence of postmarital residence is independent of local economic fluctuations. Together with the above finding regarding household landholding, we find no support for the Trivers–Willard hypothesis (Trivers and Willard 1973); otherwise, we should see that the selection favoring girl births reduces when the household is land-rich or the local rice price is low due to harvest.

4.2.2 Second and later births

The most important factors that influence the probability of having second and later births in the next year are the sex composition of surviving children and the count of previous births, as suggested in Table 3. Compared with those who currently have both male and female surviving children – the ideal composition in Japanese culture – couples who have no or single-sex surviving children are much more likely to have another birth. By contrast, the cumulative number of previously recorded births only influences the chance of having a male new birth. The more previously recorded births

the wife has, the more likely she is to have another male birth in the next year. However, it makes no difference to having female births in the next year.

Table 3: Effects of marital residence, kin coresidence, household landholding and other selected factors on the probability of having a recorded male or female second or later birth in the next year

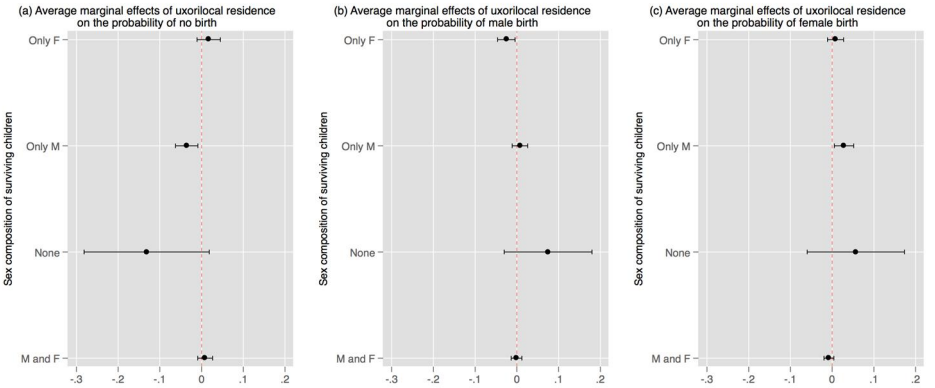
	(1) Logit model, clustered SE		(2) Multinomial logit model, clustered SE (ref.: no birth)				(3) Two-level random-intercept multinomial logit model (ref.: no birth)			
	Either sex birth		Male birth		Female birth		Male birth		Female birth	
Variable	exp(b)	p	exp(b)	p	exp(b)	p	exp(b)	p	exp(b)	p
Age	1.100	0.755	1.359	0.319	0.655	0.478	1.440	0.203	0.693	0.637
Age^2	0.990	0.000	0.989	0.000	0.990	0.000	0.988	0.000	0.989	0.000
Age at marriage	1.571	0.130	1.287	0.391	2.645	0.098	1.281	0.359	2.643	0.206
Remarried	0.950	0.658	1.130	0.413	0.779	0.133	1.119	0.533	0.754	0.157
Couple age difference (ref.: Husband 0–5 yrs older)										
Wife is older	1.178	0.312	1.282	0.361	1.088	0.694	1.291	0.337	1.089	0.760
Husband 6+ yrs older	0.845	0.040	0.842	0.109	0.851	0.136	0.819	0.085	0.829	0.118
Years from last birth	1.780	0.055	1.509	0.162	2.893	0.071	1.557	0.104	2.985	0.156
Cumulative number of births	1.180	0.003	1.262	0.001	1.110	0.165	1.178	0.027	1.034	0.644
Sex composition of surviving children (ref.: males and females)										
No surviving children	7.011	0.000	6.282	0.000	7.843	0.000	8.264	0.000	10.311	0.000
Only males	1.960	0.000	1.790	0.000	2.172	0.000	1.980	0.000	2.380	0.000
Only females	2.163	0.000	2.376	0.000	1.923	0.000	2.694	0.000	2.158	0.000
Postmarital residence (ref.: virilocal)										
Uxorilocal	1.062	0.473	0.947	0.648	1.201	0.080	0.941	0.633	1.203	0.154
Coresidence of parents (ref.: none)										
Only mother(/-in-law)	1.482	0.001	1.298	0.074	1.717	0.001	1.342	0.072	1.785	0.000
Only father(/-in-law)	1.224	0.141	1.078	0.703	1.401	0.056	1.045	0.818	1.361	0.110
Both parents(/-in-law)	1.471	0.001	1.378	0.037	1.592	0.004	1.429	0.031	1.663	0.004
Cores. of older brother(s)	1.376	0.033	1.259	0.326	1.519	0.091	1.357	0.243	1.650	0.059
Cores. of older sister(s)	0.998	0.992	0.990	0.971	1.011	0.972	0.949	0.856	0.981	0.950
Cores. of younger brother(s)	1.030	0.770	0.947	0.698	1.122	0.380	0.958	0.781	1.138	0.417
Cores. of younger sister(s)	1.413	0.003	1.266	0.119	1.593	0.004	1.275	0.137	1.592	0.005
Number of kin in the household	0.897	0.008	0.924	0.143	0.867	0.005	0.909	0.076	0.850	0.004
Number of non-kin in the household	1.094	0.000	1.100	0.001	1.087	0.003	1.105	0.002	1.092	0.008
Household landholding (in *koku*)	0.996	0.496	0.996	0.615	0.996	0.625	0.996	0.604	0.996	0.621
Logged rice price last year	1.100	0.409	1.248	0.139	0.954	0.781	1.252	0.168	0.957	0.804
Village fixed effects	Yes		Yes		Yes		Yes		Yes	
Period fixed effects	Yes		Yes		Yes		Yes		Yes	
Constant	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 3: (Continued)

	(1) Logit model, clustered SE		(2) Multinomial logit model, clustered SE (ref.: no birth)				(3) Two-level random-intercept multinomial logit model (ref.: no birth)			
	Either sex birth		Male birth		Female birth		Male birth		Female birth	
Variable	exp(b)	p	exp(b)	p	exp(b)	p	exp(b)	p	exp(b)	p
Level-2 (individual-level) parameters										
b	–		–				1 (constrained)			
Variance (s.e.)	–		–				0.255 (0.089)			
Log (pseudo)likelihood	–2,911.444		–3,610.232				–3,603.5606			
Individuals	700		700				700			
Observations	9,746		9,746				9,746			

The average effect of postmarital residence on the probability of having a female second or later birth as opposed to no birth in the next year becomes small and marginally statistically significant. However, postmarital residence has a heterogeneous influence according to the specific sex composition of surviving children. By introducing an interaction term to Model 2 in Table 3, we plot in Figure 2 the average marginal effect (with 95% confidence interval) of uxorilocal versus virilocal marriages on the probability of having no, a male, and a female new birth in the next year by sex composition of surviving children. When the couple has either no or both male and female surviving children, virilocal and uxorilocal marriages do not differ substantially in reproduction. However, among those who only have male surviving children, uxorilocal marriages are less likely to have no birth, similarly likely to have a male birth, and more likely to have a female birth in the next year. Moreover, when there are only female surviving children, uxorilocal marriages have a lower probability of having a male birth. To sum up, these interaction effects consistently suggest that, compared with virilocal marriages, uxorilocal marriages have a stronger girl preference.

Figure 2: Average marginal effects of uxorilocal vs. virilocal postmarital residence, by sex composition of surviving children, on the predicted probability of having no additional birth (a), an additional male birth (b), and a female additional birth (c) in the next year



Note: The dots with error bars indicate the predicted probability with 95% confidence intervals for uxorilocal marriages. The red dashed reference line (x = 0) indicates the predicted probability for virilocal marriages.

Returning to results reported in Table 3, coresident kin also influence producing second and later births. Living with either only mother(-in-law) or both parents(-in-law) is positively correlated with the probability of having a new birth of either sex. This, in line with the 'grandmother hypothesis' (Hawkes 2004; Jamison et al. 2002), suggests a positive helping effect of coresident mother or mother-in-law. Coresident older brothers(-in-law) and younger sisters(-in-law) have the same effect. But extra support from these coresident siblings only improves the chances of having a female birth. In other words, to produce a girl at later births is relatively subject to the household context and potential coresident caregivers. We find no evidence for an interaction effect between marital residence and parental coresidence, suggesting again that the effects of biological and in-law parents do not differ substantially, conditional on postmarital residence.

Moreover, the chances of having an additional female birth in the next year are also associated with the number of kin and non-kin in the household. Model 1 of Table 3 suggests a negative association between the number of kin in the household and the probability of having a new birth in the next year. However, according to models 2 and 3, such negative association is largely driven by its strong impact on female births yet weak influence (if any) on male births. In other words, for second and later births, competition in the household matters more for reproductive decisions regarding

daughters than sons. By contrast, the number of non-kin in the household measures support from servants, who are not competing for household resources, and has a helping effect on having additional births regardless of their sex.

We find no statistically significant effect of household landholding and rice price on the probability of having a second or later birth in the next year.

5. Conclusion and discussion

Taking advantage of individual-level panel data from two Japanese villages in 1716–1870, this study provides new empirical evidence that postmarital residence influences child sex selection. As demonstrated by different reproduction patterns, uxorilocal marriages may have stronger girl preference than virilocal marriages. For first births, uxorilocal marriages are more likely than virilocal marriages to register a girl as opposed to no birth in the next year, especially when the household is wealthy. For second and later births, uxorilocal marriages have a lower probability of producing a boy in the next year when surviving children are all girls, but a higher probability of producing a girl when surviving children are all boys.

Favoring girls in certain family contexts reflects the matrilineality of Japanese uxorilocal marriages. Limited by small sample size, this study cannot directly examine how the observed daughter preference results in the intergenerational transmission of uxorilocal marriages. However, such a tendency is likely to exist, since otherwise, given the dominant patriarchal culture, we would expect to find that uxorilocal marriages have a greater son preference than virilocal marriages to shape the next generation. As the construction of similar data, transcribed from Japanese historical population registers and other East Asian sources, is underway (Dong et al. 2015), soon we will have further evidence.

The relative daughter preference in Tokugawa Japan, especially among uxorilocal marriages, appears to differ from many other Asian populations that have a predominant son preference. Nevertheless, it may reflect a family succession strategy in stem family populations. Although both Japan and Northwestern Europe had stem family systems, in Northwestern European populations there was no apparent sex preference and selection. This may relate to one major difference between European and Japanese stem family systems: uxorilocal marriage, or son-in-law adoption, was common in Japan but virtually nonexistent in Europe (Saito 1998). Together with Japanese families being more "conspicuously vertically structured," the concept of descent line may have carried more weight in traditional Japan than in Europe (Saito 1998: 174). That being said, some recent comparative findings based on European populations from the late 19th century onward suggestively coincide with our finding of

daughter preference in stem family populations. Between 1900 and 1950 in the Netherlands and Sweden, where the Western European stem family system was typical, parents with no surviving female children substantially increased their birth intensities, suggesting an increasing preference for girls (Reher et al. 2017). Daughter preference at third birth and above has also been found in late-20th-century Danish, Norwegian, and Swedish populations (Anderson et al. 2006). However, such daughter preference does not appear in the Spanish population (Reher et al. 2017), where family organization is relatively complex and familial ties are strong (Reher 1998).

Overall, our study adds to the accumulating literature on sex preference and deliberate birth control in premodern populations and highlights complex human agency in reproduction, especially in relation to the dynamics of power and property in the family.

6. Acknowledgments

We thank Cameron Campbell, James Z. Lee, Matthew Noellert, Feng Yang, Zhuoni Zhang, the editors, and two anonymous reviewers for their constructive comments and suggestions. This research is supported by the Japan Society for the Promotion of Science Project JSPS KAKENHI (15H03139) and the MEXT-supported Program for the Strategic Research Foundation at Private Universities (S1591001L).

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Appendix

Table A-1: Descriptive statistics of variables

	First birth				Second and later births			
Variable	Mean	Std. dev.	Min	Max	Mean	Std. dev.	Min	Max
Reproduction in next year	0.141	0.348	0	1	0.107	0.308	0	1
Reproduction outcomes in next year								
No birth	0.859	0.348	0	1	0.893	0.308	0	1
Male birth	0.064	0.245	0	1	0.056	0.230	0	1
Female birth	0.077	0.267	0	1	0.050	0.219	0	1
Age	20.857	8.195	10	49	32.037	8.684	14	49
Age at marriage	15.624	5.358	3	48	26.298	6.533	13	48
Remarried	0.128	0.334	0	1	0.100	0.300	0	1
Couple age difference								
Husband 0–5 years older	0.588	0.492	0	1	0.569	0.495	0	1
Wife is older	0.059	0.236	0	1	0.034	0.181	0	1
Husband 6+ years older	0.353	0.478	0	1	0.397	0.489	0	1
Years from last birth	–	–	–	–	5.651	4.900	1	20
Cumulative number of births	–	–	–	–	2.475	1.331	1	9
Sex composition of surviving children								
Both males and females	–	–	–	–	0.416	0.493	0	1
No surviving children	–	–	–	–	0.029	0.166	0	1
Only boys	–	–	–	–	0.287	0.452	0	1
Only girls	–	–	–	–	0.269	0.444	0	1
Postmarital residence								
Virilocal	0.739	0.439	0	1	0.756	0.430	0	1
Uxorilocal	0.261	0.439	0	1	0.244	0.430	0	1
Coresidence of parents								
None	0.156	0.363	0	1	0.384	0.486	0	1
Only mother(/-in-law)	0.127	0.333	0	1	0.163	0.370	0	1
Only father(/-in-law)	0.102	0.303	0	1	0.094	0.292	0	1
Both parents(/-in-law)	0.615	0.487	0	1	0.359	0.480	0	1
Coresidence of older brother(s)	0.137	0.344	0	1	0.045	0.208	0	1
Coresidence of older sister(s)	0.132	0.339	0	1	0.035	0.185	0	1
Coresidence of younger brother(s)	0.272	0.445	0	1	0.132	0.338	0	1
Coresidence of younger sister(s)	0.282	0.450	0	1	0.107	0.309	0	1
Number of kin in the household	4.981	1.838	1	14	5.462	1.688	1	14
Number of non-kin in the household	0.433	1.527	0	25	0.456	1.530	0	25
Household landholding (in *koku*)	11.886	7.416	0	54.536	12.437	7.409	0	53.926
Logged rice price last year	–0.215	0.276	–0.673	0.732	–0.211	0.277	–0.673	0.732
Individuals (wives)			978				700	
Observations			4,142				9,746	

Note: While not reported in this table, our model estimations also include period and village dummy variables.