Deliberate fertility control in late imperial China:
Spacing and stopping in the Qing Imperial Lineage

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Introduction

Whether and how couples in China deliberately regulated their fertility before the late twentieth century remains the subject of heated debate. We and others have claimed that marital fertility in China was lower than in Europe, and subject to deliberate control (Campbell, Lee and Wang 2002; Lee, Campbell, and Wang 2002; Lee and Wang 1999; Li, Wang and Kang 2004; Wang and Lee 2002; Wang, Lee, and Campbell 1995; Zhao 1997; Zhao 2002). With Wang Feng, we have published a series of papers based primarily on analysis of two sources, the vital records of the Qing Imperial Lineage and the household registers of Eight Banner populations in northeast China (Lee and Campbell 1997; Wang, Lee, and Campbell 1995; Wang, Campbell, and Lee 2005). Similarly, Zhao (1997) detected evidence of deliberate limitation in China in the middle of the twentieth century through detailed analysis of retrospective fertility survey data. A comprehensive review of other published estimates, primarily from lineage genealogies but also from survey data, generally suggests that levels of marital fertility were low (Lee and Wang 1999).

Critics of such claims argue that even if marital fertility rates in China were lower than in Europe, fertility was not subject to deliberate control, and whatever gap existed was the unintended consequence of other factors such as poverty, extended breastfeeding, or else an artifact of measurement issues related to differences in average age at first marriage (Brenner and Isett 2002; Cao and Chen 2002; Huang 2002; Wolf 2001). Evidence cited to support the existence of uncontrolled fertility includes calculations based on Taiwanese household registers compiled by the Japanese during their occupation of the island in the first half of the twentieth century retrospective surveys and published results from other studies (Wolf and Huang 1980; Wolf 1984; Wolf 1995; Wolf 2001).

To advance this debate, in this paper we reexamine the vital records of the Qing Imperial Lineage for evidence of deliberate fertility control. We take advantage of advances in statistical methodology and computing technology in the decade since our previous analysis of fertility in the Imperial Lineage (Wang, Lee, and Campbell 1995) to test directly for the existence of deliberate fertility behavior among women on monogamous marriages according to the number, sex composition, and mortality of previous births. We begin by investigating parity-specific behavior. We show that once this heterogeneity is accounted for with a fixed effect of mother, there is strong evidence of parity-specific behavior, in that for any given woman, additional births substantially reduce the pace of subsequent childbearing, even after duration since first birth is controlled for. We then move on to fertility behavior according to the sex composition and mortality of previous births among women in monogamous marriages. We demonstrate that both had powerful effects on the timing of subsequent births, and that patterns of effects were consistent only with deliberate control.

We divide the remainder of this paper into four sections. We begin with background, identifying what we believe are the key issues that impede resolution of the debate over fertility control in China before the late twentieth century. In that context, we specify hypotheses and identify how different patterns of outcomes are consistent with different hypothesized behaviors. We proceed to a discussion of the data, the vital records of the Qing Imperial Lineage. Our discussion is brief, focusing primarily on issues relevant to analysis of fertility, since we have already described the data in much more detail elsewhere. We then summarize our methods, in particular, discrete-time event-history analysis by means of logistic regression. We then present our results. We conclude with remarks about the implications of our findings for the debate on fertility control in pretransitional China.

Background

Definitions

Lack of a common understanding about what constituted deliberate fertility control has impeded resolution of the debate over its existence in historical China. In at least one case, the same behavior is interpreted as fertility control by one camp, but not by the other. Wolf (2001, 146-147) cites the higher fertility rates of parents who have not yet had a son as evidence against the existence of fertility control, but we treat such behavior as yet another form of fertility control (Campbell, Wang, and Lee 2002, 743). Such discrepancies reflect a fundamental difference in the definition of fertility control. Whereas Wolf (2001) seems to equate fertility control with fertility limitation, we have a more expansive definition of control that includes not only foregoing or delaying births, but adding or accelerating them as well. Accordingly, to crystallize discussion of the situation in historical China, below we distinguish three forms of fertility control, assess the state of the evidence for the existence of each in historical China, and identify whether and how this study contributes to our understanding of that form of control.

First, there may have been 'classic' fertility control in which couples practiced deliberate stopping after reaching a targeted number of children. Such control can be detected in analysis of age-specific rates of marital fertility because it produces a characteristic pattern. The 'thumbprint' of this specific form of fertility control is so pronounced that indices have been developed, m and M, that can be calculated from age-specific rates and which vary systematically according to the prevalence of such behavior (Coale and Trussell 1974). Estimates of m in pretransitional Chinese populations are generally inconsistent with the presence of such parity-based stopping behavior (Lavely 1986). Thus to the extent that Wolf (2001) and others refer solely to this particular form of fertility control when they claim that fertility control did not exist in historical China, they may very well be correct, at least on the basis of published findings.

Here, however, we revisit the issue of parity-specific control, this time accounting for the possibility of heterogeneity in fecundity among women. It is possible that if there was substantial heterogeneity among women in fecundity, systematic 'within-woman' variation in the pacing of births according to parity could be drowned out by 'between-woman' variation in fecundity. Accordingly, we specify four scenarios corresponding to possible combinations of heterogeneity or homogeneity in fecundity with presence or absence of parity-specific behavior, and identify the patterns of birth probabilities as a function of current parity corresponding to each scenario. In the first scenario, where fecundity is homogeneous and there is no parity-specific effort at control, the probability of an additional birth should be determined solely by age of mother, with no effect of her current parity. In the second scenario, where fecundity is homogeneous and there is party-specific control, higher parities should lower the chances of an additional birth, holding constant the age of the mother. In the third scenario, where fecundity is heterogeneous but there is no parity-specific control, analysis that does not account for heterogeneity should reveal that women at higher parities have higher chances of an additional birth, because such women will disproportionately be composed of highly fecund women. Once heterogeneity is accounted for with a fixed effect of the mother, so that comparisons are between births to the same mother, there should be no effect of parity, only age. Finally, in the fourth scenario, if women are highly heterogeneous in terms of fecundity but also practice parity-specific control, an event history analysis that does not account for heterogeneity may indicate a positive, negative, or non-existent relationship between parity and the chances of a subsequent birth, depending on the how the combined effects of heterogeneity and control net out. Analysis that accounts for heterogeneity should reveal that the chances of an additional birth declines as parity increases.

A second, related form of fertility control may have been stopping or spacing to achieve goals for sex composition of births. It is possible that net of whatever targets parents had for number of children, or even in the absence of such targets, parents may have targeted the sex composition of their births. Possible behaviors include accelerated births on the part of parents with no sons, cessation of childbearing on the part of parents who had achieved a target number of sons, or more complex strategies aimed at achievement of a particular mix or sequence of children by sex. Lee and Campbell (1997), Wang, Campbell, and Lee (2005), Wang, Lee and Campbell (1995), and Zhao (1997) detect evidence of such behavior in data from a variety of sources.

In this study, we examine such behavior in detail. We identify three different scenarios, and predict patterns of outcomes corresponding to each. First, if parents took no measures to achieve a particular sex composition for their children, the sex composition of previous births should have no effect on the chances of an additional birth. Second, if parents sought to have one or male births, but did not seek to replace males who died, a higher proportion of previous births that are female should be associated with higher chances of an additional birth, and the prior death of a son should have the same effect as the prior death of a daughter, most likely no effect. If parents actively sought to replace sons who died, but not daughters, prior deaths of sons should be associated with higher chances of an additional birth, but prior deaths of daughters should have no effect.

Finally, and most generally, there may have been deliberate spacing behavior intended to affect the timing of a next birth, even in the absence of targets for the overall number or sex composition of children. This situational fertility control may have been in response to any number of factors, including short-term economic circumstances. Wang, Lee, and Campbell (1995) found a positive association between socioeconomic status and fertility in the Imperial Lineage. In Liaoning, family relationship, socioeconomic status, and short-term economic conditions all affected reproduction (Lee and Campbell 1997; Wang, Campbell and Lee 2005). In this study we do not address this particular form of fertility control, but we hope to do so in a future reanalysis of the vital records of the Qing Imperial Lineage.

Evidence

Another impediment to resolution of the debate over fertility control in China has been the reliance on evidence that at some level has been largely indirect. A key problem, at least from our perspective, is that until now many of the tests for the absence or presence of fertility limitation carried out by participants in the debate have in some sense been indirect. Many of the arguments published by one side or the other are based on patterns of age-specific fertility rates, average ages at first or last birth, average lengths of birth intervals, and other summary indices (Wang, Lee and Campbell 2005; Wolf and Huang 1980; Wolf 1995; Zhao 1997). Such an approach, based as it is on comparisons of what amount to aggregates and averages leaves ample room for wildly varying alternative interpretations, with different observers drawing very different conclusions from the same evidence. It is unfortunate as well because in most cases the aggregates are being constructed from longitudinal data on individuals.

One way forward is to take advantage of the longitudinal, individual-level nature of the available data and use event-history analysis to test for the existence of patterns predicted by hypothesized fertility regimes. Event-history analysis allows for much more fine-grained differentiation of fertility outcomes according to the characteristics of the mother than comparison of aggregates and averages. Potentially confounding characteristics of the mother can be accounted for by the introduction of appropriate statistical controls, or the applications of fixed or random effects models that account for variation between mothers in unobserved characteristics. Accordingly, we should now be able translate our accounts of fertility in Chinese populations into falsifiable propositions that could be tested by application of event history techniques. For each of the explanations advanced to explain fertility patterns in pretransitional Chinese populations, it should be possible to specify patterns of fertility determinants that would be apparent if the explanations were correct, and not apparent if the explanations were not correct.

Some steps along these lines have already been taken. Wang, Lee, and Campbell (1995) included linear regressions of lengths of closed birth intervals on characteristics of the mother at the beginning of the interval, and showed that birth intervals were shorter for women who had not yet borne a son. By definition, the analysis did not make use of information from open birth intervals, and could not include time-varying covariates. Discrete-time event-history analyses of household registers from Liaoning reveal effects of number and sex of previous registered births on the pace of subsequent reproduction (Lee and Campbell 1997; Wang, Campbell and Lee 2005). Results from Liaoning household registers are subject to the caveat that they reflect reproduction, the production of surviving offspring, more than they do fertility, since many sons and daughters were omitted from the registers if they died in infancy or early childhood. Event-history analyses of fertility Taiwanese household registers compiled in the first half of the twentieth century during the Japanese occupation have also been carried out (Kok, Yang, and Hsieh 2004), and we look forward to the publication of results from that effort.

The distinguishing feature of the present study, relative to our past efforts, is the combination of such methodology with complete and detailed data. As we will discuss in detail below, the vital records of the Qing Imperial Lineage are much more suitable for the analysis of fertility than the Liaoning household registers examined in Lee and Campbell (1997) and Wang, Campbell, and Lee (2005) because registration of births and deaths was far more precise and complete. In contrast with our previous analysis of the vital records of the Qing Imperial Lineage in Wang, Lee, and Campbell (1995), in this analysis we make use of discrete-time event-history analysis that allow for inclusion of information from open birth intervals, as well as introduction of time-varying covariates. In addition to estimation of basic event-history analyses that do not take into account possible heterogeneity in fecundity among mothers, in this study we apply random and fixed effects models that account for the possibility of such heterogeneity. This combination of data and methods allows us to compare patterns of outcomes with each of patterns predicted earlier from specific scenarios, and thereby adjudicate between possible scenarios.

Data

Here we only review key features of the vital records of the Qing Imperial Lineage that relate to fertility, since these data have been described in great detail elsewhere (Lee and Wang 1999, 2000; Lee, Campbell and Wang 1993; Lee, Wang, and Campbell 1994; Lee, Wang and Ruan 2001; Li and Guo 1994; Wang and Lee 1998; Wang, Lee, and Campbell 1995), thus here we only review key features relevant to the analysis of fertility. The most important feature of these data relevant to this analysis is that they are the most complete and detailed recording of any Chinese population before the twentieth century. In contrast with all other sources from before the twentieth century, all male and female births are recorded, even those that died in the first days of life. From the middle of the seventeenth century until just before the end of the nineteenth, the sex ratio of recorded births was

The data do have features that have implications for design of the analysis. First of all, the analysis only includes women who had at least one child over the course of their lifetime. Wives were included in the original data only if they gave birth to at least one child. Indeed, it is primarily in their role as mothers of lineage members that the wives of male lineage members were recorded in the core data.

Second, we proxy age of mother with duration since first birth since the data do not provide mother's age at marriage, age at birth, or age at death. This approach is valid because every estimate of female age at marriage in China before the middle of the twentieth century suggests that it was highly modal, typically in the late teens or early twenties (Lee and Campbell 1997). Ninety percent of daughters born into the lineage were married by the time they were 25 (Wang, Lee and Campbell 1995, 386). For the 214 lineage wives for whom we can calculate ages at marriage from linked supplemental data, the average age at marriage was 20.2, and 90 percent married between the ages of 15 and 25. While another approach would have been to follow Wang, Lee and Campbell (1995) and proxy mother's age with father's age, mother's age at marriage was so much more concentrated than father's age at marriage that we believed that duration since first birth would be a closer approximation.

A third, related issue is that we cannot censor observations of mothers upon their death because the data do not provide the date. We treat all mothers as at risk for thirty years from the time of their first birth. Censoring events include death of a husband, for which we have precise dates, and cessation of the registration system in 1921. As long as married female mortality risks are primarily a function of age, the primary effect of the inability to censor mother's observations following their death should be to bias downward the coefficients for duration since first birth. Such downward bias may be substantial. In the subset of imperial lineage daughters for whom complete recording of death was available, only 62.6 of women aged twenty would survive to age 40, and only 54.3 percent would survive to age 50. Mortality risks may also be related to parity, but the magnitude of effects should have been relatively minor compared to the effects of age, and the expected direction of effects is ambiguous. While the childbirth process itself may increase a woman's risk of dying, our previous analyses of Liaoning household register shave shown consistently that the presence of surviving sons decrease a woman's chances of dying (Campbell and Lee 1996; Campbell and Lee 2002).

Fortunately, we do have information on dates of death for a small subset of the mothers in the imperial lineage that permit assessment of the consequences of this assumption. These auxiliary data come from applications for funeral expense subsidies filed by their children that were archived and which we have coded and linked. They allow us to construct a subset of mother person-month observations consisting of women who had their first birth by 1880 for whom we have a recorded date of death that excludes all observations from after their death. In our examination of parity-specific behavior, we re-estimate our models using this subset to confirm that results for effects of parity are not an artifact of an association between reproduction and mortality risks.

A fourth issue to be taken into account is that as a result of widower remarriage and polygyny, many of the men recorded in the vital records of the Qing imperial lineage to have more than wife over the course of their lifetime. Thus while 49.1 of the 18,361 men in the lineage who survived to at least age 30 had only one wife, 22.3 percent had two, and 4.6 percent had three or more.[1] Men were more likely to have multiple wives in the early days of the dynasty when the lineage was smaller and resources more abundant. Of the men born by 1740 who survived at least to age 30, 36.5 had one wife recorded, but 57.6 had two or more. Because we do not have dates of marriage and death for the wives of most of these men, we cannot distinguish between polygyny and widower remarriage, and restrict analysis to monogamous men, that is men who only have one wife recorded in the vital records.

[1] Based on authors' calculations. The remaining 16.6 percent either did not marry, or married but were childless, resulting in the omission of their wives from the records.

Finally, there is some deterioration in the quality of recording toward the latter part of the nineteenth century. While the sex ratio of births until 1880 is 1.08, close to a natural sex ratio at birth, the sex ratio of births after 1880 is 1.67. After 1880, in other words, there seem to be substantial omissions of records of daughters. While recording of infant and child deaths appears complete until at least 1840, there is also some indication that deaths after that year are undercounted. For each of our analyses, accordingly, we not only carried out estimates using the full data, we also carried out additional estimates on subsets ending in 1840 and 1880 to confirm that results using the full data are not the result of problems in the last part of the nineteenth century. Fortunately the results were nearly the same, thus here we only present results from the analysis of the complete data.

Methods

To test hypotheses about fertility control as a function of parity, sex composition, and mortality of previous births, we apply discrete-time event-history analysis. We estimate logistic regressions on constructed database of person-month observations of mothers. Our primary file includes person-months for all mothers starting from the time of their first birth and continuing for 30 years, or 360 months. In this primary file, we drop observations for months after the death of the father, or after the last update of the genealogy in 1921. We also exclude observations for a mother in the nine months after her most recent birth on the grounds that it should not be physiologically possible to have a birth in that time. As noted earlier, we also construct a subset consisting of observations of mothers for whom we have dates of death, in which observations from months after her death are excluded.

We proxy mother’s age with duration since first birth. As noted earlier, female age at marriage was highly modal, concentrated around age 20, and duration since first birth should accordingly capture the physiological effects of aging on the chances of having a child. We model duration with a set of categorical variables corresponding to 2-4 years since first birth, 5-9 years, and so on up to 25-29 years. The omitted category is 0-1 years.

To capture the possible effects of postpartum amenorrhea on fertility chances, whether as a result of extended and intensive breastfeeding or other factors, we also include measures of duration since most recent birth. The categories correspond to 2 years since most recent birth, 3 years, 4 years, and 5 or more years. To allow for the possibility of an early cessation of amenorrhea as a result of the death of the most recent birth, we include an interaction term to identify observations where less than 24 months have elapsed since the most recent birth and that child is now dead.

Our variables of substantive interest are straightforward. Most are categorical, to account for the possibility that effects may be non-linear. When we estimate models that include information for women at all parities, we include categorical variables for parity. Since the data restricts us to consider women with one or more births, the omitted category is one birth. In analyses that use the primary data that includes all mothers, parities eight and higher are collapsed together. In the analyses that use the subset of mothers for which dates of death are available, parities six and above are collapsed together.

To test for targeting of sex composition, we include a continuous variable measuring the proportion of previous births that are female. If parents systematically sought sons, a higher proportion of previous births that were female should be associated with higher chances of having an additional birth. If parents were indifferent to the sex composition of their children, the proportion of previous births that were female should have no effect. Admittedly, this single variable does not capture the possibility of more elaborate preferences on the part of parents, for example, that they may have wanted a mix rather than a preponderance of males. In future iterations of this analysis we will explore alternative specifications of this variable.

To test for replacement effects, we include separate categorical variables for counts of previous male and female births that have already died. For both male and female deaths, zero is the omitted category. We expect that if apparent replacement effects were an artifact of an underlying physiological process, for example a tendency for some women to have births at short intervals and thereby increase the risk of dying for the children already born, there should be no difference in the effects of previous male or female deaths on the chances of having a birth. If parents replaced sons who died, however, increases in the number of boys who died should increase the chances of having a child, while increases in the number of girls who died should have no effect.

To account for heterogeneity among women, we take a variety of approaches. To assess the extent of heterogeneity, we estimate a model with a random effect of mother. This yields an estimate of the 'within-mother' correlation in the chances of having a birth. To control for heterogeneity among mothers while looking at parity-specific effects, we then estimate models with fixed effects of mother. Though a random effect model may help detect heterogeneity, we are concerned that it may not adequately control for it. A random effects model imposes strong assumptions on the distribution of the mother-specific effect, and requires that variables included in the model not be associated with the mother-specific effect.

To assess parity-specific behavior while controlling for heterogeneity among women, therefore, we also estimate models with a fixed effect of mother. In such an approach, each woman is assumed to have an underlying and unmeasured fecundity. Coefficients reflect comparisons among births to the same women, and are net of effects of underlying fecundity. With this approach, coefficients for parity should uncover whatever systematic relationships existed among birth intervals at different parities, holding constant the underlying fecundity. If women did not alter their behavior according to their parity, then coefficients for different parities should be zero, and variation in birth timing should be accounted for by duration since first birth. If women spaced births further apart as they attained successively higher parities, that should be revealed in a pattern of increasingly negative coefficients as parity increased. We do give something up, however, when we estimate a fixed effect model: we are restricted to using data from mothers who had at least one more birth after their first one.

To investigate how the factors that affected fertility control may have varied by parity, we also estimate separate models by parity that include the length of the previous birth interval as an explanatory variable measuring the woman's fecundity. Our specific interest is to test whether selection effects based on heterogeneity play a more important role at higher parities than at lower parities. If there was pronounced heterogeneity among women in the chances of having a birth, the higher parities should be dominated by women whose fertility is less a product of deliberate control and more a product of physiology, or whatever other factors accounted for high fecundity. Thus we expect that at higher parities, sex composition and mortality of previous births will matter less, and length of the previous birth interval will matter more.

Results

Parity-specific control

Heterogeneity is very evident in the pattern of differentials in birth probabilities according to parity. Table 1 presents results from a basic logistic regression in which the chances of having a birth are related to duration since first birth, parity, and other characteristics of the woman. According to these results, women who have had births at a rapid pace in the past have an additional birth sooner than women who have had births at a slower pace. For example, at a given duration since first birth, the odds that a woman who has already had three births will have another are 2.28 times those of a woman who has only had one birth. The pattern persists when analysis is restricted to the subset of observations where the mother's date of death is available.

Table 1 here

The source of the heterogeneity, of course, is unclear. There is likely to have been some physiological variation between couples in fecundity, so that holding coital frequency constant, some couples may have been more likely to conceive than others. Of course, there may have been other sources of heterogeneity. In particular, some couples may have had persistently higher coital frequency than others, whether because of variations in libido, opportunity, alternatives, or preferences for longer or shorter birth intervals. Such a pattern would even be consistent with the coexistence of subpopulation stopping births after achieving a particular target with another subpopulation in which 'natural' fertility prevailed. In such a situation, selection effects would lead high parity women to consist disproportionately of women who were not practicing stopping.

Results from estimation of a model with a random effect of mother confirm the existence of a within-woman correlation in the chances of having another birth. For the dataset consisting of all observations, the within-woman correlation (rho) was 0.139, and statistically significant at the 0.001 level. For the subset for which dates of mother's death were available, the within-woman correlation was smaller, 0.076, but nevertheless statistically significant at the 0.001 level. The smaller magnitude is attributable to the absence from the subset of woman who are dead and therefore unable to conceive. In both cases, models excluded the categorical variables for parity and numbers of deaths of previous children, since are likely to have been correlated with the random effect. Since the basic pattern of results for duration and other variables are essentially the same as in table 1, we do not present them here.

Controlling for heterogeneity among women by introduction of a fixed effect of mother completely transforms the picture of parity-specific behavior. According to the results in Table 2, the probability that a woman would have an additional birth declined dramatically as parity increased. For example, the odds that a woman at a given age who already had three children would give birth to another were 0.058 ($e^{-2.850}$) those of what they would be if she only had one child.

Table 2 here

To clarify the implications of these results, Figures 1 and 2 present the odds that a woman of a particular parity and duration since first birth will have another birth, relative to the odds of another birth when she only had one child, and was within two years of her first birth. Figure 1 presents values calculated from the fixed effect estimation that used all observations, while Figure 2 presents results from the estimation based on observations for which the time of the mother's death was available. The lines are labeled according to the parity to which they correspond. The curves can be thought of as trajectories of age-specific fertility chances associated with particular parities, holding fecundity constant. Having a birth moved a woman from one curve to the one below. Clearly, the likelihood that a woman had another birth depended heavily on the number of births she already had.

Figures 1 and 2 here

Such results suggest strongly that there was parity-specific fertility control in the Qing imperial lineage. Several different scenarios for control might account for such patterns, and from these results alone it is not possible to identify which. It may be that women did not practice stopping, but spaced subsequent births further and further apart. Alternatively, women may have practiced stopping, but their targeted number of children may have been diverse. Finally, women may have practiced a mixture of strategies.

Sex composition of previous births

Review of results in Tables 1 and 2 confirms that parents exercised fertility control according to the sex composition of their previous births. According to the results for all observations in Table 1, for example, a woman whose prior births were all female was 1.18 ($e^{0.163}$) times more likely to have a birth than a woman whose previous births were all male. The effect is even stronger in the results from the fixed effects model in Table 2, at least in the estimates using all observations. A woman whose previous births were all female was 1.33 times more likely to have another birth than if her prior births were all male. In contrast with Wolf (2001, 146-147), we believe that it is irrelevant whether such differentials reflected complacency on the part of couples who had achieved a targeted number of sons, or anxiety on the part of couples who had not, it reflects a deliberate form of fertility behavior.

As for why it is that the effect changes direction and becomes insignificant in the fixed effect model estimated on the subset of observations for which date of death were available, it is likely a selection effect. The applications for funeral expenses that were the source of mother's death dates were often filed by their sons. The women for whom we have death dates, in other words, are disproportionately likely to have had sons. For that reason, when we consider effects of sex composition and mortality of previous births, we restrict ourselves to the results from the model that uses observations from all mothers.

Replacement fertility

There is unambiguous evidence in Tables 1 and 2 that parents sought to replace sons they had lost, but not daughters. According to Table 1, the loss of one son increased the odds of having another child by 24.6 percent. The loss of two sons increased the odds of another child by 35.9 percent. By contrast, the loss of a single daughter increased the odds of another child by only 13.2 percent. The loss of two or three daughters actually had less effect than the loss of a single daughter, perhaps because in such cases, the deaths were more likely to be the result of infanticide, and predictive of a desire by parents to limit their fertility. These effects are above and beyond whatever physiological effect there was of the death of a recent birth and early resumption of menses, since the model includes an indicator of whether or not the mother is within two years of a previous birth that has died.

Differences by parity

To assess how the importance of control evolved as a function of parity, we estimated separate models at each parity. Table 3 presents extracts from the results that summarize the effects of sex composition and mortality of previous births, and length of the previous birth interval. According to these results, control was most evidence at earlier parities. Effects of sex composition and mortality of previous births were generally significant, while effects of the length of the preceding birth interval were weak. At later parities, however, effects of sex composition and mortality declined, and associations with the length of the previous birth interval became stronger. One interpretation is that the population was divided between controllers and non-controllers. Controllers may have dominated the lower parities and because of a tendency to have fewer births overall, never reached the higher parities. The higher parities were accordingly made up largely of couples that had births regardless of circumstances, and for whom the best predictor of the chances of a future birth was simply their fecundity, as measured by the length of their preceding birth interval.

Table 3 here

Conclusion

In this analysis we have revisited the issue of fertility control in the Qing imperial lineage, taking advantage of advances in statistical methodology and computing technology to carry out a more nuanced analysis than was possible in Wang, Lee, and Campbell (1995). We have demonstrated that once heterogeneity between women is accounted for by application of a model with a fixed effect of mother, there is strong evidence of parity-specific spacing or stopping behavior. For any given woman, higher parities are associated with lower chances of an additional birth, even after controlling for duration effects. There was also strong evidence of deliberate fertility behavior according to the sex composition and mortality of previous births, consistent with a desire by parents to achieve a particular number of sons, and replace sons they had lost. Finally, analysis by parity revealed that deliberate fertility behavior was most apparent at lower parities, while fecundity, as reflected in prior birth intervals, accounted for variation in chances of having a birth at higher parities.

Even though the Qing imperial lineage was an unusual population, we believe that these results have implications for our understanding of fertility behavior in historical China. The results demonstrate that at least one population, albeit an unusual one, exercised control over their fertility. Whatever methods lineage members used, whether reductions in coital frequency or some other approach, are hardly likely to have been a secret known only by members of the lineage. Other segments of society are likely to have been aware of such methods, and may have practiced them. Of course, whether or not such behavior was prevalent or rare is an empirical question. We look forward to replication of these analyses with other high quality fertility data, for example Taiwanese household registration data from the early twentieth century, to assess whether such behaviors existed in other areas or other social strata.

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Table 1. Logistic Regression of Birth on Characteristics of Mother

Variable	All observations Coef.	p	Where mother's date of date is available Coef.	p
Years Since First Birth (Reference: < 2)				
2	-0.297	0.00	-0.193	0.25
3	-0.512	0.00	-0.411	0.02
4	-0.576	0.00	-0.198	0.27
5-9	-0.890	0.00	-0.616	0.00
10-14	-1.488	0.00	-0.953	0.00
15-19	-2.126	0.00	-1.508	0.00
20-24	-3.046	0.00	-2.150	0.00
25-29	-4.319	0.00	-4.431	0.00
Years Since Previous Birth (Reference: < 2)				
2	1.030	0.00	1.308	0.00
3	0.974	0.00	1.233	0.00
4	0.788	0.00	1.208	0.00
5	0.244	0.00	0.496	0.00
Parity (Reference: 1)				
2	0.516	0.00	0.346	0.00
3	0.828	0.00	0.608	0.00
4	1.077	0.00	0.607	0.00
5	1.305	0.00	0.842	0.00
6 (6+)	1.448	0.00	1.019	0.00
7	1.602	0.00		
8+	1.964	0.00		
Previous Deaths of Sons (Reference: 0)				
1	0.122	0.00	0.039	0.58
2 (2+)	0.204	0.00	0.106	0.33
3+	0.267	0.00		
Previous Deaths of Daughters (Reference: 0)				
1	0.068	0.00	-0.010	0.90
2 (2+)	-0.014	0.71	0.068	0.60
3+	0.014	0.82		
Prop. Of Previous Births Female	0.163	0.00	0.283	0.00
Previous Birth Dead and < 2 Years Elapsed	0.422	0.00	0.910	0.00
Constant	-4.478	0.00	-4.682	0.00
Person-months	1835367		101597	
Log-likelihood	-100022		-6952.27	
d.f.	27		23	
Pseudo R-squared	0.07		0.0629	

Table 2. Logistic Regression of Birth, With Fixed Effect of Mother

	All observations		Where mother's date of date is available	
Variable	Coef.	p	Coef.	p
Years Since First Birth (Reference: < 2)				
2	0.520	0.00	0.411	0.02
3	1.032	0.00	0.789	0.00
4	1.495	0.00	1.442	0.00
5-9	2.235	0.00	2.020	0.00
10-14	2.781	0.00	2.904	0.00
15-19	2.747	0.00	3.068	0.00
20-24	2.108	0.00	2.681	0.00
25-29	0.910	0.00	0.385	0.48
Years Since Previous Birth (Reference: < 2)				
2	0.918	0.00	1.282	0.00
3	0.839	0.00	1.209	0.00
4	0.679	0.00	1.259	0.00
5	0.083	0.03	0.471	0.00
Parity (Reference: 1)				
2	-1.859	0.00	-1.555	0.00
3	-2.850	0.00	-2.307	0.00
4	-3.527	0.00	-3.360	0.00
5	-4.031	0.00	-3.792	0.00
6 (6+)	-4.469	0.00	-4.619	0.00
7	-4.845	0.00	-0.051	0.67
8+	-5.246	0.00	0.024	0.89
Previous Deaths of Sons (Reference: 0)				
1	0.221	0.00	-0.051	0.67
2 (2+)	0.307	0.00	0.024	0.87
3+	0.301	0.00		
Previous Deaths of Daughters (Reference: 0)				
1	0.125	0.00	0.090	0.49
2 (2+)	-0.007	0.91	-0.106	0.60
3+	-0.112	0.20		
Prop. Of Previous Births Female	0.284	0.00	-0.235	0.15
Previous Birth Dead and < 2 Years Elapsed	0.460	0.00	1.099	0.00
Person-months	1439818		90079	
Mothers	6285		405	
Log-likelihood	-80603		-5751	
d.f.	27		23	

Table 3. Results from Models Estimated for Each Parity

		Parity							
		1	2	3	4	5	6	7	8+
Previous Deaths of Sons (Reference: 0)									
	1	**0.279**	**0.152**	**0.123**	**0.150**	-0.016	0.117	0.054	-0.140
	2		**0.427**	**0.227**	**0.224**	**0.179**	0.035	0.082	0.191
	3			0.120	**0.324**	**0.297**	-0.042	**0.403**	0.240
Previous Deaths of Daughters (Reference: 0)									
	1	**0.345**	0.027	0.011	0.054	0.005	0.085	**0.261**	-0.086
	2		-0.027	0.028	-0.095	-0.008	-0.095	-0.082	0.241
	3			0.193	-0.279	0.217	-0.136	0.097	-0.057
Prop. Of Previous Births Female		**0.140**	**0.223**	0.123	**0.399**	0.197	0.300	0.119	0.186
Previous Birth Dead and < 2 Years Elapsed		- 0.128	**0.394**	**0.519**	**0.498**	**0.424**	0.337	**0.590**	**0.670**
Length of Interval Before Previous Birth in Months			0.000	**-0.002**	**-0.004**	**-0.006**	**-0.007**	**-0.010**	**-0.009**

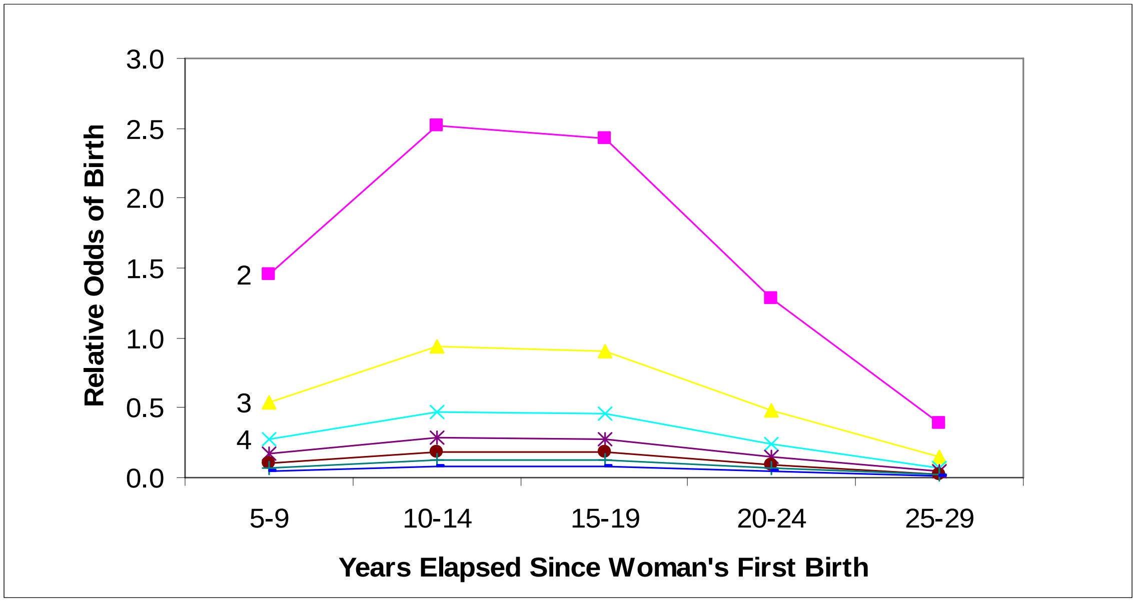

Figure 1 Odds of a Birth, Relative to When Woman Had One Child and Was Within Two Years of Her First Birth, Based on Fixed Effects Model Using All Observations

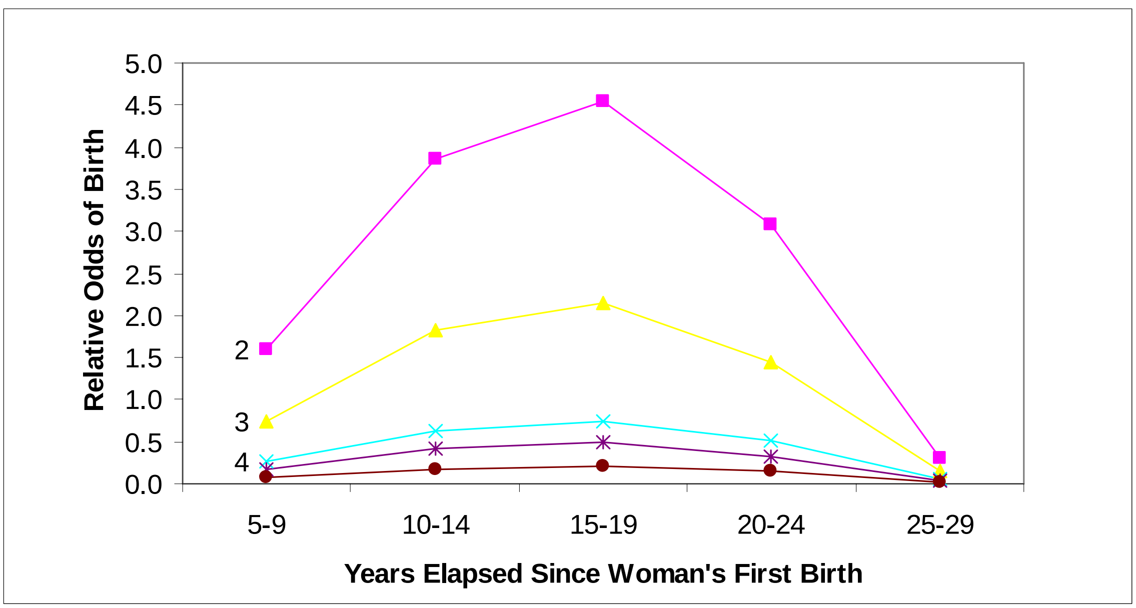

Figure 2 Odds of a Birth, Relative to When Woman Had One Child and Was Within Two Years of Her First Birth, Based on Fixed Effects Model Using Observations for Which Age of Mother's Death was Available