Missing Girls and Missing Boys: Differential Effects of Marital Residence, Co-resident Kin, and Household Wealth in Two Japanese Villages, 1716-1870

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Abstract: Postnatal reproduction control practices are common in both Eastern and Western historical populations, but in the East they are notably sex-selective. However, other than aggregate evidence of skewed sex ratios, empirical studies on determinants of such sex preference and sex-selective reproduction control practices, especially in relation to marital residence, remains limited. Taking advantage of individual-level panel data from the local population registers, *ninbetsu-aratame-cho*, in two northeastern Japanese farming villages Shimomoriya and Niita between 1716 and 1870, we examine sex-selective reproduction control by analyzing the unusual probability of having a newly recorded birth of a specific sex by parity. We focus on the contrast between two marital residence types: virilocal (married-in daughter-in-law living with inheriting sons and his family) vs. uxorilocal (adopted sons-in-law living with inheriting daughters with her family). And we study if co-resident kin and household wealth play different roles between virilocal and uxorilocal marriages in shaping their sex-selective reproductive behavior. We find that there are many more registered girls than boys at first birth, but the sex ratio skews into the opposite direction at second and later births. Our multivariate discrete-time event-history analysis further reveals that uxorilocal marriages favor girls more than virilocal marriages, even more so at first birth when uxorilocal families are land rich or at later births when their surviving children are only males. In other words, unlike other East Asian historical populations where female infanticide was overwhelming, there were not only "missing girls" but also a non-trivial number of "missing boys" in our study Japanese populations, especially among uxorilocal marriages. Our findings highlight the complex agency in human reproduction within the dynamics of power and property of the family.

Keyword: Sex-selective reproduction control, uxorilocal and virilocal marital residence, co-resident kin influence, wealth, Tokugawa Japan

1 Introduction

Postnatal reproduction control practices are common in both Eastern and Western historical populations, but in the East they are notably sex-selective (Tsuya et al. 2010, Lynch 2011, Hrdy 1987, Lee and Wang 1999). While, in principle, chances to have a human birth of either sexes should be about equal (Fisher 1930), in reality, the observed or recorded sex ratio of human infants and children is often highly skewed, particularly among historical and developing Asian populations (Zeng et al. 1993, Tsuya et al. 2010, Sen 1992, Das Gupta 1987 Coale and Banister 1994, Park and Cho 1995). In historical human populations, postnatal reproduction control practices are notably through infanticide and neglect in the East and to a lesser extent abandonment in the West (Hrdy 1987, Lee and Wang 1999, Tsuya et al. 2010, Lynch 2011). And sex preference and sex-selective control practices in reproduction could be complex according to the survival, parity, sex combination, and even sequencing of previous children (Drixler 2013, Lee and Wang 2010, Lee, Wang and Campbell 1994, Choe et al. 1995, Smith 1997, Tsuya et al. 2010, Sandström and Vikström 2015, Hank 2007, Anderson et al 2006, Drixler and Kok 2016, Reher et al. 2015, Manfredini, Breschi and Fornasin 2013)

Human reproduction, in other words, is not just a passive product shaped by external ecological environment, but often an active response to family and social context. In addition to a common recognition of the influence of family socioeconomic characteristics on reproduction (Voland 1984, Low 1990, Chen, Campbell and Lee 2010, Tsuya et al. 2010), increasing evidence suggests important effects of co-resident kin (Sear and Coall 2011). Most systematically demonstrated by the Eurasia Population and Family History Project that uses comparable individual-level longitudinal data and methods to compare between European and East Asian populations in 1700-1900, co-resident kin play critical roles in both economic and reproductive decision-making (Tsuya et al 2010: 92). Moreover, among northeastern Asian study populations, social power, such as an individual's position within the family and household hierarchies, largely defined the range of individual choices regarding reproduction. In contrast, in northwestern Europe, the socioeconomic status of an individual or a household was the main resource that enabled or compelled an individual to take actions regarding reproduction. Namely, on top of specific differences between individual and families, local norms and institutions regarding reproduction, kinship, inheritance, and family organization and succession also shape such family influence on reproduction.

In this study, we focus on the contrast between types of marital residence because marital residence is indeed one of the most crucial shaping factors to family influence. Being virilocal – wife living with husband's kin, uxorilocal – husband living with wife's kin, or neolocal – the couple living independently, makes a difference in their conjugal power hierarchy, access to resources, as well as their expected roles interacting with kin members. This is particularly the case for societies with complex family systems where neolocal residence is limited. In addition, increasing evidence suggests that paternal and maternal co-resident kin may have different influence on reproduction (Sear and Coall 2011).

However, little is known about the relationship between sex-selective reproduction control and marital residence, let alone the shaping roles played by co-resident kin and wealth. In Western populations where variation in marital residence is relatively large, sex preference and sex-selective control are atypical. In Asian populations where son preference and sex-selective behavior are common, marital residence is however predominantly virilocal. As a result, to our knowledge, under historical East Asian context only Wolf and Huang (1980) and Drixler (2013) discuss marital residence types and their reproduction differentials with quantitative data. From an anthropological perspective and based on tabulations of early twentieth century population registration data from Taiwan, Wolf and Huang find that children's marriages (called *sim-pua,* or minor marriage) had much lower fertility level than uxorilocal and virilocal (called major marriage) marriages because "the intimate childhood association aroused a marked, sustained aversion, resulted in low fertility" (1980: 176). But they neither emphasize the differential reproduction outcomes of virilocal and uxorilocal marriages, nor studies specific sex-selective reproduction control practices. By aggregating large-scale cross-sectional data from Tokugawa Japanese population registers, of which some share similar sources with our individual-level data, Drixler (2013) finds Japanese uxorilocal marriages prefer a daughter as the first child more than virilocal marriages – a pattern also confirmed and carefully examined by our study with longitudinal data. However, his finding remains preliminary in the sense that it is drawn from simple tabulations without further detailed examination (Drixler 2013: 95).

Tokugawa Japan provides a unique opportunity to study sex-selective reproduction control between virilocal and uxorilocal marriages. Like other historical East Asian populations, in Tokugawa Japan, virilocal marriages were dominant and postnatal sex-selective reproduction control was widely practiced (Drixler 2013, Saito 1992). But unlike its neighboring populations, Tokugawa Japanese population also consisted of a non-trivial proportion of uxorilocal marriages. Moreover, individual-level panel data consisting of annual observations of more than 6000

individuals living in two northeastern Japanese villages between 1716-1870 further facilitate our multivariate event-history approach to examine the influence of and interaction between select characteristics of individuals, couples, co-resident kin and households. Our study therefore provides new empirical evidence of not only differential sex preference and sex-selective reproduction control between virilocal and uxorilocal marriages, but also the associations with co-resident kin and household wealth. By demonstrating a profound historical experience of sex-selective reproduction control, it helps us to better understand the importance of various aspects of family context in shaping human agency in reproduction.

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). Peasants were active agent to control household size and sex balance of members via the channel of marriage, divorce, remarriage, adoption, service, and even infanticide. Marriage was pivotal in recomposing the family. Marriage was also vital for individual survival. Thus, marriage was universal and extremely early (Kurosu, Tsuya, and Hamano 1999). In the stem family households, inheriting children brought in the new spouse (bride or groom) and the non-inheriting sibling left home (Smith 1977; Cornell 1987; Kurosu 1996). This rule has kept "the family farm and other property in tact 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 has brought about different life course options and power structure to the families. In both uxorilocal and virilocal marriages, it was inheriting daughters in the former and sons in the latter who were more autonomous and had easier access to resources in their familiar environment at their natal households (e.g. Oto 2001: 367). Grooms and brides were to obey the practices and rules of the new marital residence. If couples got divorced, which occurred quite frequent in early modern Japan, it was grooms and brides who had to leave the marital household. Inheriting daughters and sons were to stay and often remarry in the same households.

While uxorilocal marriage is observed in various parts of Japan, it seems to be popular especially in region known to have practiced succession by the eldest daughter (*ane-katoku* in folk terms) (Maeda 1976). In terms of marriage, this takes a form of uxorilocal marriage where upon

marriage, husband comes into live with wife's family.[1] 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 that the family needed to "recruit" man-power (or sons-in-law) for labor intensive field work (Oto 1996: 265). It was also the area of relatively high mortality and harsh environments where early transfer of generation was necessary (Hayami 2009: 585-586).

Frequent practices of uxorilocal marriage, or the "son-in-law adoption," together with the "daughter first" preference might imply a peasant strategy for swift and successful transition of headship in the villages with high mortality risk (Kurosu 2013). The idea that couples deliberately had daughters in order to find capable sons-in-law is often discussed as strategy for the families of merchants and medical doctors (Otake et al. 1988). It might find even a contemporary equivalent. Mehrotra et al. (2010) found that the practice of adopting adults, even if one had biological children, made family firms unusually competitive in post-war Japan. For the interest of this study, it is important to note that inheriting women married uxorilocally in general are considered to be able to keep higher social status and power even after marriage (Mori 1999; Maeda 1992: 71-74).[2]

2.2 Sex preference and infanticide in Tokugawa Japan

Infanticide has been a central topic in the discussion for the low fertility and population stagnation of 18th century. Findings are mixed as to whether poor peasants practiced infanticide due to economic hardship as the conventional pre-war historians viewed, or peasants, regardless of the social status, deliberately limited family size as a strategy to improve household income, just like "post-partum birth control" or "family planning" (e.g. Hanley 1972; Smith 1972). While most historical demographers agree that it was a practice embedded deeply in cultural and historical contexts, the regional variation, its persistence and/or spread, as well as its importance to population patterns and other demographic behaviors are yet to be fully examined. Also,

[1] While *ane-katoku* is the equivalent of *primogeniture* (succession by the eldest child), successions by the eldest daughters are emphasized here as those by the eldest sons are considered to be the major and common pattern of succession in early modern Tokugawa (Yamamoto 2006). Demographically, Yamamoto (2006) claims five conditions have to be met for the *ane-katoku* inheritance: the eldest child is female, there exists a second or higher order son, the eldest daughter survives to adulthood, the eldest daughter marries uxorilocally, and her husband becomes head of the household and all other male siblings leave the household. Yamamoto (2006) also discusses the reason for such inheritance system.

[2] It is, however, not possible to examine the power structure between husbands and wives from our data. Once married, sons-in-law became heads of the households. Therefore, on NAC records, the households appear patriarchal. However, it is also important to note that it was sons-in-law who had to leave the household once they were divorced and that happened quite frequent in these villages (Kurosu 2011).

some other studies claim that what appears as infanticide could be attributed to miscarriages induced by overwork and sexually transmitted disease (Tomobe 2001); and that other factors related to exposure (e.g. age at marriage, sexual networking, spousal separation, breastfeeding) need to be investigated, placing infanticide as only one of "multiple components of demography" (Cornell 1996). Recent studies try to place infanticide in the wider context of the history of parenting, childhood, and reproduction, as well as cosmology and cultural beliefs (Ota 2007; Sawayama 2005; Kawaguchi 2002).

Drixler's work (2013) based on a large cross-sectional data collected from Eastern Japan brings infanticide back to the center of explanation for the 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 to be closer to 40 percent during the decades when they were at their most frequent (2013: 18). While the estimate stands for question, his work empirically supports the wider use of child control among peasants and, more importantly, showed that in regard to sex preference of children, 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 the studies that the desire for sex-balanced offspring have prevailed in Tokugawa society to assure family line and for gendered labor (Ota 1991). 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 eastern part of Japan as a daughter could help the mother by tending to her younger sibling(s) as a baby sitter and a caregiver (Hanley and Yamamura 1975; Skinner 1987). In addition, the girl-boy(s) sequence served the interests of the father (and the mother), who had 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). For the purpose of this study, it is important to note another finding of Drixler, although not discussed too much in length, a relationship between marriage and sex selection and that the male-to-female sex ratios of children among uxorilocal marriages were much lower than those of virilocal marriages (2013: 92). In other words, couples married uxorilocally appeared to have preferred daughters than sons.

2.3 Settings of our study population

Our study population is from two Northeastern Japanese villages, Shimomoriya and Niita, located in the current 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, on flat land, had less severe winter weather (Nariamtsu 1992: 4-6), but was vulnerable to frequent floods lying on the banks of the Gohyaku River. In other words, the circumstances of the two villages were often at the mercy of fluctuations in agricultural output.

Despite the environmental hardships,[3] or partly due to such adverse circumstances, peasants appear to have been active agents who adjusted household size and composition for the integrity and survival of the households and to have achieved the overriding aim of family continuity (Kurosu 2013). Studies that use the same village records as this study reveals strategies taken by the farm households for their survival upon economic and demographic constraints---by using the channels of marriage (Tsuya and Kurosu 2014), adoption (Kurosu 2013), divorce (Kurosu 2011), remarriage (Kurosu 2007), and by controlling the timing of siblings' departure in relation to heirs' marriage and first birth (Kurosu 1996). Being the head or immediate members of the stem family reduced the mortality risk of individuals (Tsuya and Kurosu 2004). Thus individual life course was tightly bound to and stratified by the stem family rules (Saito 2000). Tsuya and Kurosu (2004, 2010) suggest that the mortality level was at relatively higher end while the fertility level was at the extremely low end of the distribution among the observed villages of the same period – only one-third of the natural fertility standard. Strong reproductive control was prevalent, not only through parity-specific efforts (stopping), but also from behaviors not related to family limitation 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 eighteenth and nineteenth century rural Japan. There was clear indication of extensive and sophisticated use of sex-selective and parity-specific infanticide, aiming to achieve a relatively small and sex-balanced offspring set (a daughter was preferred first). This confirmed the normative understanding of the general sex preference and infanticide practices in historical Japanese populations. Our study develops these previous work further to examine the relationship between marital residence and reproduction.

[3] 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 Shimomoriya 419 and were stable for the first 35 years. However, both villages suffered population decline being disturbed by various losing a total of 30–40 percent from the initial period. The populations started a gradual upturn only after 1840, with the general improvement of climate resulting in less frequent famines, and the development of agricultural techniques that improved the 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 eighteenth century. The average size of households was stable around four members, which was small for a preindustrial population, and increased only after the Tempo famine in the 1830s to around 6 persons in both villages.

3 Methodology

3.1 Data

This study takes advantage of data from the local population registers called *ninbetsu-aratame-cho* in Shimomoriya and Niita (NAC-SN), two farming villages in the present Fukushima prefecture in northeastern Japan. These NAC records extend over a period of about 150 years, 1716–1869 for Shimomoriya and 1720–1870 for Niita, with only a small number of intermittent years missing. Registers annotated all major demographic events, including birth, death, marriage, and migration for all individuals residing in the villages. In addition, exits from and entry to the households including movements within and outside the village were recorded in detail, allowing this study to examine two types of post-marital residence as well as other characteristics of individuals. Exits for unknown reasons were extremely rare, accounting for less than 1 percent 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 for historical population in Japan, and possibly in East Asia (Tsuya and Kurosu 2004, Dong et al. 2015).

To compare marital reproduction between virilocal and uxorilocal families, we define our population at risk as married females aged 10-49. In addition, unlike many other East Asian populations, divorce and remarriage were relatively common in Japanese populations in the past. We therefore further restrict our analysis to those who start the marriage under observation and have neither own children ever recorded nor co-residing children resulted from husband's previous marriage or adoption. By so doing, although we have no information for women's marriage and reproduction history outside the village, if any, we assure that all observed births and their parities are exactly measured for each marriage under study. Besides, only those individual observations with a linked observation right in the next year are eligible for analysis, which guarantees exact timing of each birth. The average between-year linking rate of individual multiple observations from different registers in the NAC-SN data is around 95%, the highest among comparable historical population panel data in East Asia (Dong, et. al 2015). As a result, our analysis includes 13888 annual observations of 1045 married females, 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, which is also widely used by previous studies using these Japanese data or similar East Asian data (e.g.

Tsuya et al. 2010). We first, to provide a general picture, apply logit models and examine the effects of selected factors on the probability of having a recorded birth in the next year. We then apply multinomial logit models and distinguish differential probability of three mutually exclusive competing outcomes: male, female, or no birth. This is a methodological advance from previous studies. Although also differentiating the differential probability of having male and female births, the East Asian part of analysis in Tsuya et al. (2010) only uses simple logit models with two separate binary outcome variables as whether having a recorded male birth or not, and a recorded female birth or not. Such 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 explanatory variables. In addition, considering the possible correlation between multiple observations of the same individual, we compare two correction methods: multinomial logit models with clustered standard errors at individual level, and two-level random-intercept multinomial logit models having individual observations as the first level and individuals as the second level. Especially, by assigning a random intercept for each indexed individual, the latter one takes account of time-invariant unobserved characteristics of the woman or the couple, for example, fecundity, adverse early experience, household environment, etc., which may influence the estimation on reproductive outcomes (e.g. Campbell and Lee 2010).

Moreover, we separately study first births and later births. As discussed before, sex preference of Japanese families differs by parity and the sex composition of surviving children. It is therefore important for our multivariate analysis to differentiate the pattern by parity, and to include measures for previous births or surviving children when studying later births. Below we introduce all variables included in our multivariate analysis, and we report their summary statistics in appendix table 1.

We have two outcome variables, a general dummy variable indicating whether the woman have a new recorded birth in the next year, and a specific categorical variable suggesting whether the woman have non birth, male birth, or female birth in the next year. We find no woman having both males and female births recorded in the same year so that three categories are mutually exclusive. While we have no direct evidence to verify this, it may be partly due to our limited data size.

Our key explanatory variable is a dummy variable for marital residence patterns: virilocal or uxorilocal. For other individual and couple characteristics, we include variables for wife's age and its squared term, wife's age at current marriage, whether current marriage is a re-marriage,

and, following previous research (Tsuya et. al 2010), age difference between the wife and husband – whether the husband is 6 and more years, 0-5 years, or younger than wife. While they are not available for the study of first births, we include three measures regarding characteristics of previous births for the study of second and later births: Years from last birth, cumulative number of recorded births up to the current year, and whether the surviving children are none, only males, only females, or both males and females.

For co-residence of kin as well as other household- and community-level characteristics, 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 co-residence 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. These two variables allow us to differentiate the overall effects of the possible competition or helping between co-resident kin, and the service or dependence from non-kin that are predominantly servants and labors. Moreover, we have detailed annual landholding information for each household, which is measured by the account of household land taxation, *koku*, which is especially rare and valuable for historical population studies. We also have annual rice price for the village and include in the model with a one-year lag and in logarithm. Finally, to take account of unobserved characteristics between villages and periods, following exiting studies (Tsuya et a. 2010), although the coefficients are not reported in our result tables, we also include fixed effects for the two village and for four periods: 1716-1759, 1760-1779, 1780-1839, and 1840-1870.

4 Results

4.1 Descriptive patterns

In our study population, sex ratio of recorded births is skewed and, more importantly, changes dramatically between first and later births. As suggested in table 1, while wives in virilocal marriages appear to be slightly older to start marriage and reproduction, they seem to have relatively more male births than their counterpart in uxorilocal marriages. However, among first births, there are many more females than males recorded overall, despite such differences between the two types of marriage: 94.0 and 68.1 males per 100 females in virilocal and uxorilocal marriages, respectively. By contrast, among second births, there are many more males than females among second births, 123.3 males and 116.4 males per 100 females for virilocal and

uxorilocal marriages, respectively. Among third and later births, the sex ratio is around 109, which remains slightly high but relatively normal.

Table 1 here

Such skewed patterns of sex ratio in reproduction by parity, in line with much existing understanding of the sex preference in historical Japan, is unlikely to be an artifact of household registration. Our Japanese annual registers omit infants born after the current registration and died before the one in the next year. However, based on our comparative evaluation of data, records of children are overall balanced between sex, which suggests no evidence for systematic omission of one sex that is common in some other Chinese and Korean historical population registration data (Dong, et. al 2015). Moreover, remaining documents of the basic law and ordinance of Nihonmatsu domain where these two villages belonged also demonstrates the completeness and strictness in practicing registration (*Goryounai ninbetu aratame no oboe*, transcribed in Nihonmatsu-han Shi Kanko-kai 1992: 518–519). And previous studies based on these data have yielded many plausible findings to understand mortality, marriage, and reproduction behavior in comparison with other East Asian and European populations. In other words, while the absolute levels of sex ratio by parity may subject to specific data, region and period, the observed patterns are in line with Drixler (2013)'s finding based on concurrent Japanese population data with a much broader geographic coverage, and therefore probably reflect the common pattern in Tokugawa Japan.

The life-course predicted probability of reproduction, plotted in figure 1, also confirms the observed varying sex ratio at different time points. To predict such probability, we regress the two outcome variables – whether having a birth, and whether having no birth, male birth, or female birth in the next year – on dummy variables of the 5-year age groups and marital residence types as well as their interaction terms, controlling for fixed effects of villages and periods. We fit a logit model and a multinomial logit model for the two outcomes, respectively. For both virilocal and uxorilocal families, we have dot lines for the predicted probability of having a birth of either sex recorded in the next year, dash lines for it of having a male birth, and solid lines for it of a female birth.

Overall, in line with table 1, the uxorilocal wives start earlier in child bearing that their predicted probability peaks at age 15-19, while the peak is at age 20-24 for virilocal wives. However, such early start of uxorilocal wives aged 10-14 and 15-19 is not sex balanced: they are more likely to have a female birth than a male birth. After age 20, their probability of having a

male or female birth becomes similar. By contrast, among virilocal wives, at age 10-14 and 15-19, the probabilities of having a male birth and having a female birth is similar. But between age 20 to 30, their probability of having a male birth exceeds that of a female birth. After 30, the sex difference in probability becomes not apparent, and the levels are similar to those of uxorilocal wives. To sum, if we believe that biologically the probability of either sex births should be largely equal and independent from age and types of marital residence, and the data are reliable sources of family and population behavior, what we observed may reflect the deliberate sex-selective postnatal birth control. Although little has been understood about the difference between virilocal and uxorilocal marriages based on previous studies, the general pattern observed here are as well stated from existing understanding of the birth control practices including infanticide and deliberate neglect. But, unlike other East Asian historical populations of which female infanticide was predominant, there were not only "missing girls" but also "missing boys" in our study Japanese populations.

4.2 Multivariate event-history analysis

4.2.1 First birth

In terms of the recorded first births, as suggested by our multivariate analysis reported in table 2, uxorilocal marriages are more likely to reproduce than virilocal marriages, especially female births. This pattern, although already revealed by our simple tabulation in table 1, remains to be true after we take into account of selected confounding factors of the individual, couple, co-resident kin, household, and community. Model 1 suggests that, overall, uxorilocal marriages have higher probability to have a recorded first birth than virilocal marriages. The odds for uxorilocal marriages to have a first birth is 47 percent more than the odds for virilocal marriages. However, if we further distinguish the sex of their first birth with the multinomial logit models 2 and 3, such difference between virilocal and uxorilocal marriages, is particularly apparent in their chances of having a female birth. Due to different correction methods – applying clustered standard errors or random intercepts to account for the correlation between individual multiple observations, models 2 and 3 yield slightly different estimated results. But the pattern resembles each other: Of having a male first birth, with a statistical significance beyond the 0.05 level, uxorilocal marriages have 40 or 60 percent higher relative risk than virilocal marriages; of having a female first birth, statistically significant beyond the 0.01 level, the relative risk for uxorilocal marriages is 52 or 71 percent more.

Such other characteristics of the couple as the wife's age at marriage and her remarriage status also matter. But they influence the chances of having a male birth. Model 1 suggests that the older the wife gets married, the more likely the couple reproduce. By model 2, we find that such reproductive tendency of late starting wives is, however, not sex neutral: they are more likely to have a recorded male birth, but indifferent with others in terms of giving a female birth. But we should note that such difference is marginally statistically significant ($p = 0.066$). Indeed, after we account for heterogeneity between wives or couples with model 3, it even disappears, which suggests certain unobserved characteristics may confound the observed effect of late marriage. Meanwhile, in both model 2 and 3, we find that, compared with other firstly married wives, remarried wives are around 50 percent less likely to reproduce males as their first birth, but of similar chances to have a girl birth. In our analytic sample for multivariate analysis, there are 66 first births born to those remarried wives. The sex ratio is even more skewed than the overall pattern: 78.6 in virilocal marriages and 32.3 in uxorilocal marriages. Apparently, those remarried wives– given our study restriction, being childless from previous marriage(s) – have different, if not stronger, sex preference for the first birth. Besides, we find no evidence that the couple age difference, a common measure for the conjugal power relationship (Skinner 1993), makes a difference in the probability and sex of the recorded first birth. Our additional examination, while not reported here, suggest there are no substantial interaction effect between the wife's remarriage status and two types of marital residence. In other words, such practices of sex selection on the first birth may not differ substantially between remarried wives in virilocal and uxorilocal marriages.

Table 2 here

We find no strong evidence for the effects of co-resident kin on the probability or sex selection of the recorded first birth, except that living with only father or father-in-law lowers the probability of having a male birth and living with at least one younger sister or sister-in-law in the household hinders reproducing a female birth. As usually father or father-in-law is the head of the household and decides the household resource allocation, the negative correlation between presence of father in the household and probability of having a male birth in the next year may reflect the resource competition of 'dependent' household members between generations. Given limited resources, in order to support the co-resident father's living, the couple may decide, or have to, postpone bearing and rearing a male heir. The similar negative association between co-resident younger sisters and having a female first birth, however, implies a substitution effect related to the girl preference at first birth. In other words, be she a sister or

daughter, it is probably a need to have a young girl in the household, who may later grow up and help take care of the elderly and other children. However, the number of kin in the household doesn't matter. And, although not reported here, we have also examined whether the effects of co-resident parents and of co-resident parents-in-law differ by interacting the parental co-residence variable with the marital residence type variable, which suggests no different roles played by living with the wife's biological or in-law parents.

While such other household characteristics as number of non-kin and landholding, as well as community short-term economic fluctuation measured by logged rice price in previous year, have no overall influence on the probability and sex of the first birth, we find interesting moderating role of household landholding on the effect of marital residence. Based on a model of the same specification as model 2 in table 2 but with an additional interaction term between marital residence and household landholding, we plot in figure 2, along the landholding, the contrast of the predictive margins (i.e. marginal effect) of being uxorilocal versus virilocal marriages on the probability of having no birth, a male birth and a female birth in the next year. We find that, when the landholding increases, while uxorilocal marriages show no difference from virilocal marraiges in terms of the predicted probability of having a male birth, they are substantially less likely to have no birth but more likely to have a female birth. In other words, uxorilocal households especially favor a girl as the first birth when they are rich in land. This demonstrates a very different family reproduction strategy in contrast with virilocal peasant households in the village, as well as in other East Asian societies.

Figure 2 here

4.2.2 Second and later birth

The reproduction pattern of second and later births, similar to table 1, is very different from first births. Nevertheless, in table 3, our multivariate analysis allows us to further find important associations between the probability and sex of the new births and various characteristics of the couple and their existing children, and their co-resident kin and household. First of all, compared to first births, the difference between virilocal and uxorilocal marriages in terms of the probability of having a girl as second or later births becomes much smaller and marginally statistically significant. Moreover, neither the wife's age at marriage nor her remarriage status has a substantial effect on the reproduction of second and later births. Instead, the couple's age difference matters to the extent that husband being over 6 years older than his wife may result in a decreased probability of having a new birth. And, although marginally statistically

significant, such effect seems to be no different on male and female births. By contrast, the cumulative number of previously recorded births only influences the chances of having a male new birth. The more previously recorded births the wife has, the more likely she will have another male birth in the next year. But it makes no difference for having female births.

The probably most important factor to the reproduction of second and later births is sex composition of surviving children. Compared with those currently having 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. Such desire for reproduction is especially strong among those having no surviving children, but appears similar to future births of both sexes.

That being said, we find differences between virilocal and uxorilocal marriages in response to specific sex composition of surviving children. By introducing an interaction term to the model 2 in table 2, we plot in figure 3 the contrast of predictive margins of being uxorilocal over virilocal marriages, according to different sex composition of surviving children, on the probability of having no, a male, or a female as the second or later birth in the next year. When the couple have either no or both male and female surviving children, there are no substantial difference between the virilocal and uxorilocal. 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 than virilocal marriages. Moreover, when there are only female surviving children, uxorilocal marriages have lower probability to have a male birth than virilocal marriages. Overall, these interaction effects consistently suggest that, compared with virilocal marriages, uxorilocal marriages have a stronger preference of girls in reproduction.

Figure 3 here

Co-resident kin, back to model estimations in table 3, also have stronger influence on later births than the first birth. Living with either only mother (-in-law) or both parents (-in-law) is positively correlated with the probability of both having male and female births. This, in line with the "grandmother hypothesis" (Hawkes 2004, Jamison et al. 2002), suggests a positive helping effect. So are the effect of co-resident older brothers (-in-law) and younger sisters (-in-law). But, extra support from these co-resident siblings improves the chances of having female births but not male births, in a way suggesting that to have a girl at later births is relatively subject to the household context and potential co-resident care givers. Besides, we find no

evidence for an interaction effect between marital residence and parental co-residence, suggesting again no substantial difference between biological and in-law parents on the couple's reproduction.

The sensitivity of female births to household context is also apparent when we look at the influence of the number of co-resident kin and non-kin. Model 1 suggests a general negative correlation between the number of kin in the household and probability of births, which implies the overall impact from the competition of household resources between co-resident kin. However, according to model 2 and 3, such negative association is largely driven by its strong impact on girl births yet weak influence, if any, on male births. In other words, for second and later births, competition in the household matters more to the reproduction decision on female births than male births. By contrast, the number of non-kin in the household that measures not only the household wealth but also the support from those non-competing servants, has a helping effect on having additional births, similar to both sexes.

We find no overall or interaction effect of household landholding on the chances and sex of the second or later births. Neither is the logged rice price in previous year.

5 Conclusion

Taking advantage of individual-level panel data from two Japanese villages for as long as over 150 years, this study provides new empirical evidence that virilocal and uxorilocal marriages respond to the family context actively, and have different preference and selection practices in on the sex of children. Uxorilocal marriages, where husband living with the inheriting daughter and her family, demonstrate stronger girl preference than virilocal marriages, where wife moving in to live with the inheriting husband and his family. Despite the overall low ratio of boys over girls among first births, compared with virilocal marriages, uxorilocal marriages are more likely to reproduce and register a girl, especially with the increase of household wealth. Even among second and later births of which the overall sex ratio favoring boys over girls, uxorilocal marriages have lower probability to reproduce a boy when surviving children are girls only, but higher probability to reproduce a girl when surviving children are boys only. In other words, the sex-selective practices in reproduction of uxorilocal marriages demonstrate much matrilineality.

Limited by small data size, this study does not directly examine if the observed strong daughter preference lead to intergenerational transmission of uxorilocal marriages. The tendency is however likely to exist since otherwise we may expect to find that uxorilocal marriages prefer

sons over daughters to change their trajectory in the next generation. As the construction of similar data transcribed from Japanese historical population registers as well as other East Asian sources is in process (Dong et al 2015), we are soon able to provide further evidence regarding the implications of this differential sex preference to population growth and social dynamics in the long run.

Different tendency in family organization in general and family succession in particular may have played a central role in shaping such sex preference and reproductive behavior. The daughter preference in Tokugawa Japan, especially among the uxorilocal marriages, appears unique, but it may reflect a family succession strategy of Japanese stem families. Comparatively, while both were practicing stem-family system, sex preference in Northwestern European populations was not as apparent as Japanese population. In addition to the fact that sex-selective reproduction control was atypical in the West, this may relate to one major difference between European and Japanese stem family system that "son-in-law adoption" is common in Japan but virtually non-existent in Europe (Saito 1998). Together with the characteristic of Japanese family being more "conspicuously vertically structured", the concept of descent line may carry more weight in traditional Japan than in the European past (Saito 1998). That said, interestingly, although to a much lesser extent, some recent comparative findings based on European populations from late 19th century onward suggestively coincide with our finding about daughter preference in stem-family populations. Between 1900 and 1950, in the Netherlands and Sweden where the Western European stem-family system is typical, those parents having no surviving female children substantially increases their birth intensities, suggesting an increasing preference for girls (Reher et al. 2015). But such daughter preference does not appear in the Spanish population (Reher et al. 2015), where family organization is relatively complex and familial ties are strong (Reher 1998). Similarly, daughter preference at third and above births has also been found in late 20th century Danish, Norwegian and Swedish populations (Anderson, et al. 2006).

Overall, our study adds to the accumulating literature on sex preference and deliberate birth control in pre-modern populations. It also highlights the complex human agency in reproduction, especially under the dynamics of power and property of the family. In line with many previous studies on both Western and Eastern populations, we find strong evidence of reproductive responses to household context and socioeconomic status. Existing comparative evidence suggests that unlike the Malthusian East-West dichotomy, East Asian historical populations had even lower marital fertility than their European counterparts. Differential deliberate reproduction control, especially practices of infanticide in the East but not West, is

believed to play an important role in shaping such differences between populations. Our comparison between two types of Japanese families however calls for attention to recognizing similarly important differences between sub-populations. Under the same local culture, institutions, and environment, reproductive behavior may differ systematically according to marital residence, and such difference may persist for long.

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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

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)		(2)				(3)			
	Logit model, clustered SE		Multinomial logit model, clustered SE (ref.: No birth)				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
Marital 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	-1493.876		-1879.477				-1875.817			
Individuals	978		978				978			
Observations	4142		4142				4142			

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

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)		(2)				(3)			
	Logit model, clustered SE		Multinomial logit model, clustered SE (ref.: No birth)				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
Marital Residence (ref.: Virilocal)										
Uxorilocal	1.062	0.473	0.947	0.648	1.201	0.080	0.941	0.633	1.203	0.154
Co-residence 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
Co-residence of older brother(s)	1.376	0.033	1.259	0.326	1.519	0.091	1.357	0.243	1.650	0.059
Co-residence of older sister(s)	0.998	0.992	0.990	0.971	1.011	0.972	0.949	0.856	0.981	0.950
Co-residence of younger brother(s)	1.030	0.770	0.947	0.698	1.122	0.380	0.958	0.781	1.138	0.417
Co-residence 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
Level-2 (individual level) Parameters										
b	-		-				1 (constrained)			
variance (s.e.)	-		-				0.255 (0.089)			
Log (pseudo)likelihood	-2911.444		-3610.232				-3603.5606			
Individuals	700		700				700			
Observations	9746		9746				9746			

Appendix table 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 yrs 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+ yrs 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
Marital 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
Co-residence 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
Co-residence of older brother(s)	0.137	0.344	0	1	0.045	0.208	0	1
Co-residence of older sister(s)	0.132	0.339	0	1	0.035	0.185	0	1
Co-residence of younger brother(s)	0.272	0.445	0	1	0.132	0.338	0	1
Co-residence 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	4142				9746			

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

Figure 1. Predicted probability of having a recorded birth in the next year

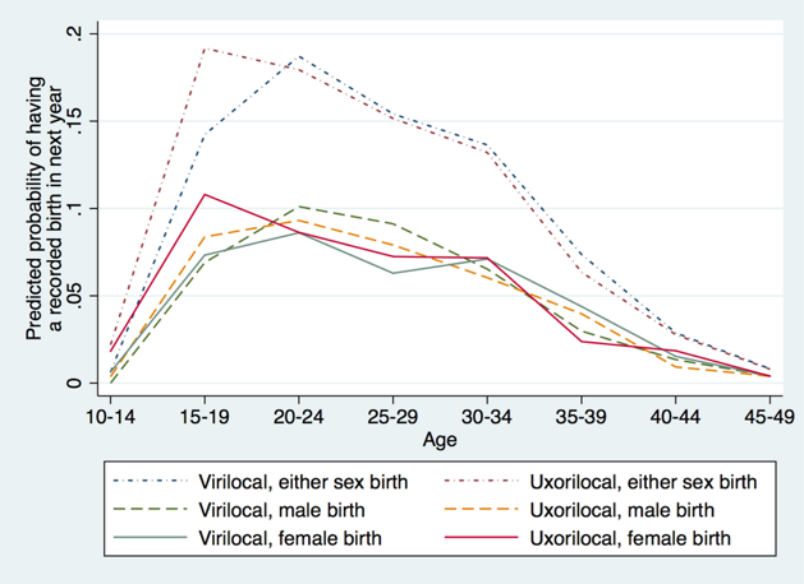

Figure 2. Average marginal effects of uxorilocal (vs. virilocal) marital residence along with household Landholding

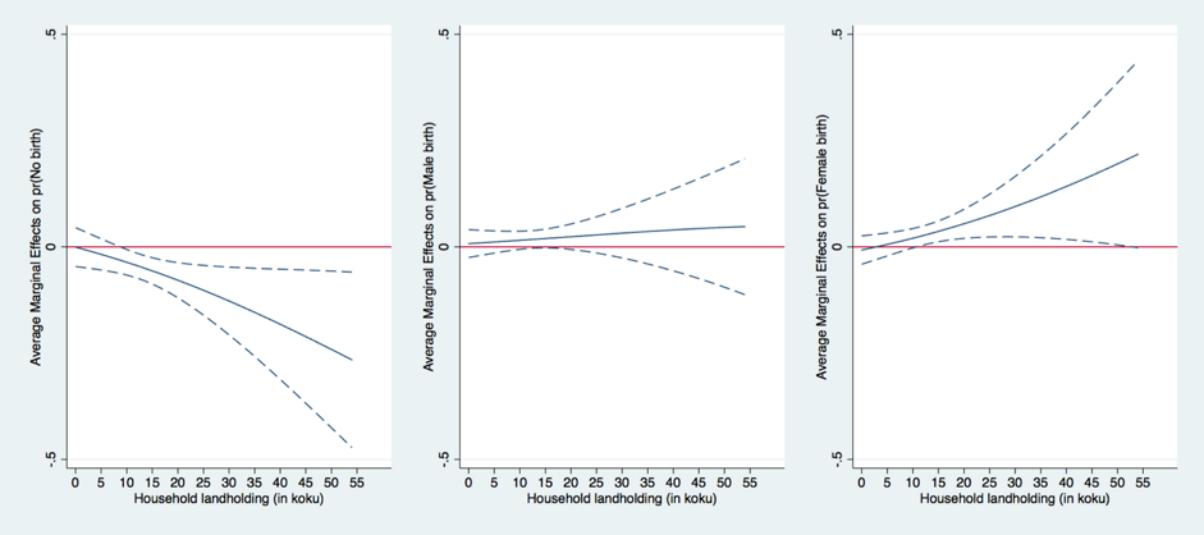

Figure 3. Average marginal effects of uxorilocal (vs. virilocal) marital residence by sex composition of surviving children