Human Capital and Fertility in Chinese Clans, 1300-1850

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Abstract

Theories of modern economic growth assume the income and technological shocks of the industrial revolution triggered the declining fertility and increasing human capital of the demographic transition. To shed light on the question of whether households might be engaging in investment behavior in the pre-industrial period, this paper provides demographic evidence on China over the 14th to 19th centuries, a period well before the onset of its demographic transition and industrialization to investigate the relationships between human capital, fertility, and social mobility. Social mobility, both upward and downward, was substantial during much of this period. Fertility was linked to household's objectives for upward social mobility, which depended on high level investments in child education. I first show fertility varied across the status of households. Second, I examine the sibling size and family characteristics of men who obtained success in the official state administered examinations. I find that conditional on father's status, there appears to be a robust negative relationship between family size and sons' education since the late 17th century that is consistent with a quantity-quality trade off in an instrumental variables estimation framework. The findings suggest there may be a demographic role for modern growth that pre-dates the industrial revolution

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1. Introduction

Sustained per capita growth first emerged when economies exited the Malthusian trap and temporary income increases ceased to translate one-to-one into higher fertility. A drop in society-wide fertility—as seen in a demographic transition—is often assumed to be triggered by modern economic development.[2] In neoclassical theory, positive income shocks increase the relative demand for child quality versus quantity (Becker, Murphy, and Tamura 1990; Becker 1981; Becker and Tomes 1976). Similarly, a reduction of fertility in favor of higher educational investments is crucial in human capital models. Technology shocks such as the inventions of an industrial revolution give rise to per-capita income growth because they increase demand for human capital and raise incentives to acquire education (Galor and Weil 2000). .

While few would dispute the significance of these changes for world history, many key questions remain unresolved. How important are new human capital investment strategies in changing individual fertility behavior? Are the factors that change fertility behavior mediated through market prices and individual rational choice as in the neoclassical model, or through changing social norms? In this paper, I bring new evidence to bear on these questions based on an analysis of Chinese clan genealogies for the years 1300 to 1850.

[2] See Cleland and Wilson (1987), Mason (1997), Easterlin (1978) for overviews of demographic transition theories. On the social and economic explanations of demographic transitions, see Thomson (1929), Davies (1945), and Notenstein (1945), Carlsson (1966), and Cleland and Wilson (1987). Notwithstanding the fact that the timing of the demographic transition does not always support the view that industrialization was the cause, many interpretations hypothesize that declining fertility was a response to the changing costs of children. For example, formal insurance mechanisms, declines in mortality, industrial production, and wage-based labor markets eroded the reasons why children and kin networks were useful in past societies. For empirical studies and interpretations, see Coale and Watkins (1986), and Guinnane, Okun, and Trussell (1994).

This paper provides demographic evidence on China during a period well before the onset of its demographic transition and industrialization to investigate the relationships between fertility, income, and social mobility. I show that low fertility was in part due to education objectives. Based on genealogical evidence, I argue that social mobility, both upward and downward, was substantial in this time period in China. Opportunities for rising in status depended on human capital investments for one's child. Fertility was linked to household's objectives for upward social mobility, which over the 14th to 19th centuries in China depended on high level investments in child education. I first show there were systematic patterns in fertility that varied across the status of households. Second, I examine the household sibling size of males who obtained success in the official state administered examinations. I find that conditional on father's status, there appears to be a robust negative relationship between family size and sons' education, consistent with a quantity-quality trade off.

There exists limited historical empirical evidence on the factors that determined family size.[3] The Asian case provides an important comparison to the studies based on European economies because Asia has long been viewed as a region that favored large numbers of children. The Malthusian view contrasts Asian populations—characterized by uncontrolled fertility, universal and early marriages, subsistence living standards, and resulting cycles of population booms and bust—with Europeans fertility restraint and low

[3] Most studies suggest natural fertility and a lack of fertility control among the general population, where controlled fertility implies couples aim for a certain family size while natural fertility implies that they do not. See Knodel (1978) on Germany before 1850, and Wilson (1984) on England in 1600-1800. Clark and Hamilton (2006) uses English will records dated to the 16th and 17th centuries; Harrell (1985) examines three Chinese lineages from Zhejiang, and Telford (1995) studies Chinese lineages in Anhwei in the 16th and 17th centuries. These studies find that prior to the 19th century, the rich tended to have more offspring than the poor.

population growth.[4] Recent work has revised this perception to some extent, showing that although a larger fraction of women remained unmarried in Europe, fertility within marriage was much higher in Europe than in China (Coale 1985, Lee and Campbell 1997; Lavely and Wong 1998).[5]

How were these relatively low premodern fertility rates achieved in China? On this question, authors have typically made a distinction between fertility rates resulting from private and deliberate control versus fertility driven by biological reality and the social environment.[6] For example, social norms such as marriage norms or breastfeeding practices, and environmental factors such as malnutrition and poverty have demonstrable impacts on fertility rates, but are not typically considered the result of private individual deliberations.[7] Pre-modern families also engaged in a multitude of strategies in family planning. However, "rational planning" of family size in these societies invariably invokes post-natal methods of family limitation such as infanticide or abandonment, the selling off children or sending them to away to apprenticeships (Mason 1995). In the case of pre-industrial China, all the reasons given to explain low overall marital fertility rates amount to biological factors and rational behavior in the context of given social norms (Lavely and Wong 1998, Lavely 2007).

In contrast to biological factors and social norms, the deliberate limitation of family size to achieve upward mobility would be regarded as a feature of post-transition

[4] These norms include a high fraction of women remaining unmarried for life and late age of marriage. For details on the European marriage pattern, see Wrigely and Schofield, 1981.
[5] Although critics have questioned the scope and the representativeness of the Chinese data used in these studies, see Wolf 1984.
[6] Wrigley (1978, 148) refers to the idea that the key change of the demographic transition was a move from a system of control through social institution, biological factors, and custom to one in which "the private choice of individual couples played a major part in governing the fertility rate."
[7] The precise distinctions between individual control and social control with regard to some factors can become blurred in some cases (Knodel 1983, Menken 1979).

behavior. These evidently did not become widespread in developing countries until very recently. Society-wide trends, however, tend to obscure important incentives that were in fact acted upon within populations.[8] Furthermore, theories of the demographic transition suggest that technological and productivity shocks are needed to trigger higher demand for human capital and lower fertility behavior.

The contribution of this paper is to provide evidence that human capital demand did create incentives that reduced family size in the pre-modern, pre-transition period when these shocks were absent. The implications are two-fold. First, it appears that premodern fertility was not only driven by social and biological factors, but private and deliberate choice also had an important role in reducing fertility, especially for the wealthiest households. Second, the fact that there exists fertility-control behavior in the absence of income or technological shocks suggests that there may be a much broader set of economic factors that can induce lower fertility behavior. The Chinese case demonstrates that demographic relationships thought to have been induced by industrialization were present before modern economic growth, even if they may not have been yet pervasive. This implies there is a need to reevaluate models of human capital and fertility, and the mechanism by which lower fertility is achieved. These relationships are important for understanding how demographic transitions come about, whether the demographic transition was indeed merely a response to the changes brought

[8] There is some suggestive evidence that there was fertility restriction among many European Jewish populations after 1700 (Livi Bacci 1986), but these declines may be markers of an early stage of Europe's demographic transition, rather than features of a pre-transition equilibrium. Garrett et al. (2001) finds a negative association between income and the numbers of children born in the late 19th century for England at the start of its demographic transition. Litchfield (1969) finds declining fertility among Florentine aristocrats in the 16th to 19th centuries, but attributes this in part to a strategy to preserve wealth in a society with rigid status structure. Clearly, this motive is different from an investment strategy to increase child quality.

about through industrialization, or whether there could be a demographic role for economic growth and what it consists of.

The organization of the paper is as follows: Section 2 provides a historical background on social mobility and education in China. Section 3 discusses the data and descriptive statistics on father-son status and intergenerational mobility. Section 4 gives an empirical analysis of fertility and status and addresses whether there is a quantity-quality tradeoff in family size. Section 5 concludes with a discussion of the nature of this tradeoff.

2. Historical Background

2.1. Social Mobility in China

Although there were large differences in wealth and status within Chinese society, there were neither official nor legal barriers to entry into the elite classes.[9] From the Tang dynasty (670-906 AD), hereditary aristocracies in China had been eliminated. Beginning in the Song dynasty (960-1127 AD) officials of the state were selected on the basis of formal examinations. By about 1650, the only types of hereditary privileges and automatic status that remained belonged to the imperial lineage and court, and the families of the Eight-Banner military system. The rest of society, which was the large majority, was governed by a meritocracy where high status and political power depended directly on individual success in the state administered written examinations.

The most important source of income for those who obtained gentry status was the state's compensation for their official services (Chang 1962, 3). It was with this

[9] For further discussions on social mobility in China during the late imperial era, see Greenhalgh (1988) and Ho (1964).

income that they were able to uphold their relatively high living standards, contribute to local community projects, and make investments in landed property. With perhaps the exception of the famed merchant families of China, official status must have offered one of the most financially rewarding careers available, and the prestige and power that came with high level positions was unmatched. Merchants who had accumulated fortunes could on occasion purchase minor titles and thus buy into some part of the governing elite, but direct participation in the state exams was the direct route, and the only way to acquire the highest level positions.

The institution of using classical education to legitimize bureaucratic officials was a central aspect of governance until the last years of the Qing dynasty (1644-1911). Whereas in Europe, nobility status could be passed down across generations, social status in China relied to a far greater degree on investments made by each generation on the next. The regular erosion of political power, at all levels below the throne, was in this way institutionalized from an early point on.

No one who had proved himself a qualified candidate could be excluded from participating in the exams because of his current status. For those who had some degree of wealth and status, investments in sons were necessary to prevent a loss of standing in the next generation. Small family size in itself was not enough to preserve status. For poorer households without official titles, the relevant question was whether such investments could be afforded at all, or whether poverty precluded the possibility.

An important question is whether social mobility was fluid in practice as well as in theory. Wealth alone would have meant better access to tutors for the sons of the rich, for example. In addition, it is possible that kinship networks and connections among the

clan in high status positions helped to extend personal advantages to other lineage members trying to stay in their high status positions or to climb the social ladder. The available evidence suggests, however, that kin network effects did not matter that much.[10] What did matter for social mobility and gentry status was whether or not it was possible for a household to support a son in preparing for the official exams.

2.1 Investment in education

In this section, I briefly discuss the Chinese state exam system and investments in child education. The costs of schooling in basic literacy during the Qing period were relatively modest. Parents paid the local schoolmaster tuition fees if they could afford it, and if not, lineage subsidies, clan schools, and publicly financed charitable schools were alternatives. Schools were present in most villages (Rawski, 1979, p.17), and only open to males. It is estimated that around 30-45 percent of males and 2 percent of females were literate in the late Qing (Rawski, 1979, p. 23). Education in preparation for the imperial examinations, however, was much more expensive and required significant time and effort. Exam questions included policy question on statecraft, and fiscal policy, military and political institutions at the time, but it was also based on the moral and political thinking of classicism.[11] Since the Ming dynasty (1368-1644), the state supported a variety of schools specializing in areas such as military education or medicine, and schools were located in both rural villages as well as urban places. There was an official subsidized schooling system (*ruxue*) located in counties, sub-prefectures,

[10] A recent study by Cameron and Lee (2003) on the Eight Banner military population examined the likelihood of men obtaining an official title because of distant kin networks found that a significant proportion of new appointments were made to men who had no connections within the bureaucracy.
[11] See Twitchett and Mote (1998), Ch 7, p. 361.

and prefectures for students intending to take the state exams, but only those already literate in classical Chinese could be enrolled.

The state's examinations were serious competitions that took place in stages. Local nominees were nominated at the prefectural level for candidacy to the first level examinations. Every three years, these exams were given in the provincial capital over a period of nine days.[12] Students had to write their exams in secluded cubicles and soldiers monitored the room to prevent cheating. Names were removed from exam papers and given anonymous codes. Provincial graduates, those who passed these exams, were already eligible for official appointments and tax exemptions for their family, but they could also choose to take the next level examinations, the metropolitan examinations, which took place in several rounds. A few thousand examiners were involved in the process, and at the conclusion of those exams a list of the successful candidates was produced, in rank order. Graduates of these exams enjoyed an extremely high reputation. Depending on the rank and the level of exam, men who graduated with degrees were eligible to begin careers in the government.

Since the early Ming dynasty, exams were open to all, but only those who demonstrated sufficient preparation could participate. Most importantly, the initial preparation for civil service was a private investment decision. Certainly by the 18th century, China was characterized by a market economy that was in many ways as developed as many economies of Western Europe at the time (Shiue and Keller 2007). It is thus not surprising that while the state established rules for the exam and the promotion system, the decision on whether or not to prepare for the exam was a private choice. The state offered incentives, but otherwise did not interfere with respect to decisions on which

[12] Upwards of 4000 persons appears for provincial exams at the capital (Twitchett and Mote 1998, p. 36)

investment activities households should pursue, how many children to raise, or how much education to acquire.

I now turn to discussing the genealogical data used in the analysis.

3. Data

3.1 Tongcheng genealogies

The data are from the genealogies of Tongcheng County, in the prefecture of Anqing, in Anhwei Province. The county is approximately 30 miles by 60 miles, and is situated on the Yangzi River about 300 miles inland from the coast of the East China Sea. The county is about 150 miles from Nanjing, the early Ming Dynasty capital, and 650 miles from Beijing, the later Ming and Qing capital. Anhwei Province was representative of the more developed and densely settled regions of China. In the Ming and Qing, the region was mainly a rice-producing agricultural area where the wealthiest families were typically landowning gentry (Beattie 1979, 130-131).

The dataset is created from genealogies of seven clans from Tongcheng County.[13] Ancestral worship was an important Chinese characteristic, and the purpose of genealogies was to keep a record of the rituals of the family and a record of the achievements of its members.[14] They were compiled or updated by the literate members of the lineage. The genealogies were valued and kept in the hometown of the lineage in ancestral halls, providing future generations with a record of the location of graves, texts relating to grave worship, family rules of conduct, biographies of prominent members, a record of lineage lands, and an overall history of the family.

[13] Other Tongcheng clan genealogies of similar quality exist, and these could be potentially added. At the same time, there do not appear to be any clear gains to enlarging the sample.
[14] Surveys of the content and scope of Chinese genealogies are in Liu (1978), Telford (1986).

All male individuals were lineage members, regardless of wealth of status, and were supposed to be included in the genealogy. Fertility and mortality characteristics, however, must be studied with attention to certain facts on how the information in genealogies was recorded. First, Chinese genealogies are organized patrilineally. The most complete data available in the genealogy are those for the male population that survived beyond childhood. Infant and child mortality up to the age of around 8 were incompletely recorded in the genealogies, and consequently crude birth rates cannot be precisely calculated from genealogical data, although informed estimates are possible. In addition, the vital statistics for daughters are underrepresented relative to sons. As a rule, female vital data appear with greater detail in the genealogy of their marital lineage, rather than that of their natal family's. For these reasons, fertility counts are in this study limited to the sons only.

Second, because genealogies were meant to record the achievements of lineage members, the data on upper status members of the lineage were recorded fairly completely. This is useful for the analysis in this paper because key aspects of this paper's findings relate to higher status men. The people who were most likely to be missing in genealogies are low status single men who died young. This is the group most likely to have lacked relatives (especially children) who were able to provide their vital data to the compilers of the genealogy.[15] Unmarried men, however, are not part of the analysis of this paper, since my focus is primarily on the size of families.[16] Low status married men who had surviving children were far less likely to be left out of the

[15] Permanent migrants would also cease to be recorded in genealogies, but the percent of migrants was very low.

[16] Low status single men still do exist in significant numbers in the genealogical data, so we would still have quite a large sample to work with if that were the group of interest.

genealogy, and, as I will show in later sections, individuals with low status in fact comprise the vast majority of the individual records.

Thus, despite the fact that the lineage would have had to rely on the literacy and wealth of a subset of individuals to compile the genealogy, genealogies compiled from a large lineage of thousands of individuals, such as those underlying the analysis in this paper, provide a good sample of the socioeconomic distribution of the population (Harrell 1987, Telford 1990). Indeed it is generally recognized that genealogies are the most complete source of demographic data available for the general (non-hereditary status) population. Among the advantages of the genealogical data is that it includes information on a variety of socioeconomic characteristics of related individuals. Moreover, there is information on number of children, as well as their birth order. This information rarely available even in contemporary population surveys.

3.2 Descriptive Statistics

This section summarizes some of the main variables. The progenitor of each of the Tongcheng clans included in the dataset arrived in the vicinity sometime before the year 1500. The earliest birth year recorded was in year 1298 (Chen lineage). The average number of years covered for all seven clans is 495 years (ranging between a minimum of 286 years and maximum of 571 years). There are no breaks in the intergenerational linkages within each clan, meaning someone in the clan was always alive throughout the period. It is possible to follow the demographic patterns of the seven families for an average of 14 generations, and a maximum of 20 generations. All seven lineages

experienced growth in population over time. About 90 percent of the married men in the data was born in 1650 or after. The last birth date is 1885.

Population growth overall in China was relatively rapid in the 18th and 19th centuries compared to the past. Much of the increase resulted from settlement on frontier lands, but the population residing in Tongcheng also increased to some extent. According to the land tax census of year 1765, there were 850,168 persons registered in Tongcheng County. By 1790, gazetteer data for Tongcheng report a population of about 1.3 million.[17] These numbers suggest that the fraction of the total population sampled by current dataset is around half of one percent.

The sample yields 9,773 unique records on men. There are 11,330 marriages between the male descendants of the lineages and in-marrying women. This includes marriages in which there were multiple wives (wives not alive at the same time) as well as polygynous unions. Polygynous unions were uncommon—occurring among less than 2 percent of all married men. Most men married once, and those who married more than once typically did so after the death of their spouse. Remarriage upon the death of a spouse, by contrast, accounted for about 12 percent of all marriages.

Not included in the sample are the husbands of the daughters of the lineage. By contrast, there is considerably more information on the wives of lineage sons, i.e., those women who married into the lineage and who became the mothers of the male line. This asymmetry also explains why there are many more records of women than of men in the dataset.

[17] Three gazetteers cover the period under analysis: *Tongcheng xian zhi* (1490), *Tongcheng xian zhi* (1696), *Tongcheng xuxiu xian zhi* (1827).

Intergenerational cohesion depended in part on household structure. Genealogical statistics do not record whether family members resided in the same household, although Chinese social norms favored the idea of the large multi-generational household sharing a common residence. It is plausible thus to assume that members of older generations were residing in the same household as younger generations as long as both were alive. In that case, the maximum size of the extended household depended on the average length of life, the number of sons born, the age difference between generations, whether or not there had been natural crises or man-made social disruptions. A count of the household size of a nuclear household consisting of parents and their children suggests that the average household contained at least 4 to 5 people. Tax census data for the late 18th century suggests household size was about 7 to 8 persons, which may have included other relatives. While it would have been possible for married siblings to reside together, typically it was the grandparents who shared a household with their sons and grandchildren.[18]

Life expectancy at birth for all recorded males was about 28 to 32 in the 17th and 18th centuries.[19] Some young children did get recorded in the genealogies, and to the extent that they did, we can observe high mortality for children under age five. Conditional on having reached the age of ten, life expectancy was 46 years.[20] Among first-born sons who died after their father did, the average number of years of lifetime overlap was 23 years (standard deviation 13 years).

[18] One way of estimating the maximum number of people in the average extended household is to calculate the number of years of overlap across generations.
[19] This is well within the range of life expectancies for largely agrarian economies. Compare with London in the late 18th century (23 years), England (35-38 years) in the 18th century, France in the late 18th century (28 years), Anhwei Province, China from 14th to 19th centuries (28 years). See table 5.2 in Clark (2007).
[20] Lee and Campbell (1997, 60), using Chinese army population registers of about 3500 people in North China find life-expectancy for the age group 10-15 to be on average 48 years for the late 18th to mid-19th century, and life-expectancy at 6 months of age around 33 years.

The mean age at death of all married men was 49, with a standard deviation of 15 years. Nearly 19 percent of married men did not have a son that survived past adolescence, while the figure is 25 percent for women. The mean age at the birth of the first son was 24 for women (standard deviation of 5 years), and 28 for men (standard deviation of 8 years).[21] Also, a significant minority of males never married. Among all men who reached the age of 30, 10 percent remained single for life.

3.3 Social Status and Intergenerational Mobility

Genealogical data contains information on social status designations associated with official titles and other designations that can be ranked. I have constructed a status variable that consists of four categories. In accordance to Chinese notions of status, ranks are designated by attainment of these offices and degrees rather than with pure financial wealth. However, financial wealth would have been highly positively correlated with status. In general, less than 5 percent of the population in China could be categorized as the gentry, who were moderate to high ranking officials, and the genealogical data is consistent with this. In this, there is quite high representation of the non-gentry population in the data.

Information on the frequency and percentages for fathers' and sons' status are given in Table 1. The lowest status group, labeled "No titles/Wealth", consists of those men who had no titles, nor notable accomplishments, nor evidence of wealth attached to their names in the genealogy. This applied to the majority of individuals. These households were likely to have been mostly peasant farmers and artisans.

[21] Marriage dates are estimates based on the year of birth of the first child (Telford 1990) for some women .

The next group, labeled "Moderate wealth", includes men for whom there is some evidence of wealth. These men may have been a village head, or may have received some honorary or posthumous title because of their contributions to the lineage, but we do not know what their occupations were. Men with no other evidence of status other than having multiple sequential marriages are included also in this category.

The next group, the "Near Gentry", were those men who had more significant indicators of wealth and property. Men who had no official title, but who were able to make substantial contributions, philanthropic or otherwise, were likely to have been wealthy farmers, landowners or merchants. Other men in this category, for example, were those individuals who may have prepared for, but did not pass their official examinations, and so were educated, yet did not obtain degrees or office.[22] Others may have obtained purchased official titles, or, held relatively minor official positions in the military.

The highest status categories are designated the "Gentry", and included men who had obtained moderate to the highest degrees, and had or were expecting appointments in the military or civil branches of the government above minor rank.

From Table 1, it is evident that the distribution of the status categories was not very different between the fathers and sons in the sample overall. About 65-70 percent of all men in the father-son sample had neither titles nor evidence of wealth. The "moderately wealthy" make up 7-12 percent. The "near gentry" are 18-19 percent, and the "gentry" comprise about 3-4 percent of the entire sample. The percentages are plausible and consistent.

[22] The sons of high gentry and near gentry are placed in this category, rather than in the lowest category, even if they did have other signs of wealth or status. It is highly likely that these sons would have had some education, even if they did not obtain degrees. They may also have inherited some land or wealth not noted in the genealogy. Placing these sons in the "no titles/status" category would not change the qualitative results that follow.

Contingency tables provide a way of summarizing intergenerational status associations across fathers and sons. Table 2 shows the marginal frequencies across status groups for fathers and sons over the entire sample. The diagonal gives the percent of sons in each class that had the same status as their fathers. The sum of the off-diagonal terms gives the percentages of sons with either higher status (above diagonal) or lower status (below diagonal).

For the gentry, the near gentry, and the moderately wealthy, less than one-third of the sons of fathers in these classes remained in the same status category. Only 15 percent of the sons of the moderately wealthy were also moderately wealthy. These percentages are low, suggesting that social mobility into and out of the top third of society was high. Sons of fathers with no titles were more likely to remain in that category, but 13 percent of the sons were able to move up socially.

The mobility of high and low status groups is not symmetric, however. A higher fraction, about 30 percent, of the sons of the gentry and near gentry was able to maintain their status, compared to those with moderate wealth. About 87 percent of the sons of fathers who were peasants or had no evidence of wealth had no status of note either. For those with moderate wealth, only about a quarter of the sons were able to maintain or improve upon this status, while three-quarters moved downward in status. Among the gentry and the near gentry, a relatively higher fraction were able to maintain their status (at 32 and 40 percent, respectively), although it is still the case that the majority experienced a fall in status in subsequent generations.

Persistence in status across generations was highest, then, in the “no titles/wealth” category. From Table 2, we can conclude that over all status categories, about 65 percent

of sons stayed in the same status group as their fathers with no change, where this percentage is largely driven by the large numbers in the “no titles/wealth” group. A total of 12 percent of the sons were upwardly mobile, while twice that number, 24 percent were downwardly mobile. The overall picture is thus one where the tendency towards downward mobility was much stronger than upward mobility.

In summary, status in Chinese society was difficult to maintain across generations. Most men without titles had sons who had none either, while those with titles did not have sons that stayed in the same status as their fathers. The gentry as a class may have had a strong hold on political power, but the genealogical information confirms that this was not a society where political power was monopolized across generations of the same gentry family and automatically passed on from father to son. Overall, social mobility was fluid.

4. Fertility and Status

I now turn to the relationship between fertility and status in premodern China. In a society where there were virtually all births took place within marriage and the remarriage of widows was rare, births within marriage constitute an accurate record of fertility. The measure of fertility used in this section is based on two considerations. First, the number of male children who survive past childhood is the most reliable variable on children that is available from genealogies. Second, the number of sons for the father and for the mother is different because of polygamy and multiple sequential marriages, especially among wealthier men. This tends to result in men having more children than women in higher status households (Telford 1995). For the same reasons, women who

marry high status men, by contrast, have significantly fewer children over their lifetimes than women who marry low status men.

Table 3 shows the number of sons across status groupings.[23] Higher status men have more children, although there is a slight tapering off at the richest status (gentry) category. As has been suggested before in the existing literature, it appears that higher status men have more children than lower status men because they had a greater number of marriages per man. Table 3 confirms also that wives of high status men had fewer children than wives of low status men.

Marriage rates—both sequential and simultaneous marriages—were lower for low status groups. There may be reason to believe, however, that income affects fertility differently from how it affects the probability of remarriage. In particular, income is likely to affect the probability of remarriage differentially across status groups. Therefore, to obtain a comparison that addresses this, I compare only the households across all status categories where the husband and at least one wife survived past the age of 40, and have thus completed lifetime fertility. According to Table 4, the number of wives is still higher for higher status husbands, but limiting the sample to complete fertility marriages shows that the average number of sons born in gentry households is smaller than in the "no titles/wealth" households. There is a non-linear relationship between income and fertility in which the moderately wealthy have more children than the poor or the very rich. The fact that gentry households had fewer children than lower status households, even though gentry households were better able to afford more

[23] Records with missing death year data for the husbands were dropped because these were generally in the later period when it was likely that the genealogy was compiled while an existing cohort of lineage members were still alive.

children, suggests fertility control of a type that is very different from having few children because of poverty or food crises epidodes.

Tables 5 and 6 show the number of sons and the number of wives for each status category, for separate periods, (1300-1649) and (1650-1800). The qualitative trend between status and the number of wives did not change: richer men had more wives, but fertility in the later period among the highest gentry declined relative to other groups, and also relative to fertility of the high gentry in earlier time periods. Fertility among the other, lower status groups, on the other hand, either increased or stayed about the same. Those with no titles or wealth had more children, whereas the moderately wealthy and near gentry stayed about the same. In the period after the mid-17th century, the gap in fertility across status was wider than it had been in the past: fertility rates among the highest status group were about 20 percent less than households with no titles and wealth.

The average differences are large from the standpoint of fertility changes.[24] Furthermore, there are other fertility attributes that differ across status. Five percent of low status married men had no sons whereas ten percent of high status men had no sons. For women, only 1 percent of low status women who survived to age 45 had no sons, whereas 25 percent of high status women had no sons at that age. The average gentry wife had 1.4 sons, compared to 2 sons of the wife of a man with no titles or status. Higher status men had more wives, and with the children borne spread out across more wives, each wife would have had fewer children. Also consistent with this is that while only 5 percent of first wives who survived to age 45 had no son, 25 percent of third or

[24] A ten percent decline in martial fertility is the definition used by the Princeton European Fertility Project for the start of a demographic transition. Those fertility rates however, are based on annual country-wide crude birth rates and general marital fertility rates (number of births per 1000 married women between 15 and 49 years old).

fourth wives did not have sons, again suggesting fertility restriction in high gentry households.

4.1 Is there a quality quantity trade-off in children?

If income and status were the only determinant of fertility in a Malthusian world, then higher incomes should be associated with both higher child quantity as well as child quality. This does not seem to be what is observed. High status gentry had fewer children than the moderately wealthy, despite having the resources to afford more children.

One explanation for why the high gentry had fewer sons may be that the norms of that class are different from that governing behavior of the other groups. If socio-economic factors are part of the explanation for why high gentry had fewer sons, however, then the number of sons and the investments in each son are joint decisions determined by characteristics inside the family as well as external to it. In particular, the cost of education matters. It is therefore useful to examine this relationship in greater detail by focusing on those who obtained education.

I now examine the number of male siblings of married men across educational levels as demonstrated by having passed official examinations, holding constant the status of fathers. For a given status of the father, the son's education is broken down simply to whether or not he obtained in his lifetime a title that required substantial educational investments and the passing of official written examinations. A negative correlation between education attainment and the number of male siblings would be suggestive of a tradeoff.

Table 7 shows the number of male siblings conditional on father's status and whether or not there was at least one educated son. Gentry families had on average 0.5 (or 27%) fewer sons when there was an educated son.[25] The near gentry had on average about 0.6 (or 26%) fewer sons when there was an educated son, and the moderately wealthy had 0.11 (or 11%) fewer sons. Educated sons with fathers that had no status or title were a very small fraction, but came from larger households than their uneducated counterpart, by 0.31 (or 13%) more sons.

The fraction of gentry families where at least one son is educated is 51 percent, followed by 31 percent for the near gentry, 6 percent for the moderately wealthy, and 0.01 percent for those with no titles or status. Table 7 shows that the number of male siblings declines stronger with human capital investments the higher the father's status. The chance of gentry sons becoming educated is raised relative to moderate and no status sons, up and beyond the effect coming from the wealth of the parent, because gentry households also chose to have a relatively smaller family size.

This table demonstrates that there was also fertility control in the moderate and near gentry groups for specific subgroups. But because the number of families engaged in fertility reduction and the extent of the reduction differs, it is not always possible to see overall fertility differences averaged on income alone as in Table 4. Only in a comparison of the family size of the educated son versus the non-educated son do fertility differences appear large and systematic.

[25] Families often invested in the education of one son, while sending other sons to work in other activities, in part to pay for the education costs of the brother. Further breakdowns by birth order and status across siblings would be necessary to confirm whether families usually educated only one sibling, or whether there was there was equitable treatment.

4.3 Instrumental Variables Regressions: Ordinary Least Squares and Probit

How would additional demographic controls affect these results? Table 8 examines the relationship between education and the number of male siblings in a linear regression framework that also allows one to control for additional characteristics of the households. I now code "no title and no wealth" = "0", "moderately wealthly" = "1", "near gentry" = "2", and "gentry" = "3", which implicitly adopts a particular cardinal structure between different groups.

Column (i) shows that controlling for father's status, there is a negative and significant (at 5 percent) relationship between education and total siblings in a household. On average, an additional male sibling is associated with about one percent lower probability of education for the entire sample. Column (ii) uses indicators for family size, and suggests that there is a stronger negative effect at larger family sizes. Using demographic controls on family characteristics, including mother's father's status, age of death, age of death of mother and father, and a 50-yr cohort index does not change the coefficient on total number of siblings much (Column iii). As was seen in Table 7, there is a partial effect of total siblings on education that depends on father's status. Column (iv) therefore shows the coefficient of an interaction effect between father's status and total siblings, in addition to the demographic controls of Column (iii). Total sibling size is no longer significantly different from zero, but the interaction effect is negative and significant. There is a strong negative and significant partial association between number of siblings and education that depends on father's status.

Column (v) considers the additional explanatory variables. There are different reasons for why unobserved heterogeneity may matter. In particular, not all family clans

may be the same. Sublineage groups, at the segment of each clan may share unobserved characteristics. In addition, regional effects, the location of schools, for example, may have an impact on educational levels. Genealogical data provides information on the clan segment to which each individual belongs, and also the village of residence. These fixed effects indicators for the seven family clans, the 23 different branch segment within the family clans, and the 63 different villages of residence for the population in the sample are included in the column (v) estimate in addition to demographic controls. The results are similar to the previous column.

These regressions provide associations between status, male sibling size, and education. They cannot establish causal relationships. The decision on family size may be correlated with parental preferences that also go into decisions on the education of children, and is likely to be endogenous to education. To resolve these issues, I formulate an instrumental variable model as follows:

(1) $$Edu = \beta_0 + \beta_1 TotSibs + \beta_2 X + \varepsilon$$

(2) $$TotSibs = \alpha_0 + \alpha_1 BirthOrd + \alpha_2 X + \nu$$

In Equation 1, *Edu* is an indicator variable for education, which equals 1 if a son passed examinations at any level, and 0 otherwise. *TotSibs* is the total number of male siblings or half-siblings a person has, and *BirthOrd* is the birth order of all male siblings or half-siblings. This measure skips births of daughters, and orders by date of birth all sons from all wives in the household. Birth order is not strongly correlated with education, suggesting that there was no set rule on which son obtained higher education that

depended on birth order, and the instrument is valid in this case.[26] The X variables include demographic controls on family characteristics.

Table 9 shows the OLS results and endogeneity test of the total siblings variable, based on a comparison of the IV and OLS results. The null hypothesis of exogeneity of total siblings is weakly rejected at the 18 percent level of significance. As for the validity of the birth order instrument, the first stage regression is strong, with a positive and highly significant coefficient, consistent with the fact that higher birth orders are associated with greater numbers of siblings. The second stage regression results for number of siblings are negative and significant. Qualitatively, this is similar to the OLS results, but the IV point estimate is about 40 percent larger.

The dependent variable, education, is limited between zero and one, which raises the possibility that fitted probabilities can be less than zero or greater than one. For comparison, Table 9 also gives instrumental variables probit regression results, which ensures that estimated response probabilities are strictly between zero and one. The magnitude of the reported coefficients of the Linear Probability Models (LPM) and Probit Maximum Likelihood Estimation (MLE) is not directly comparable. The scaled probit marginal effect estimate of *TotSibs* is 0.042; it suggests that an additional son decreases the probability of obtaining education by 4.2 percent, instead of the 1.6 percent according to the linear probability model.

4.4 Marginal Effects of an Additional Son on Education, by Father's Status

To take into account how father's status affects education at the margin of an additional child, I use a new variable, the interaction between father's status and *TotSibs*.

[26] The correlation between *Edu* and *BirthOrd* is close to zero, -0.005.

Table 10 shows that this interaction variable picks up nearly all the sibling effect on education (as it does using OLS; Table 8, iv.). Three samples are shown for comparison: the full sample, 1650-1800, and the sample with fixed effects for regional and lineage heterogeneity. All coefficients on the interaction effect of siblings and father's status are negative and significant at least at the 10 percent significance level.

For the LPM, the average marginal effect is reported in Table 11. An additional sibling has a more negative impact on the education of gentry sons than on sons coming from families with moderate wealth. The gentry had apparently a greater incentive to restrict family size from the point of increasing the human capital of their sons, which confirms the earlier discussion above. The marginal effect estimates for the Probit reinforces this general result from the LPM, and generally, the estimates are very close. However, the LPM assumes a constant partial effect, so that given status changes has a discreet effect (= 0, 1, 2, 3), and the resulting impact of family size on education is linear.

In contrast, the Probit implies diminishing magnitudes of the partial effects. Table 11 reports comparison for the estimated decrease in probability of obtaining higher education, by status, for the LPM and the Probit. For the Probit, Table 11 shows the change in probability of education as total siblings increase from 1 to 2, 2 to 3, all the way up to son five, which encompasses about 95 percent of all households in the sample. It clearly shows that the effect varies non-linearly by father's status. The probability of education of sons from moderately wealthy households are effected by -1.2 percent at the birth of the 5th male sibling, less than the estimate from the LPM. The probability of education for gentry sons, however, are effected by -8.0 percent at the birth of the 5th male sibling, more than the estimate from the LPM.

Figure 1 plots the Probit's marginal effects averaged for all sons (last column of Table 11), again demonstrating that the LPM and the Probit estimates are similar, but the Probit reveals more pronounced negative effects on education for the higher status groups. The fact that we observe the elites restricting fertility more than other groups strongly suggests that larger family sizes impacted their probability of obtaining higher education, their primary source of income and social status, more negatively than it did other groups with lower status.

Conclusion

There are a number of ways in which the findings of this paper are unexpected. First, high income households in China were having fewer children as early as the second half of the 17th century. Second, households could choose to have their sons obtain education, and those who did tended to have smaller family size. This pattern is consistently observed not only for the high income groups, but also for the moderately wealthy and the near gentry. Third, the human capital motivation to reduce family size pre-dates observable declines in aggregate fertility measures across income classes.

Education was a costly investment, but came with both financial and social rewards. The group that invested in education most, the gentry, had the fewest children, conditional on their status and wealth. This result is estimated consistently from a number of regression models and it is robust to treating family size as an endogenous variable.

In the early stages of the English demographic transition in the 18th century, fertility control was adopted by the upper end of the social scale first. While it is difficult

to make a general comparison, the trends observed for Tongcheng county suggest that fertility control for social mobility reasons started at the upper end of the status distribution as well. In the Chinese case, the likely reason for these declines is that the gentry relied relatively more on human capital sources of income. Obtaining higher education was a costly investment that required many years of preparation. At the same time, the estimates show that additional children had a negative impact on the probability of high education for existing sons, and that negative impact is larger for higher status households who as a group were sending a higher fraction of their sons to school.

This may be explained in a framework in which both child ability and investment in child education enter into households' bid for higher status. Ability and human capital investment are complements for succeeding on the official examinations so that higher ability sons require fewer resources than lower ability sons to succeed. If households allocate a certain fixed fraction of their income beyond the basic means of subsistence to spending on the children of the household, for food, education, or other goods, households with little or no wealth will rarely be able to afford the considerable (and indivisible) investment of preparing a son for the state exam. This is why we do not see much evidence that these households reduced family size for educational goals. In the data, when sons of households with no titles or status did move up in status, the vast majority moved not into the gentry or near gentry classes (only 0.01 percent passed the official exams), but the moderately wealthy class. The few individuals who did manage to pass the exams from no status households were probably brilliant minds at the top end of the ability distribution who managed to pass the exams with little or no financial input.

At the other end of the income scale are the gentry households. They were first

of all wealthy enough to relatively frequently consider investing in their sons' preparation for higher education. Second, the fact that a higher fraction of sons from high status families are being considered for acquiring this education also implies that these sons have relatively low average ability, assuming that innate ability is not perfectly correlated with father's status. Gentry households therefore had to invest on average more in their sons' education for many of them to succeed in the state exam, in contrast to poor households that would by and large only manage to have the occasional brilliant son obtain a degree. For both of these reasons, the strategy to lower total spending on children by reducing the number of children to make room for substantial educational outlays tends to be more relevant for relatively wealthy households. Thus the presence of an educated son had a stronger negative effect on the probability of education of the existing male siblings. In the estimates, these are reflected in the larger negative marginal effects of number of children on education.

It is especially striking to discover that fertility control for human capital objectives existed in China starting as early as the late 17th century, a pattern that so far has been found in Western economies of the 19th century with the onset of the demographic transition as well as in developing countries of today. But China in the 17th century was neither industrializing, nor in the beginnings of a demographic transition—the proportion of gentry in the population was too small to change the average fertility rates for the entire population by much. What could trigger a switch from a higher fertility to a low fertility regime? The findings of this paper suggest that the basis of low fertility regimes have been there already in the pre-transition period. It may be more appropriate to ask not what triggers the change in behavior, but what allows it to spread.

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Table 1

Fathers' and Sons' Lifetime Status, Frequency and Percentages

	Son's Status			Father's status		
	Freq.	Percent	Cum.	Freq.	Percent	Cum.
No titles/wealth	6,957	71.17	71.17	6,418	65.66	65.66
Moderate wealth	1,791	18.32	89.49	1,809	18.51	84.16
Near Gentry	699	7.15	96.64	1,157	11.84	96
Gentry	328	3.36	100	391	4	100
Total	9,775	100		9,775	100	

Table 2

Contingency Table on Fathers' and Sons' Lifetime Status

	Father's highest lifetime status (Column percentages sum to 100 %)				
	No titles/wealth	Moderate wealth	Near gentry	Gentry	Observations
Son's highest lifetime status					
No titles/wealth	87.15	75.35	0.09	0.00	6,957
Moderate wealth	10.72	15.31	60.24	32.99	1,791
Near gentry	1.78	6.74	28.26	34.78	699
Gentry	0.36	2.60	11.41	32.23	328
Total Observations	6,418	1,809	1,157	391	9,775

Table 3

Number of wives and total number of sons born to each male head of household, by status of the male.

Summary statistics	Status	No Titles	Moderate	Near Gentry	Gentry
Total sons		1.95	2.17	2.33	2.04
	Std. dev.	1.62	1.72	1.77	1.66
	Max	11	10	8	9
	Obs.	5793	1421	648	270
Number of wives		1.00	1.54	1.45	1.54
	Std. dev.	0.03	0.60	0.71	0.75
	Max	3	4	5	5
	Obs.	5793	1421	648	270

Table 4

Number of wives and total number of sons born to each male head of household, by status of the head.

Summary statistics, husband and at least one wife survives to age 40.

	Status	No Titles	Moderate	Near Gentry	Gentry
Total sons		2.64	2.70	2.71	2.35
	Std. dev.	1.60	1.70	1.73	1.64
	Max	11	10	8	9
	Obs.	3296	931	484	199
Number of wives		1.00	1.62	1.52	1.62
	Std. dev.	0.02	0.62	0.75	0.79
	Max	2	4	5	5
	Obs.	3296	931	484	199

Note: Records with missing death year data dropped.

Table 5

Number of wives and total number of sons born to each male head of household, by status of the head.

Summary statistics, husband and at least one wife survives to age 40, 1300-1650.

	Status	No Titles	Moderate	Near Gentry	Gentry
Total sons		2.34	2.76	2.62	2.74
	Std. dev.	1.43	1.31	1.48	1.62
	Max	8	6	7	6
	Obs.	303	88	84	38
Number of wives		1.00	1.40	1.67	1.82
	Std. dev.	0	0.56	0.84	0.83
	Max	1.00	3	4	4
	Obs.	303	88	84	38

Table 6

Number of wives and total number of sons born to each male head of household, by status of the head.

Summary statistics, husband and at least one wife survives to age 40, 1650-1800.

	Status	No Titles	Moderate	Near Gentry	Gentry
Total sons		2.66	2.72	2.69	2.15
	Std. dev.	1.56	1.74	1.75	1.42
	Max	10	10	8	7
	Obs.	2375	612	340	99
Number of wives		1.00	1.58	1.47	1.60
	Std. dev.	0.02	0.61	0.72	0.82
	Max	2	4	5	5
	Obs.	2375	612	340	99

Table 7

Number of Brothers Conditional on Having Received Education, 1650-1800

		Number of Male Siblings					
		Obs	Mean	Std.dev.	25-pctile	median	75-pctile
Father's status: Gentry							
son educated?	no	122	2.38	1.63	1	2	4
	yes	127	1.88	1.45	1	1	4
Father's status: Near Gentry							
son educated?	no	581	2.94	1.72	2	3	4
	yes	257	2.33	1.62	1	2	3
Father's status: Moderate wealth							
son educated?	no	1280	2.64	1.74	1	2	4
	yes	85	2.53	1.91	2	2	3
Father's status: No titles/wealth							
son educated?	no	4652	2.36	1.62	1	2	3
	yes	46	2.67	1.67	1	3	4

Table 8

Effect of Number of Siblings and Birth Order on Educatio

Dependent variable Education	i.	ii.	iii. With demographic controls(see note)	iv.	v. With demographic controls & fixed effects^
Father's status	0.149**	0.148**	0.129**	0.195**	0.109**
	(0.003)	(0.003)	(0.005)	(0.017)	(0.018)
Number of Siblings	-0.007**		-0.011**	0.0007	0.002
	(0.001)		(0.002)	(0.002)	(0.002)
2-son household		-0.015			
		(0.010)			
3-son household		-0.012			
		(0.009)			
4-son household		-0.016*			
		(0.010)			
5-son household		-0.052**			
		(0.011)			
6-son household		-0.034*			
		(0.013)			
7-son household		-0.027*			
		(0.016)			
8-son household		-0.074**			
		(0.029)			
9-son household		-0.092**			
		(0.048)			
10-son household		0.037			
		(0.052)			
Siblings*father's status				-0.018**	-0.008**
				(0.004)	(0.002)
Number of observations	7855	7855	4057	4057	4017
R-sq	0.23	0.23	0.28	0.29	0.36

** Significance at 5 percent level.
* Significance at 10 percent level. Standard errors in parentheses.
Note: demographic controls include mother's father's status, age at death, mother's age at death, Father's age at death, 50-year cohorts.
^ Fixed effects on family clan (7), segment within clan (23) and village of residence (63). Heteroskedasticity consistent standard errors.

Table 9

Instrumental Variable Estimation of Effect of the Number of Siblings on Education

	OLS	First Stage	Second Stage
Number of Siblings	-0.011**		-0.016**
	(0.003)		(0.005)
Birth Order		0.660**	
		(0.015)	
Endogeneity test	1.794		
[p-value]	[0.181]		
F-stat		1993.50	
[p-value]		[<.001]	
Root Mean Squared Error			0.26

	Probit	First Stage	Second Stage
Number of Siblings	-0.066**		-0.106**
	(0.023)		(0.037)
Birth Order		0.661**	
		(0.015)	
Endogeneity test	1.94		
[p-value]	[0.163]		
Log likelihood		-861.04	
[p-value]		[<.001]	
Pseudo R2			0.36

All regressions include indicators for mother's father's status, age at death, mother's age at death, father's age at death, 50-yr cohort.
Heteroskedasticity consistent standard errors in parentheses.
Number of observations: 4057.

Table 10

Instrumental Variable Estimation with Interaction Effects

Two Stage Least Squares	i. Full Sample	ii. 1650-1800	iii. With fixed effects*
Number of Siblings	0.001	0.0005	0.003
	(0.004)	(0.003)	(0.003)
Siblings*Father's status	-0.025**	-0.026**	-0.016**
	(0.006)	(0.006)	(0.005)
Father's status	0.221**	0.217**	0.141**
	(0.024)	(0.025)	(0.019)
Probit (MLE)	Full Sample	1650-1800	With fixed effects*
Number of Siblings	-0.004	-0.002	0.032
	(0.064)	(0.067)	(0.071)
Siblings*Father's status	-0.070**	-0.074**	-0.062*
	(0.036)	(0.037)	(0.038)
Father's status	0.989**	0.999**	0.761**
	(0.132)	(0.136)	(0.141)
Pseudo R2	0.36	0.35	0.39
Log-likelihood value	-859.81	-815.12	-753.88
Number of Obs.	4057	3951	3911

Col. i & ii: with demographic controls on mother's father's status, age, mother's age, father's age, and 50-yr cohorts.

* Fixed effects on family clan (7), segment within clan (23) and village of residence (63). Heteroskedasticity consistent standard errors.

Table 11

Marginal Effect of an Additional Sibling on Education, by Father's Status

Full Sample	LPM	Probit				Probit
		At son 1 to 2	At son 2 to 3	At son 3 to 4	At son 4 to 5	Average
Marginal Effects percent						
Father High Gentry	-7.6	-7.5	-8.3	-8.3	-8.0	8.0
Father Near Gentry	-5.1	-5.2	-4.0	-4.4	-4.8	-4.6
Father Moderate Wealth	-2.5	-1.2	-0.9	-1.0	-1.2	-1.1
Father No Titles/Status	0	0	0	0	0	0

Figure 1. Marginal Effect of an Additional Sibling on Education: LPM and Probit Compared