The London School of Economics and Political Science

A Micro-Demographic Analysis of Human Fertility from Chinese Genealogies, 1368-1911

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A thesis submitted to the Department of Economic History of the London School of Economics and Political Science for the degree of Doctor of Philosophy, London, September 2020

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Abstract

This thesis is a micro-demographic analysis of human fertility from Chinese genealogies in the Ming (1368-1644) and Qing (1644-1911) dynasties. It exploits a new genealogical dataset comprising 72,861 individuals from six lineages to account for the fertility decisions taken in Chinese families. Following the comprehensive micro-level analyses of a small population, the thesis demonstrates the main features at an individual level of the fertility patterns and the relationships between demographic outcomes and social outcomes in imperial China.

This thesis consists of three substantive chapters. The first constructs the marital fertility levels and provides the ongoing debate with quantitative evidence on whether the Chinese consciously practised fertility controls in the pre-modern era. The second substantive chapter shows the social gradients in fertility and examines the mechanisms through which social status affected fertility. The third expands the reproductive success story of a single generation into a multi-generational one, focusing on the process of transmitting fertility choices across generations and the effects of family size on the quality of the children.

The three chapters together exhibit the micro-demographic dynamics in Chinese families from the fourteenth to the twentieth centuries. The thesis shows that Ming-Qing China had a moderate fertility level, with no deliberate fertility controls. Throughout the entire period, climbing up the social ladder could significantly increase men's net reproduction through increasing their marriage chances and the number of marriages they could have. Moreover, elites in traditional China also managed to transmit reproductive success to their offspring, mainly by passing on their high social outcomes. Family size could also affect the quality of the offspring, but the effect was not powerful enough to bring about any change in parents' fertility choices.

In sum, the thesis contributes to the prior literature from two main perspectives. First, it showcases a new individual-level dataset that has great potential for research in Chinese economic history and demography. Second, this systematic research deepens our understanding of China's demography by re-addressing traditional questions and by investigating frontier issues so as to shed light on the view of economic growth in Ming-Qing China.

Acknowledgement

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Table of Contents

List of Figures

List of Tables

Chapter 1

Introduction

1.1 World population growth and trends in fertility

The world's population reached 7.7 billion in mid-2019 (UN 2019). In 2019, the global total fertility rate (TFR) – the total number of births per woman[1] – was 2.5, which was only slightly more than the replacement-level fertility of 2.1 births (UN 2020).[2] On a global scale, nearly half the world's population live in a country where the fertility rate is below 2.1. According to the United Nations' (2020) fertility report, in 2019, the TFR in China, the largest developing country globally, was 1.7; it is closely comparable to the rates in many developed countries, such as the United Kingdom (1.7), France (1.8), Germany (1.6), and the United States (1.8).

However, seen against the backdrop of human existence, both the large population and the low fertility rates are relatively new to human society. The emergence of the Industrial Revolution two hundred years ago not only transformed the landscape and economy of Britain, but also triggered a worldwide demographic shift. As Figure 1.1 shows, the population has not increased at a constant rate throughout history, and almost all of the growth has occurred since the 1800s. In the context of the rapid worldwide population growth, fertility, however, started to show signs of decline in the early nineteenth century.

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[1] More specifically, total fertility rate (TFR) refers to the number of children who would be born per woman if she were to pass through all the childbearing years, 15-49 (UN, Population Division). Available at https://www.un.org/en/development/desa/population/publications/dataset/fertility/total-fertility.asp.

[2] Replacement-level fertility refers to "the level of fertility at which a population exactly replaces itself from one generation to the next" (Searchinger et al. 2013). The high fertility levels in many African countries have driven the global TFR higher than the replacement level. In 2010-2015, 55 countries or regions had a TFR higher than 3.5 births per woman, 42 of which were African countries (UN 2017).

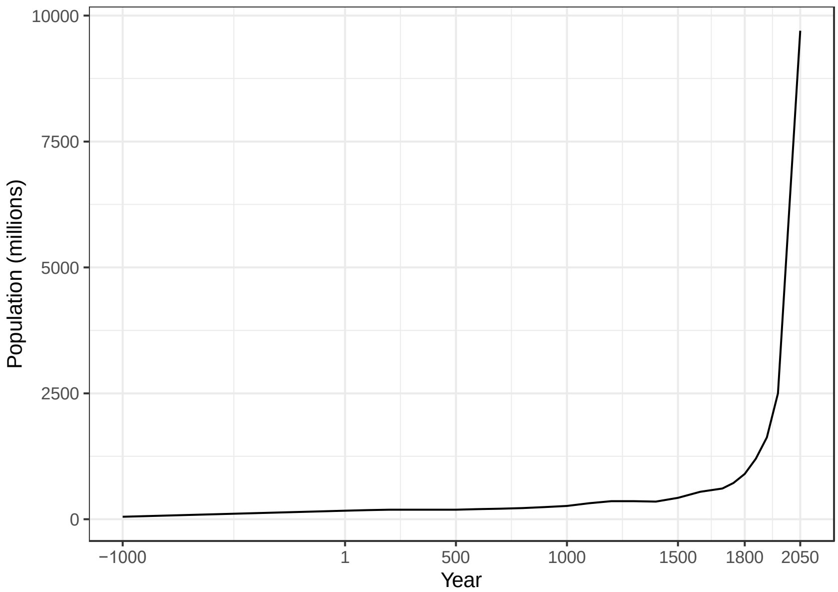

Figure 1.1 World population growth, 1000BCE to 2050

Sources: The population before 1950 is estimated as in McEvedy and Jones (1978). The population from 1950 onwards is estimated by the Population Division of the Department of Economic and Social Affairs, United Nations (2019).

Accompanied by the sustained decline of fertility since the 1800s, the relationship between fertility and income has also been modified. In the pre-modern period, "the elasticity of fertility with respect to incomes was positive" (Guinnane 2011). As Malthus (1826, pp. 6) postulated, in places "where the means of subsistence were so abundant…the increase of the human species would evidently be much greater than any increase that has been hitherto known", and the greater size of population would erode any improvements in living standards. For instance, Figure 1.2 shows that in pre-industrial England, the population size and real wages always moved in opposite directions. Nonetheless, the fertility transition broke the old order in the Malthusian world; today the relationship between fertility and income is largely negative, as clearly shown in Figure 1.3. Moreover, the modern world has also evolved to a stage of sustained economic growth where the increase in population does not eat away the gains in real wages.

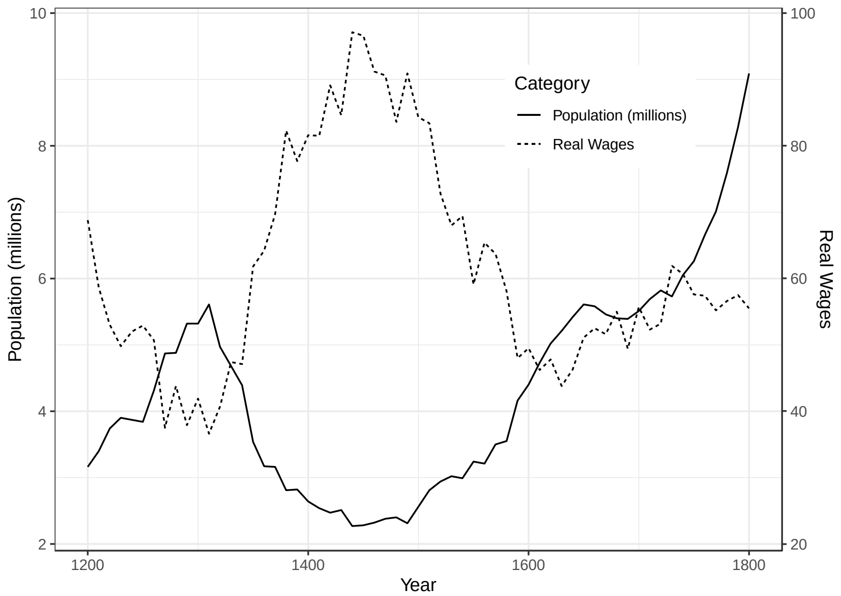

Figure 1.2 The relationship between population and real wages, England 1200-1800

Source: Clark 2010, Table 7 and Table 28.

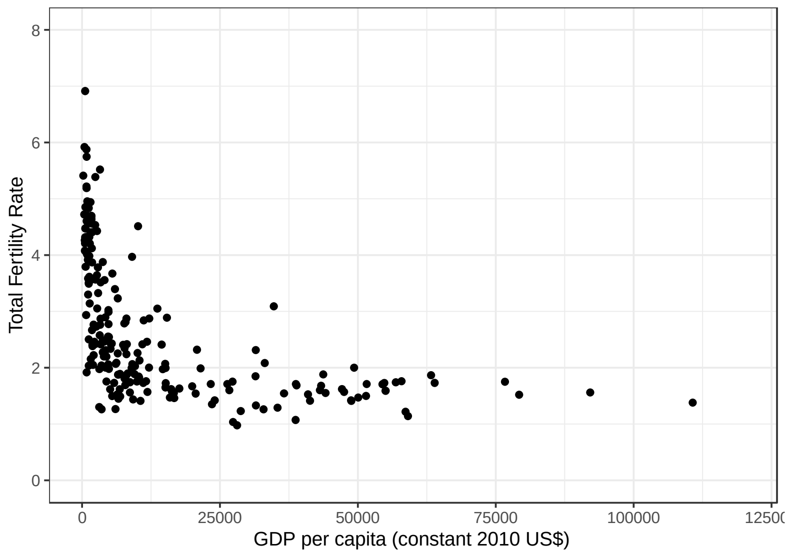

Figure 1.3 Relationship between fertility and income in 2018

Notes: 1. Each point represents a country or a region. In total, 228 countries and areas are included. 2. Estimates are for the year 2018.

Sources: TFR estimates: United Nations Population Division. World Population Prospects: 2019 Revision. GDP per capita estimates: World Bank national accounts data.

Nonetheless, the timing and speed of all these transitions vary considerably between different countries. Western Europe was undoubtedly in the lead with the demographic changes and in taking the path of modern economic growth. France was the first country to experience declining fertility, which began around 1800 (Knodel and van de Walle 1986). When Britain's total fertility began to decline in the 1880s, it took only about 40 years for births to drop from 5 per woman to fewer than 2 (Woods 2000; Jaadla et al. 2020). In contrast, China, the country inhabited by nearly forty per cent of the world's population in 1800, lagged far behind. Although China's fertility level is similar to those of most European countries at present, the fertility pattern and family system of imperial China have consistently been treated as complete contrasts to their European counterparts (Malthus 1826; Hajnal 1982). However, as pointed out by previous scholars (see for example, Lee and Wang 1999a; 1999b), this impression is to some extent misleading. Hence, this thesis is interested in providing an in-depth micro-demographic analysis of human fertility in pre-modern China. By using a new genealogical dataset that includes information on 72,861 individuals from six lineages in Southeast China, I have been able to systematically examine Chinese fertility in the Ming (1368-1644) and Qing (1644-1911) dynasties.

This thesis consists of three substantive chapters. The first chapter reconstructs the level of marital fertility in the lineages, the second investigates the socio-economic determinants of male reproduction, and the third examines the long-run survival of Chinese lineages and the mechanisms through which short-run fertility was able to affect long-run survival of bloodlines. The three chapters together demonstrate the micro-demographic dynamics in Chinese families in the fourteenth to the twentieth centuries.

The rest of this introduction traces, first, the empirical and theoretical motivations for doing this research. Second, it provides a background to China's population history between 1300 and 1900. Third, it introduces previous Chinese genealogical studies, and presents the basic information about the region, the lineages, and the genealogies explored in this thesis. Finally, it outlines the structure of the thesis.

1.2 Why Chinese historical fertility?

1.2.1 Empirical motivations

Montesquieu's supposition that "in China, the women are so prolific, and the human species multiplies so fast" (Montesquieu 1989, pp.127-128) underlay the basis of Western understanding of Chinese population and fertility. Malthus' (1826) view that the China of his day was solely dominated by positive checks and had no preventive checks was for a long time widely accepted in academia.

After the 1980s, the Chinese studies of more and more Western scholars became accessible in China, eventually enabling the Chinese scholars to communicate with and respond to their Western counterparts.[3] From the 1990s, with the growing disputes on the Great Divergence between China and the West, Chinese historical demography began to receive more attention. Because of the large geographic area and the complex ethnic composition of China, many issues are still under debate. The lack of systematic and consistent national population registers over time makes it difficult to conduct national-level demographic studies, whether on fertility, mortality, or marriage patterns.

Therefore, a generalized picture of Chinese historical demography must begin with micro-level studies until enough have been made to generalize from them. The progress in European demographic history in the last three decades has mostly been based on individual records, and this kind of individual and family level analysis should also be the avenue for future studies of Chinese demography (Harrell 1995).[4] Similarly, Guinnane (2011) draws attention to the use of unexploited individual-level data in fertility studies, "especially individual-level data that include wealth and income, or reasonable proxies for wealth and income (such as occupation)." Chinese genealogical records are sources that include such individual-level information.

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[3] For the reasons for the absence of demographic research in China and the development of the discipline, see Lavely, Lee, and Wang (1990).

[4] For instance, Cummins (2017) mainly uses the genealogical records provided by the LDS Church to study the increase of longevity of European elites from 800 to 1800. Clark and Cummins (2015a) have tracked the surnames in the genealogies to discover the features of social mobility in Britain from 1170 to 2012.

In recent decades, demographers and sociologists have started to use genealogies to examine historical demography in China, but, given the enormous stock of genealogies, only a fraction has so far been explored. In my thesis, I construct a new genealogical dataset that consists of information about more than 70,000 individuals for over 500 years, which allows me to conduct a systematic and in-depth study of Chinese micro-demographic dynamics.

1.2.2 Theoretical motivations

Why are some countries rich and others poor? The historical root of the wide economic divergence across countries that we observe in the world today is probably the most intriguing topic in economic history studies, and demography is one of the key factors that shape a country's development pattern in the long run.

Livi-Bacci (2012, pp. 1-2) points out that "population has been synonymous with prosperity, stability and security" and "a crude index" of social development for the most part of human history. Similarly, as emphasized by Wrigley (1969, p. 13) and Schofield (1989, p.279), demography in a traditional society is both a reflection and a determinant of its economic and social conditions. Not only demographers, but economists have also realized that understanding the interactions between demographic and economic conditions is key to explaining economic growth (Doepke 2004).

In the endogenous growth models, the "population-idea nexus" is always of the essence (Mokyr and Voth 2010, p.11). Technology, a key element of economic development, does not "just happen", but depends on the population. Early models in the endogenous growth literature imply that in most eras, a large population could stimulate technological changes (see, for example, Kremer 1993). Given that each individual's chance of coming up with an innovation is largely constant, a growing population would increase the probability of generating new ideas. Kremer' model predicts that without technological exchange between countries, those with larger population will have a higher technology growth rate, but eventually the rise in income will cause a decline in fertility and thus in population growth. In many newly proposed unified growth models that seek to explaining both the Malthusian stagnation and economic take-off, the relationship between fertility and technology in the long run is carefully traced.

In the Unified Growth Theory that Galor and his co-authors (Galor and Weil 2000; Galor and Moav 2002; Galor 2011) develop, human history is divided into three stages, the Malthusian Epoch, the Post-Malthusian Regime, and the Modern Growth Regime. In the Malthusian epoch, improved living standards lead to higher net reproduction, and a larger population stimulates faster technological progress. In the two latter stages, human capital takes over the dominant role in advancing the frontier of technology. When technological progress accelerates, human capital is more highly valued. Hence, although with the rise in income parents are able to have more children, investing in the "quality" of children could provide them with more additional utility than increasing the number of children (Becker 1960). Thus when human capital stock increases fertility is effectively limited. Finally, limited fertility, high human capital stock, and rapid technological progress finally trigger the modern economic growth.

However, how do these theories square with the empirical evidence from Ming-Qing China? Can they effectively account for its economic stagnation and its failure to transform itself into a modern growth regime in the two dynasties? In order to address these two broad questions, I decide to tackle several more detailed questions concerning the pattern of Chinese fertility from the fourteenth to the twentieth centuries. More specifically, how high was the fertility level and did Chinese couples consciously control fertility? How did individuals' fertility choices respond to their economic conditions? How did one generation's fertility decisions affect the demographic and educational outcomes of their descendants in the long run?

1.3 Chinese historical macro-demography

Table 1.1 lists six sets of widely cited estimates of China's population from 1300 to 1900. The major sources used are the national registration and provinces' local gazetteers (*fangzhi, 方志*) in the Ming and Qing dynasties. These records are official, compiled first by literate clerks in county-level governments, then aggregated by the prefecture-level governments, and finally by provincial and national authorities. Skinner (1986) criticizes this kind of top-down approach of studying only the aggregated data and suggests using the disaggregated data, the original county-level records. Hence, Cao (2001) exploits more than 3,000 volumes of county- and prefecture-level records and about 100 volumes of notes and writings by literati of the period, and reconstructs a more accurate demographic history (see column "Ge-Cao" of Table 1.1).

Although gaps and differences are unavoidable in different scholars' estimates, as shown in Table 1.1, they still provide us with a general idea of the population size and also its trend in Ming-Qing China. From 1300 to 1900, according to Cao's estimate in column 6, China's population increased almost sevenfold. For the most part, it increased at a regular and steady rate, but two major population losses were also suffered in these six centuries. One, in the first half of the seventeenth century, was caused by the Manchu invasion and a series of internal conflicts. The other was in the nineteenth century, because of the Taiping Rebellion (1851-1864). Cao (2001) and Li and Lin (2015) believe that the death toll from the rebellion could have reached at least 70 million.

Table 1.1 Chinese population, 1300-1900 (millions)

Year	Ho	Perkins	McEvedy-Jones	Lavely-Wong	Lee-Wang[2] (Zhao-Xie)	Ge-Cao
1300			86			59.8
1393	60.5	65-80	81		63.4	74.3
1500		150	110		91.9	
1600	150	120-200	160			173.4[3]
1650		100-150	140	130		160
1700			160	150	160	
1750	179.5	200-250	225	215	225	276
1800	295.3		330	320	350	352.3
1850	430	410(±25)	435	420	422.5	436
1893		385(±25)	415		386.1	394
1900		430(±25)[1]	475		396.4	411

Notes: 1. The number is the estimate for 1913. 2. Lee and Wang's data were largely selected from Zhao and Xie (1988). 3. The number is the estimate of the population in 1580.

Sources: Ho 1959; Perkins 1969; McEvedy and Jones 1978, Lavely and Wong 1998, Lee and Wang 1999a; Ge 1991; Cao 2001; Cao and Chen 2002.

The eighteenth century is special in China's demographic history. As suggested by all the estimates in Table 1.1, this was the century in which the Chinese population doubled. The rapid population growth was so exceptional that it aroused much attention at the time. In 1793, Hong Liangji, a Chinese bureaucrat and scholar, expressed his worries about a booming population in his essay "On governance and well-being of the empire" (*Zhi Ping Pian, 治平篇*),

> *"Our society has been stable for more than a hundred years. In terms of the number of households, it is five times more than thirty years ago, ten times more than six decades ago and twenty times more than a hundred years ago…Farms and houses are always scarce, and they are not enough for the excessive population growth…How will Heaven deal with this problem? Floods, droughts and plagues are the means Heaven uses to mitigate the tension."*

In the same year, Sir George Staunton visited China as a member of the famous Macartney Embassy. After reading the official account of the mission, Malthus was startled by the large population of China and also expressed his concerns about the fast population growth (Malthus 1826, Chapter 12). Considering that the average annual population growth rate was over one per cent throughout the eighteenth century, both Hong's and Malthus' worries were reasonable.

These aggregated accounts of the population exhibit a general picture of historical macro-demography, but the micro-demographic dynamics remain unclear. Therefore, this thesis intends to exploit the genealogical records and study individuals' fertility decisions to decipher the notable population numbers in the Ming-Qing era.

1.4 Sources and data

"Genealogy is the written record of family or lineage members descended from a common ancestor or ancestors" (Zhao 2001). The origins of keeping genealogies can be traced back to the time of the Six Dynasties (222-589). During this period, only noble families, that is, families related to a royal family, could be recognized as "lineages" and were qualified to keep a genealogical record. Because the marriage system was "closed" – because the noble class married only within its class – keeping genealogies was intended to record marriages and thus to protect the "purity" of the bloodline and their political and financial privileges. Moreover, genealogical books were at the time compiled under the strict supervision of the central government (Huang 2009).

But most of these noble lineages, which for centuries were politically and socially dominant, failed to survive the time of great turmoil in the Tang-Song transition period, around the tenth century (Johnson 1977). Their collapse, together with the formalization of *keju* (Chinese imperial examination system, 科举), triggered a "transformation in the nature and composition of the Chinese socio-political elites" and a rise of gentry scholars of low birth (Tackett 2014, p.5). In the Song (960-1279) dynasty, keeping genealogies was transformed into a common and private practice, although it still was more widely practised in elite families than in common ones. Two famous scholar-officials in the Song dynasty, Ouyang Xiu (1007-1072) and Su Xun (1009-1066) both compiled their own lineages' genealogies, and their ways of compiling genealogies also became the prime examples for later generations to follow.

In Ming and Qing China, when lineages evolved into the "fundamental organizing constructs in Chinese society", compiling genealogical books finally became widespread among commoners, and was particularly prevalent in Southeast China (Zelin 2009, p. 626; Feng 2009; Feng and Chang 2001). Rather than protecting the family's "purity", the aims of most of these compilations became fourfold: to remind the offspring of the family's history, to teach them to venerate their ancestors, to cultivate family loyalty, and to unify the lineage.

Therefore, to the Chinese, especially to people in traditional China, genealogy means more than merely the "written record of family or lineage members". A commonly held belief in imperial China was that, because every imperial dynasty had its orthodox historical account and every prefecture had its local gazetteer, every lineage should also have its own official historical book (Li 2016). The three types of historical record were complementary to each other and formed a comprehensive account of traditional Chinese society (Huang 2009). Genealogies record the rises and falls of a clan or a lineage over a long period of time, and are the best manifestation of the family's history. With constant wars and conflicts in the late imperial period and the Republican era, considerable numbers of official and private records have been destroyed. Fortunately, however, thanks to their significance to Chinese families, many genealogies have been well protected.[5]

1.4.1 Chinese genealogy studies

Telford (1986) estimates that more than 10,000 clan genealogies survive in China. Despite this enormous stock, only a small proportion of studies exploit genealogical data. The earliest demographic study using genealogies is I-Chin Yuan's (1931) "Life table for a southern Chinese family from 1365 to 1849". He studies the genealogical books of the Li lineage from Guangdong Province, and constructs ten life tables of 3,748 males and 3,752 females. Later, because of the usefulness of genealogies, many other scholars also started similar projects.

The Taiwanese scholar Tsui-jung Liu has pioneered the charting of Chinese demographic history through genealogies. Liu (1992) explains that the lack of use of Chinese genealogical records from the 1950s to 1970s was largely because of the time-consuming nature of transcribing the data. At the time, many genealogies were stored on microfilm. Without reading and photocopying machines, people could only copy the data by hand. In recent decades, as modern science and technology have developed, reading, digitalizing, and transcribing genealogies are no longer impossible tasks.

Therefore, since the 1980s, more genealogical studies have been conducted. Harrell (1985) explores the demography of three lineages in Xiaoshan County, Zhejiang Province, and focuses on the differences between the rich and poor branches within a lineage. Harrell and Pullum (1995) paint a general picture of the mortality, marriages, and lineage developmental cycle, also by examining genealogies from Xiaoshan. Telford (1990, 1992, 1995) comprehensively studies families in Tongcheng County, Anhui Province, reconstructing the fertility, mortality, and marriage patterns in the Ming and Qing dynasties. Liu (1981, 1985) studies genealogies from the Yangtze area and presents an overall investigation of the clans in Southeast China.

[5] Genealogical books always have multiple duplicates kept in the clan temple and by some large families in the clan. Moreover, when genealogical records were destroyed, family members would try their best to recompile or replace the lost and missing parts.

Peng and Hou (1996) investigate the long-term trend of demographic changes in the Fan Lineage in Jiangsu Province from 1370 to 1900. In contrast with the above writers, Lee, Campbell, and Wang (1993; 1994) enquire into the Qing imperial lineages who lived mainly in North and Northeast China, revealing the life pattern of the Qing nobles in the late imperial era.

In recent years, the team led by Cao Shuji has collected a great many family records, including genealogical books, property division records, and accounting books from Zhejiang Province. A series of socioeconomic studies have focused on the population pressure, fertility behaviours, the allocation of wealth, commercial activities, and the localization of migrants of a local lineage, the Que lineage (Che and Cao 2011, 2014; Li and Zhen 2015; Cao and Jiang 2010, 2012; Zhang 2009).

Not only demographers and historians, but economists now also see the value of investigating genealogical records. Three recent works by Carol Shiue (2016, 2017, 2019) set an example to scholars by her use of genealogies, while also highlighting the need to use this "largely unexploited" source in demographic economics in the future.

The previous genealogical research provides us with a framework for investigating the data and constructing further arguments. Notwithstanding all these studies, Chinese historical demography can be explored far more; as Harrell (1995) concludes, the study is still in its "infancy".

1.4.2 The region

The main primary sources of data for this thesis are the genealogical records of six lineages (the Huang, the Que, the Zhou, the Zha, the Gu, and the Zhuang) from four prefectures in Jiangsu Province and Zhejiang Province. Of the six lineages, three are common ones (i.e., families with a low proportion of scholars and officials), and three are elite lineages (i.e., families with a high proportion of scholars and officials).[6]

The three common lineages, the Huang, the Zhou, and the Que, are all located in Songyang County, Chuzhou Prefecture, in southern Zhejiang. The three elite lineages are located in the Lower Yangtze area.[7] The Zha lineage is from Haining County, Hangzhou, in north Zhejiang.[8] The two remaining elite lineages are located in Jiangsu Province. The Gu lineage had settled in six different counties in Suzhou,[9] and the Zhuang lineage came from Wujin County in Changzhou. Figure 1.4 shows the locations of the two provinces and four prefectures.

The gazetteer maps (Figures 1.5-1.8) vividly demonstrate the physical features of the prefectures and counties. Changzhou, Suzhou, and Hangzhou are located in the fertile Lower Yangtze area; they are all situated on the southern section of the Grand Canal, and Hangzhou is the southern terminal of the canal. Changzhou and Suzhou control the Lower Yangtze area north of Lake Tai, the third-largest freshwater lake in China; Hangzhou is at the head of Hangzhou Bay, and is connected to the multiple waterways in the Lower Yangtze area. Chuzhou lies within the mountainous area, not the wide alluvial plain that dominates the Lower Yangtze area. As depicted in Figure 1.8, the dominant physical features of Songyang County, the county where the three common lineages are located, are a rolling terrain and undulating hills.

According to Buck's division of China Proper (Buck 1937, see Figure 1.9 in the present chapter), Suzhou, Changzhou, and Hangzhou are all in the "Yangtze Wheat-Rice Area", while Chuzhou is in the "Rice-Tea Area". The three Lower Yangtze prefectures have long been major rice-surplus regions of China. After the completion of the Grand Canal in the seventh century,

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[6] Che and Cao (2011; 2014) use genealogical records of two branches of the Que lineage after 1700 to test the effect of population pressure and economic shocks on the lineage. I thank them for kindly sharing with me the data on these two branches.

[7] The Lower Yangtze area comprises mainly southern Jiangsu Province and northern Zhejiang Province.

[8] Haining was the easternmost county in Hangzhou in Ming-Qing era, on the historical border of Hangzhou and Jiaxing. It was under the jurisdiction of Hangzhou Prefecture in the Ming and Qing dynasties, and was moved to Jiaxing after 1949.

[9] The six counties are Taicang, Changshu, Chongming, Kunshan, Wushan, and Wuxi.

Changzhou also rapidly developed into a canal port and collecting centre for grain production. Although Chuzhou was not a prefecture that produced much grain, Songyang County in the Qing dynasty was the most important rice-producing region in Chuzhou Prefecture, with a growing iron-smelting and silver-mining industry (Zhang and Ren 2016).[10] The combination of rice and metal makes Songyang a typical county in rural China in the pre-modern era.[11]

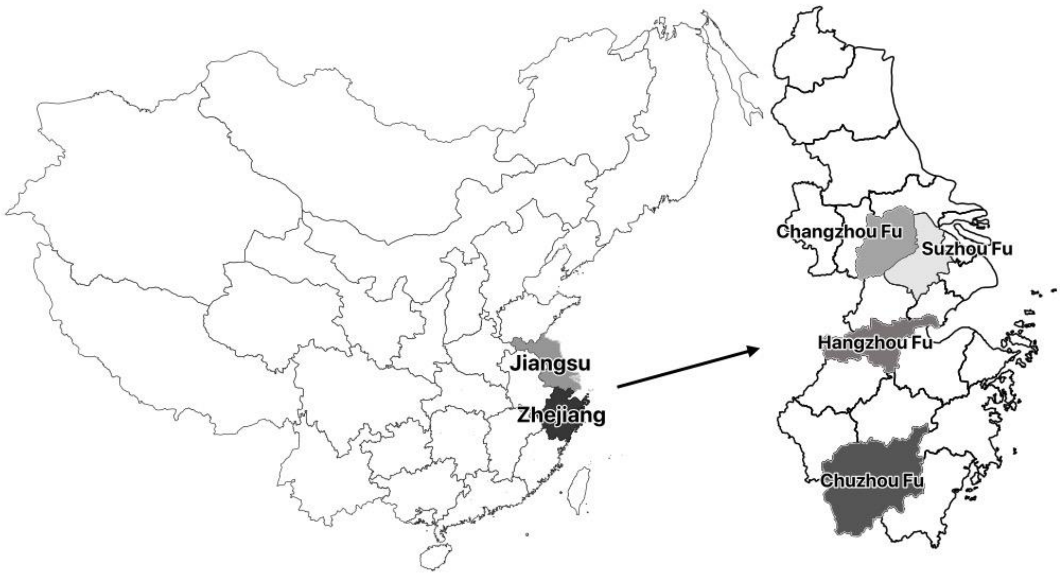

Figure 1.4 Map of Jiangsu and Zhejiang, China in 1820

Source: CHGIS 2007.

[10] As an old local saying goes, "If Songyang has a good harvest, then all of Chuzhou will have enough food to eat".

[11] Per Deng (2016, pp. 105-107), South China has yielded large quantities of rice and metal products since the Song dynasty. They are both common industries in Southern villages.

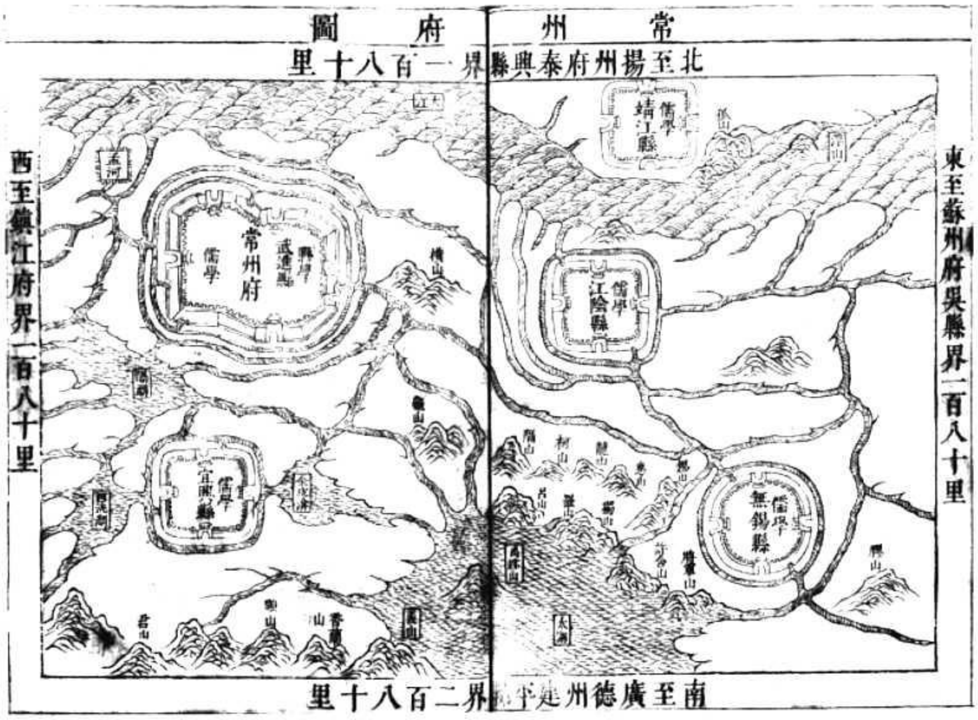

Figure 1.5 Gazetteer map of Changzhou prefecture and counties

Source: Map 4, Chapter 2, Elman (1990). Gazetteer of Changzhou prefecture. 1886 edition.

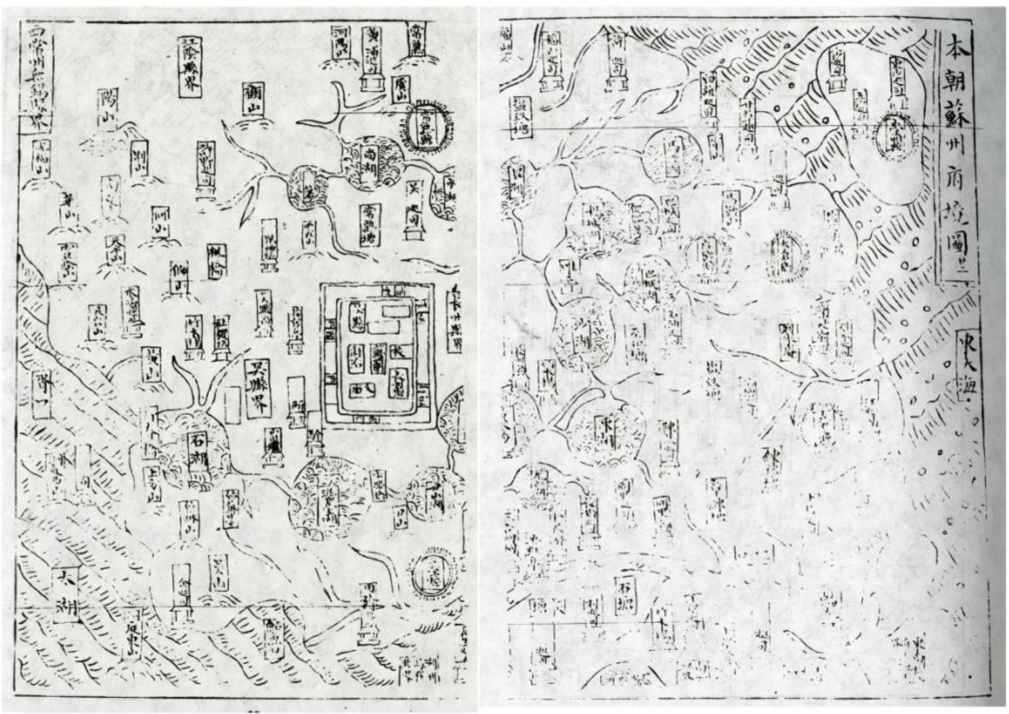

Figure 1.6 Gazetteer map of Suzhou prefecture and counties

Source: Gazetteer of Suzhou prefecture, Hongwu era (1368-1398). Online collection of University of Minnesota Libraries, East Asian Library. Available at: https://umedia.lib.umn.edu/item/p16022coll365:72.

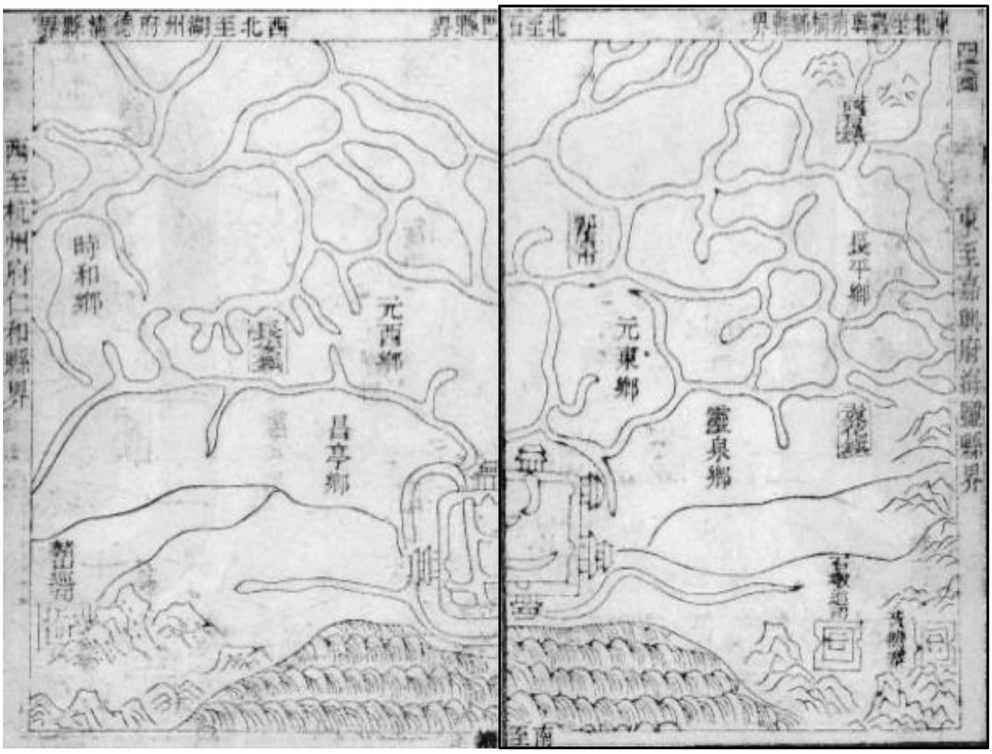

Figure 1.7 Gazetteer map of Haining county and towns

Source: Gazetteer of Haining county, 1557 edition.

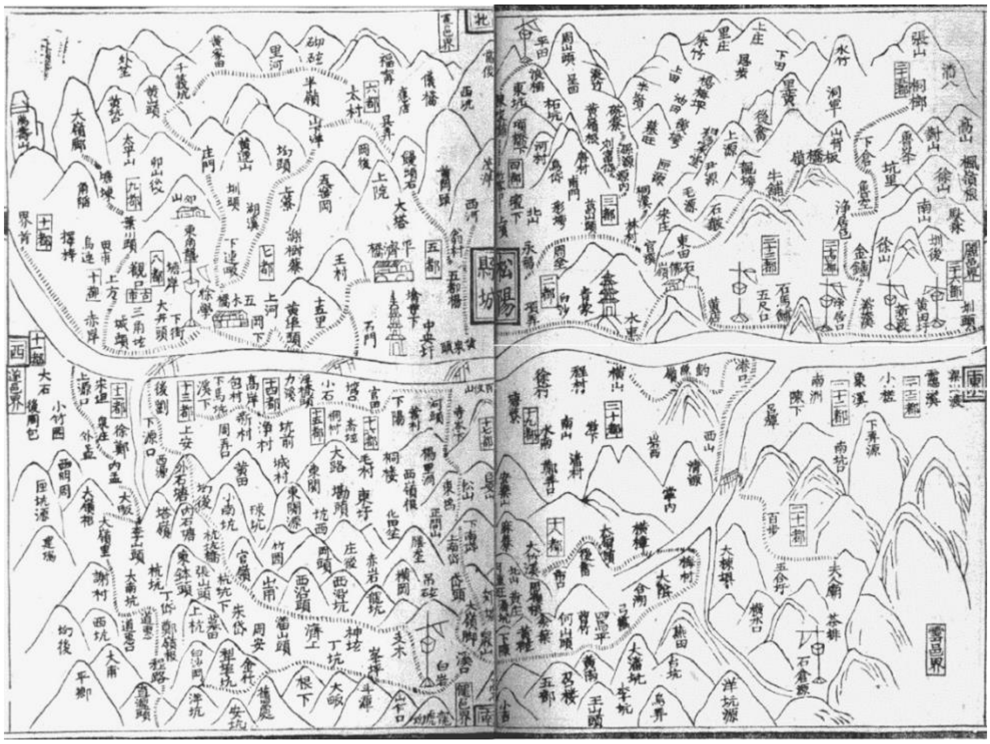

Figure 1.8 Gazetteer map of Songyang county and towns

Source: Gazetteer of Songyang county, 1874 edition.

Figure 1.9 Eight agricultural regions of China

Source: Buck 1937, Map 4, p. 27.

As might be expected, there was also a big economic gap between the three prefectures in the Lower Yangtze area and Chuzhou. The Lower Yangtze area has long been considered one of the wealthiest areas in pre-modern China and "the country's economic core during the last millennium" (Li 1998, p. 3; Ma 2008). In recent work by Broadberry, Guan, and Li (2018, Table 8 and Figure 8), their estimate of GDP per capita shows that although some of the richest regions in medieval Europe, such as Italy and the Netherlands were already way ahead of China by 1500, GDP per capita in the Lower Yangtze area was, until 1700, still on a par with the level of leading European region.

I apply here the population densities to roughly illustrate the levels of development of the four prefectures. Table 1.2 lists Cao's (2000, 2001) population estimates for the four prefectures from 1391 to 1910. The dense network of waterways in Changzhou, Suzhou, and Hangzhou made them communication and commercial centres with high population density in the Ming-Qing period. In the Ming dynasty, Suzhou was the most densely populated and Chuzhou the least. From 1391-1580, the populations in all of the four prefectures doubled. After the decades of conflicts and wars during the Ming-Qing transition (1620-80), each prefecture experienced a massive decline of population, except for Changzhou. Changzhou lost about 12,000 people during 1630-50, but recovered soon after 1650, with a larger population in 1680 than in 1580. In 1820, the highest population density was again found in Suzhou, and the population density in Changzhou also increased to 516.7 people per square kilometre. However, in the second half of the nineteenth century, the Taiping rebellion caused another dramatic population loss in the Lower Yangtze region. The populations of the three Lower Yangtze prefectures in 1880 were only about or less than one third of their populations in 1851. In the late nineteenth and early twentieth centuries, these populations were restored, although their economic supremacy was later challenged by Shanghai. To sum up, in contrast to Changzhou, Suzhou, and Hangzhou, Chuzhou had low population densities: it was not comparable to the other three prefectures in terms of economic development.

Table 1.2 Population in the four prefectures, 1391-1910

Prefecture	Area (km^2)	Population (thousand)							
		1393	1580	1680	1776	1820	1851	1880	1910
Suzhou	7111	2405	4888	3655	5111	5908	6543	2367	2528
Changzhou	7540	776	1577	2270	3115	3896	4409	1491	2318
Hangzhou	7509	1118	2070	1828	2682	3197	3721	805	1201
Chuzhou	18346	748	1385	534	862	1074	1298	922	1050

Source: Cao 2000, 2001.

1.4.3 The social origins of the elite lineages

As noted above, the Gu, the Zha, and the Zhuang lineages are three elite lineages. The main criterion for distinguishing the two types of family is the number and proportion of “scholar-officials” in each. Within the strict social class structure of imperial China, the presence of more academic degree holders who passed the imperial examinations and more office holders within a lineage brought more wealth and higher social status for the lineage (Ho 1962; Elman 2000). Table 1.3 shows the different proportions of academic degree holders in the six lineages. The Zha and the Zhuang lineages had the highest proportions, with more than eleven percent of the male population in the two lineages holding academic degree holders.

The Zha lineage was a prominent lineage in the Lower Yangtze area throughout the entire Ming-Qing period. The ancestor of the Zha lineage of Haining, Zha Junbao (1325-1385), moved to Yuanhua Town in Haining County in 1357. The rise to prominence of the Zha lineage began in the late fourteenth century, thanks to Junbao's son, Zha Shu. Zha Shu was an experienced physician. Because of his superb medical skills and widespread fame, he was appointed chief physician in the Imperial Academy of Medicine by the Hongwu Emperor, the founding emperor of the Ming dynasty. The reputation of the Zha lineage as an elite lineage grew when a century later, in 1490, Zha Huan, in the fifth generation of the lineage, was awarded the *jinshi* degree, the highest-level academic degree that one could achieve from taking the imperial examinations. The lineage enjoyed its heyday in the Qing dynasty when the Kangxi Emperor wrote a plaque for the lineage, which was taken as the highest compliment at the time.

In *Classicism, Politics, and Kinship: The Ch'ang-chou School of New Text Confucianism in Late Imperial China*, Benjamin Elman (1990) focuses on two elite lineages in Changzhou, one being the Zhuang lineage. The Zhuang lineage first came to prominence in the middle of the Ming dynasty, and its rise to high social standing was mainly because of the success of Zhuang Yi (1458-1528). According to his mini-biography, he earned the *jinshi* degree in 1496; he started his political career by working as chief magistrate of Baodi County in Zhili Province, and later he was promoted to be chief magistrate of Hejian Prefecture in Zhili and finally to the post of provincial administration commissioner of Shandong Province, taking charge of the collection and allocation of the province's tax revenues. As Elman (1990, p.39) comments, "[Zhuang Yi's] academic success, and the high political office that such success brings, provided the financial resources from which … the [Changzhou] lineage developed." After

Zhuang Yi, nearly every generation was also able to produce a high-ranking official, which successfully continued the lineage's prominence in Changzhou.[12]

The Gu lineage is special here. Historically speaking, the surname Gu was one of the "aristocratic surnames of great antiquity" and was also one of the "big three" regional elite surnames in the Lower Yangtze region (Hao and Clark 2012). The earliest recorded ancestor in the Gu genealogies, Gu Yewang (519-581), was born in Suzhou and was a celebrated scholar-official and historian in the Northern and Southern dynasties (386-589). Although the proportion of degree holders in the twenty-two generations of male population in the family was fairly low, among these was a relatively large number of high-degree holders and high-ranking officials. As early as the Song dynasty, the lineage had already produced four *jinshi* degree holders. Furthermore, its long span of genealogies alone is enough to demonstrate its "eliteness".

Table 1.3 Academic degree holders in the six lineages

Lineage	Generation	Number of degree holders			% of total male population
		Upper rank	Lower rank	Total	
Huang	1st-17th	0	4	4	0.3%
Que	1st-25th	2	149	151	1.7%
Zhou	1st-28th	10	41	51	4.8%
Gu	17th-44th	31	142	173	1.0%
Zha	1st-20th	64	528	592	11.7%
Zhuang	1st-20th	89	420	509	11.1%

Notes: "Upper rank" degree holders denote the candidates who passed the national-level and the provincial-level civil examinations, including *jinshi*, *juren*, and *gongsheng*. "Lower rank" degree holders denote the candidates who passed only the county- or prefecture-level civil exams, including the *guoxuesheng*, *taixuesheng*, *lingsheng*, *fusheng*, and *zengsheng*, *xiangsheng* and *yisheng*.
Source: The lineage sample.

[12] For more of the history and the rise of the Zhuang lineage, see Elman (1990), Chapter 2.

1.4.4 The lineage sample

The lineage sample in this thesis comprises the genealogies of the six lineages, which in total contain 96 volumes of genealogical books (see Table 1.4). The genealogies of each lineage would always start with the following sections: introduction to the history of the family, the rules of compilation, the regulations that every member had to follow, the contributions of some prominent figures in the family, and a tree chart of all the male members recorded in the book. The main body of genealogical books record, in chronological order, the names of all the male members of the lineage, with his corresponding mini-biography. These mini-biographies constitute the principal source of my genealogical dataset (see Figure 1.10 for a sample page from the genealogical book). Each such mini-biography tells us the male's name(s), position among his brothers, birth and death dates, academic degrees and honours, the surnames of his wives and concubines, their birth and death dates, and, most importantly, the number of children whom he sired. Not all the entries, however, contain all the above information: Table 1.4 shows the numbers of individuals who have both birth and death years recorded.

Table 1.4 Basic information of genealogies by lineage

Lineage	Huang	Que	Zhou	Gu	Zha	Zhuang	Total
Number of volumes	4	16	4	32	24	16	96
First compilation year	1487	1664[3]	1598	1286	c.1500	1572	/
Last compilation year	1846	1928	1947	1876	1909	1875	/
Number of times compiled[1]	6	5	12	12	9	10	/
Average length between compilations (years)	59.8	52.8	29.1	49.2	45.4	30.3	/
Period covered[2]	c.1300-1846	c.1300-1920	c.1200-1946	c.1100-1876	1325-1905	c.1350-1875	/
Number of generations	17	25	28	28[4]	20	20	/
Male entries	2,353	10,198	1,059	17,451	5,728	4,618	41,407
Number of wives	1,701	6,749	776	13,576	4,964	3,688	31,454
Males with birth years	1,127	7,915	730	6,528	5,163	4,074	25,537
Individuals with birth and death years	685	4,236	679	5,087	4,753	2,475	17,915

Notes: 1. The "times" refers to the times of the large-scale compilations recorded in the prefaces to the genealogical books, but not including the times of small-scale editing. 2. The start of "Period covered" is the approximate birth year of the male in the first entry, and the end is the latest birth/death year found in the genealogical book. 3. This is the first compilation after the branches started to move to Zhejiang. Records of the male family members before generation 14 are compiled on the basis of the original records in the Jiangxi Que genealogies. After the fourteenth generation, all the males recorded in the Que genealogies lived in Zhejiang. 4. Given the long history of the Gu lineage, only generations 17-44 of the Gu lineage are studied in the present chapter.

Source: The lineage sample.

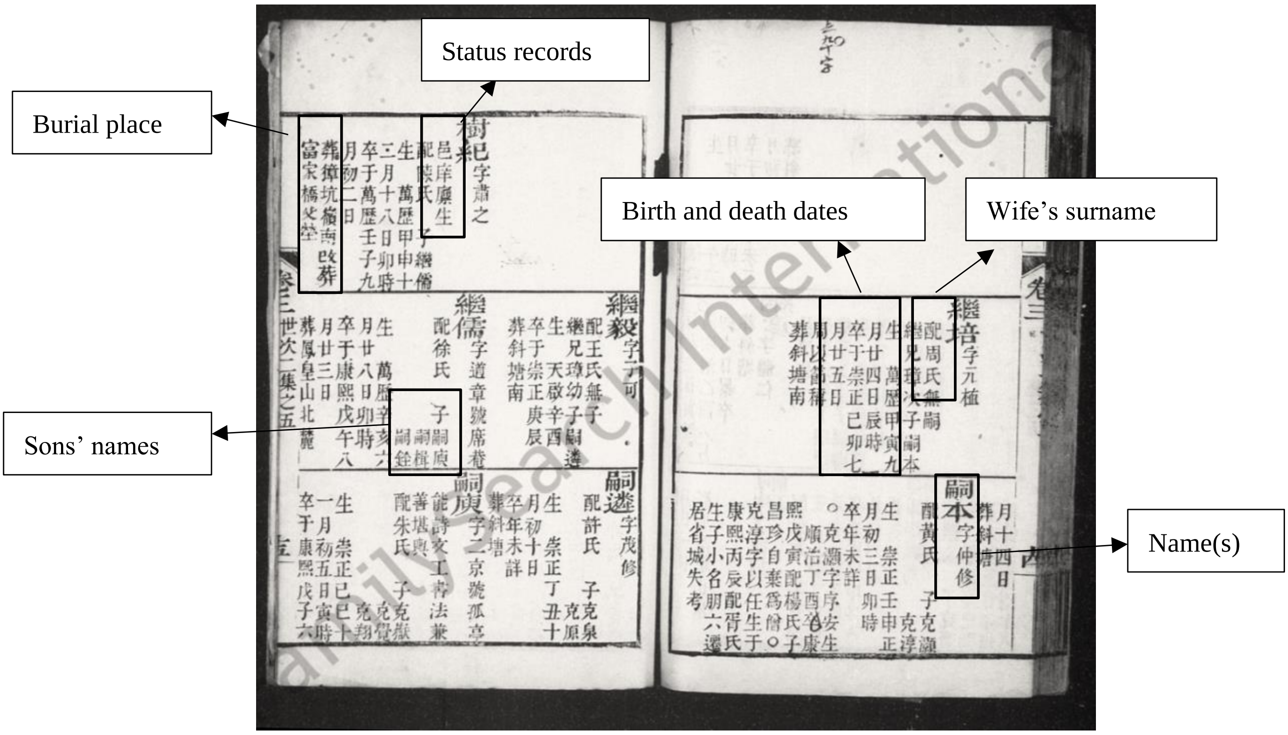

Figure 1.10 Sample page from a Chinese genealogical book

Source: Familysearch.org.

1.5 Structure

The thesis is structured in the form of three substantive chapters. Chapter 2 begins the research by a descriptive study that demonstrates the trend and the level of marital fertility in the lineages. It finds that Ming-Qing China had a unique fertility pattern, which was a combination of moderate marital fertility rates and an absence of deliberate fertility controls. Chapter 3 moves to study the forces and factors that affected the net reproduction of males and reveals a positive relationship between social status and fertility. Climbing the social ladder would significantly increase the number of sons that a male could have, mainly through increasing their marriage chances and the number of marriages that they could contract. Chapter 4 investigates the story of reproductive success in a multi-generational model by testing the presence of two trade-offs of children in Chinese families, the Darwinian trade-off and the Beckerian trade-off. It shows that high fertility could be transmitted across generations mainly through the transmission of high social outcomes from fathers to sons. It also finds that family size could affect the quality of the children, although the effect was not strong enough to trigger a change in parents' fertility decisions. Finally, Chapter 5 concludes and discusses the implications and the limitations of the research.

Chapter 2

Descendants over half a millennium: Marital fertility in five lineages in Ming-Qing China

Abstract

The chapter studies the marital fertility of five Chinese lineages in Ming-Qing China. By exploiting new genealogical data and studying more than 50,000 individuals in the five lineages, a unique pattern of Chinese marital fertility is demonstrated. On the one hand, contrary to the conventional wisdom on Chinese fertility, the results show that the marital fertility rates in the period were much lower than those of Northwest Europe in similar periods. On the other hand, in line with the classic ideas, the paper finds no clear signs of parity-dependent controls within marriages. The results suggest that imperial China had moderate marital fertility, but with no deliberate limitations.

2.1 Introduction

China has for centuries been the most populated country in the world. Malthus (1826, p.206) once commented that the Chinese population in the late nineteenth century was so large that it would "startle the faith of many readers". However, there is still no consensus on the level of marital fertility in pre-modern China. The classic view of historical fertility in China was that its birth rate had no parallel because of the worship of large families (Mallory 1926; Tawney 1932; Fei 1947; Chandrasekhar 1967, cited in Zhao 1997), though some scholars doubt if

Chinese fertility was in fact abnormally high. Barclay et al. (1976) find that the index of marital fertility (I_g) of China was only 0.51 in the 1930s, and there is no evidence for the "very large historical family size that has been imputed to the Chinese" (Barclay et al. 1976, p.613).[13]

Lee and Wang (1999a, p.8) emphasize the phenomenon of low marital fertility rates in Qing China: "[w]hile Western married women in the absence of contraception had on average a total marital fertility rate (TMFR)…of 7.5 to 9, Chinese married women had a TMFR of 6 or less". According to Liu (1985), in the seventeenth to the nineteenth centuries, a married woman from Southeast China would on average give birth to only about 5 children during her lifetime.

Besides the debate on the absolute level of marital fertility, another unresolved issue is whether fertility controls existed in imperial China – whether China was a "natural fertility" regime or the Chinese were constantly controlling their fertility within marriages. The concept of "natural fertility" was first coined by Louis Henry (1953, 1976); it represents the fertility a population would have if there was no any form of intentional birth control within marriages. Henry (1961) specifies that birth control existed if a married couple avoided having more births after reaching the desired number, and this type of birth control is then defined as parity-dependent control. A fertility which is determined by parity-dependent controls is regarded as "controlled fertility", as Henry defines it (Coale 1986).[14]

Generally, scholars who posit high Chinese fertility also describe China as a "natural fertility" regime. The need for old-age insurance, the custom of early marriages, and the high rates of infant mortality all discouraged Chinese people from consciously limiting fertility

[13] I_g = the ratio of the births the married women in a given population actually have to the number they would have had if subject to the maximal age-specific fertility schedule. An I_g of 0.51 here means that the marital fertility rate is 51 per cent of the highest recorded schedule, the Hutterite fertility rate. I calculate the total marital fertility rates of Hutterites, 1921-1930, by using data reported in Barclay et al. (1976, Table A-5). The result is 12.44, so the total marital fertility rate of China here is about 6.34.

[14] The existence of fertility controls in pre-modern European societies before the fertility transition has always been a hotly debated topic in historical demography (England: Wrigley and Schofield 1983; Wrigley et al. 1997; Cinnirella, Klemp, and Weisdorf 2017; Clark and Cummins 2019a; Sweden: Bengtsson and Dribe 2006; Germany: Knodel 1987; Amialchuk and Dimitrova 2012; Belgium: van Bavel 2004).

(Mallory 1926, pp.88-92; Fei 1947). Huang (2002) reckons that population in China's past was mortality-driven; it was affected by "positive checks", rather than "preventive checks".

The revisionists, however, argue that historical fertility in China was under systematic control. In their studies of the Manchu royal families in the Qing dynasty, Lee, Campbell, and Wang find existence of the three fertility controls that were also observed in most European societies during the transition period – late starting, longer spacing and early stopping (Wang, Lee, and Campbell 1995; Wang and Lee 1998; Lee, Campbell, and Wang 2002a). Moreover, they insist that the Chinese controlled fertility by widely practised female infanticide (Lee, Campbell, and Wang 2002b). Besides postnatal abortions, Li (2000) argues that many techniques of abortion and contraception were recorded in medical books published in the Song dynasty and were routinely used in Southeast China thereafter.[15] Zhao (1997) believes that if Chinese people had not previously embraced the concept of regulating fertility, the One-Child Policy after the 1970s would not have been so smoothly and successfully implemented. Lee and Wang (1999a, p.92) support this reasoning and claim that "[t]he Chinese fertility transition…derived from a long tradition of conscious control, which facilitated the formulation and implementation of a national family planning program dating back to the middle of the twentieth century". However, the presence or the absence of fertility controls in pre-modern China has not been rigorously studied and exhibited by quantitative evidence.

Among the ongoing debates on Chinese marital fertility, this chapter seeks to reveal the nature of it in the Ming and Qing dynasties by studying the genealogical records of five lineages in Southeast China. On a basis of over 500 years of detailed records of individual births, deaths, and marriages, I reconstruct and re-examine the fertility patterns in the five lineages. The chapter mainly deals with the following research questions: how high exactly was the level of marital fertility in Ming-Qing China? Was it stable over time? Did the Chinese consciously limit fertility within marriage?

[15] However, the effectiveness of abortion practice and contraception techniques has been questioned. Sommer (2010) shows that abortion before 1949 was extremely unsafe and was mainly used when a woman wanted to abort an illegitimate birth.

I use two measures to reconstruct the marital fertility rates. First, I calculate the average number of sons per married male in the five lineages over the entire period. 21,608 married males produced in total 33,482 sons in the five hundred years, which derives an average of about 1.6 sons per family. Second, I estimate the total marital fertility rate and age-specific marital fertility rate by using detailed information about 7,767 married females in the sample. Of the five lineages, the Huang lineage and the Que lineage had higher marital fertility rates than the other three had; between 1600 and 1900 the marital fertility rates in all five lineages are also generally moderate, ranging from 4 to 6.

I then test the presence of two fertility controls, parity-dependent early stopping and parity-dependent birth spacing. With regard to early stopping behaviour, I estimate the rate of decline of age-specific marital fertility rates after the age of 34 in females whose net fertility at the age of 30 was different. I find that the decline rate for females who reached high parities before age 30 were similar or even slower than that for females with low parities. This finding indicates the absence of parity-dependent early stopping in the five lineages. I apply the Cox proportional hazard model to test the existence of parity-dependent birth spacing. The result shows no parity effects on the speed of having a successive birth, which suggests that parity-dependent spacing behaviour was also absent.

Therefore, this chapter argues that, as demonstrated by the fertility pattern of the five lineages, historical marital fertility in China was unlimited, but the rates were moderate. Clear signs of parity-dependent controls were absent, but still the fertility rates of all five lineages were comparable to, or in most cases, lower than the Western European rates in the same period.

The following chapter has five sections. Sections 2.2 and 2.3 introduce the genealogical data of the five lineages, and the methodologies applied in the chapter, including a discussion about the biases of the data. Section 2.4 contains the descriptive results of marital fertility in the long run and the different age patterns of childbirth in the different lineages. It also examines the presence of parity-dependent early-stopping and longer-spacing behaviours. Section 2.5 compares the results with other estimates within and outside China and discusses the results on fertility controls. Section 2.6 concludes.

2.2 Data

2.2.1 Nature of the data

Still waiting to be fully exploited, genealogy is one of the most worthwhile sources for studying historical demography. Because of the ritualistic significance that genealogies carry, many genealogical books are well protected and have been maintained in many Chinese families to this day. Genealogies record the vicissitudes of a clan or a family line over a long period, and are the best evidence of its history.

The primary data used in this chapter come from the genealogical books recording five lineages in Southeast China. Three of them are ordinary families, and two of them are elite families. The three ordinary families, Huang, Que and Zhou are from Songyang County, Chuzhou, South Zhejiang; the two elite families are both located in the Lower Yangtze Delta, the Zha lineage in Haining County, Hangzhou, North Zhejiang, and the Gu lineage in Suzhou, South Jiangsu.

2.2.2 "Patching the holes" of the data

Although genealogical data are valuable for research in historical demography, they also suffer from the common problem of under-registration (Harrell 1987; Zhao 2001; Telford 1986, 1990). The methods that I employ to impute missing information were as follows.

The first type of missing information concerns infant deaths. Although death information is deficient in nearly all Chinese genealogies, there is still no consensus on ways of tackling it.[16] In the genealogies of the five lineages, as in the genealogies from other villages in southern China, three particular terms are used to refer to males who have died at an early age. One is *幼卒*, which means that the individual died under the age of eight *sui* (approximately six to

[16] Liu (1985, 1992) was not concerned with the problem of missing deaths of infants, male children and adolescents (those who died younger than nineteen), which has always been held to account for her low estimates of Chinese fertility rates.

seven years old)[17]; the second is 早逝, which means that the individual died between the ages of fifteen and twenty *sui* (around thirteen to eighteen years old).[18] If a male individual is described by either of these terms, he is generally recorded with a birth year, but not a death year. The third term is 未娶而卒, which means that the individual died before getting married. In this case, records for males are always complete, and they lived for about twenty-five *sui* (twenty-three years). These three terms refer to males who have their own mini-biographies, but records of earlier child deaths are different. A male child who dies between one and four years old does not qualify to have a generational name and his own separate mini-biography, but can be found under his father's entry, with the description, 一子早逝 (having a son who died at an early age). Clearly, these four cases prevent us from accurately estimating the infant mortality rates.

In 1800, male infant mortality in North China was as low as ten percent in the royal lineage (Lee et al. 1994). Harrell (1995) and Telford (1995) both suggest an infant death rate of 250 deaths per 1000 births in South China in the Qing dynasty. Chinese scholars during the early twentieth century conducted a series of social surveys in both rural areas and urban areas in South China, and reported the infant mortality ranging from 12 per cent to 18 per cent.[19] Although the living standards in South China in the eighteenth to the twentieth centuries were largely stagnant (Allen et al. 2011; Allen 2009; Baten et al. 2010; Li and van Zanden 2012), because of the improvements in public health after the 1850s, one would expect a decrease in the infant mortality rates in the early twentieth century. Therefore, a cautious infant mortality

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[17] Ages recorded in genealogies are in *sui*, which is about 1.5 years longer than Western counterparts on average.

[18] See more for the explanation of the particular terms in Telford (1990).

[19] For instance, Zhang carried out a demographic survey of 2,634 people in 481 families living in three villages of Jiangning County near the capital of the Republic of China, Nanjing, and found that the rate of infant mortality was about 18.37 per cent in 1925, and about 15 per cent in Nanjing in 1931. Qiao's survey from 1924 to 1925 of 4,216 families in four provinces of South and Central China, Anhui, Henan, Jiangsu and Shanxi, showed that infant mortality was about 12.9 per cent. See Li, Xia, and Huang (2014) for the original reports of all these social surveys conducted around the 1920s and 1930s.

rate of 25 per cent is applied in the present chapter to the three ordinary lineages, and 20 per cent to the elite lineage.[20]

The second type of missing information is the number of daughters that the male family members produced. The number is highly under-recorded in the genealogies. Although Lee and Wang (1999a) consider female infanticide to be a key strategy for controlling the number of births, this chapter does not view infanticide as a birth control method and, in order to report the rate of non-regulated marital fertility, does not take it into account.[21] Thus, I approximate the number of daughters by using the "natural" sex ratio at birth, 105 boys to 100 girls.[22]

The third type of missing information is the birth and death years of mothers and sons. In order to measure fertility, both the birth and death years of mothers are required. Of the 27,766 wives recorded in the genealogies, only 5,828 have complete birth and death records. All of them are first included in my lineage sample. To have largely accurate estimates of fertility rates, women missing both birth and death years, and women whose data lack more than half of their sons' birth years are excluded from the sample.

For females with only a birth year or a death year recorded, and also with more than half of their sons' birth years recorded, I try to impute their missing birth or death years by referring to the standard life tables for the Lower Yangtze Valley in 1800 constructed by Elvin and Fox (2007), and also by referring to the number of children they had. A woman with missing

[20] Results from using different infant mortality rates are reported in Appendix 2.B.1.

[21] Malthus (1798, cited in Macfarlane 2003, p.13) first put infanticide into his wide category of "positive checks", which is also agreed by most scholars, "[t]he positive checks to population include all the causes, which tend in any way prematurely to shorten the duration of human life, such as … wars, infanticide, plague, and famine." Cornell (1996) claims that rather than "postnatal abortion", he prefers to call infanticide "infant homicide", and views it "as a component of mortality rather than of fertility".

[22] In fact, reported by several hospital survey data in China in the 1920s and 1930s, the ratios are all higher than the natural one (Li et al. 2014). According to the 1927-1929 register records of 2,909 births in an obstetric hospital in Shanghai, the sex ratio at birth was 116.8 boys to 100 girls; based on the survey of 4,000 births in Peking Union Medical College Hospital, the sex ratio was 119.1 to 100; in 1931, the record of 793 births in a hospital in Nanjing showed the ratio as 120.2 to 100. Compared to administrative records, which would be easily suffered from the issue of non-registration of births, the hospital records were much more accurate and plausible in reporting the natural sex ratio at birth of the Chinese, but the skewed ratio still suggests that practices which could decrease the number of female births, such as sex-specific abortions, may exist.

birth/death-year data will be cautiously and conservatively given a death year according to several rules based on the following situations.

First, all these women are divided into two categories – one consists of women who had no children, or had sons without the sons' birth years being recorded, and the other of women who had sons whose birth years were noted. Second, two methods are applied to the two categories. For the former category, if the woman had no children, she would be considered as dead at 20-24 years old; if she had one or two children, then she would be estimated to be dead in age group 25-29; if three children, then the age group 30-34; four children, the age group 35-39 and so on. For the latter category, the woman's birth/death year is estimated according to Elvin and Fox's life tables, by adding the remaining life expectancy to her at the age when she gave birth to her last son.

In terms of the missing birth years of sons, I apply the technique that Ts'ui-jung Liu (1978, 1985) applies in studying lineages in Zhejiang and Taiwan. If the birth year of the first son or the last of several sons is missing, the missing year is estimated by subtracting five years from the birth year of the second son, or by adding five years to the birth year of the penultimate son.[23] If the birth year of a son born in the middle is missing, then the missing value is filled by the midpoint of the birth interval bounded by the birth years of sons just before and just after the son whose birth-year was missing.

Table 2.1 presents the number of married females finally selected for the sample, and the proportion of females and of sons with missing year records. Table 2.2 summarises the statistics of the birth and death records of the females who are in the sample.

[23] Liu (1985) adds three years to the previous son's birth year to estimate the next son's birth year. However, from her later study of forty-eight lineages in the Ming and Qing dynasties, it appears that the average birth interval between two sons is around four to five years (Liu 1992).

Table 2.1 Married females and sons without birth/death years, the lineage sample

Lineage	No. of wives	No. of wives, no birth year	No. of wives, no death year	No. of sons	No. of sons, no birth year
Zhou	393	33	84	503	17
Que	1,898	32	70	3,836	278
Huang	906	88	189	1,569	51
Zha	2,071	428	321	2,434	115
Gu	2,499	7	427	3,723	581
Total	7,767	588	1,091	12,065	1,042

Source: The lineage sample.

Table 2.2 Summary statistics, married females

Statistics	N	Mean	Std.	Min	Max
Birth year	7,767	1785.32	62.79	1304	1934
Death year	7,767	1832.14	61.08	1388	2004
Age at the 1st birth	5,523	24.46	5.42	13	52
Age at the 2nd birth	3,395	28.97	5.50	15	57
Age at the 3rd birth	1,790	32.61	5.27	17	52
Age at the 4th birth	859	35.39	4.99	23	55
Age at the 5th birth	324	37.33	4.40	26	54
Age at the 6th birth	130	39.07	3.98	29	47
Age at the 7th birth	36	40.36	3.83	35	48
Age at the 8th birth	7	44.14	5.15	38	51

Notes: The term 'birth' denotes a male birth. There is no record of daughters' birth years.

Source: The lineage sample.

2.3 Measuring fertility

2.3.1 Standard and non-standard fertility measures

In demographic studies, the standard method of measuring fertility is to link fertility to females, rather than males. Constrained by the lack of female information in the genealogies, this chapter employs both standard and non-standard measures. The two main standard measures that this chapter used are the total marital fertility rates (TMFR) and the age-specific marital fertility rates (ASMFR), since only married females are included in the genealogical books.

The total marital fertility rate is the number of births a married woman would hypothetically bear throughout her entire reproductive span, normally from 15 to 49 years of age. It is calculated as:

$$TMFR = 5 \times ASMFR_i, \qquad (1)$$

where ASMFR is the age-specific marital fertility rate of age group *i* (for 5-year age groups). More specifically, ASMFR is the number of births in a certain age group per year or in a reference period to the total number of married women in that age group. It is calculated as:

$$ASMFR_i = \frac{Birth_i}{Exposure_i}$$

and

$$Birth_i = (Son_i/1.05 + Son_i) \times 1.25(or\ 1.20)\ , \qquad (2)$$

where *Birth* is the number of births to married women in age group *i* in a given reference period, and *Exposure* equals the number of married women-years of exposure in age group *i* during the reference period. As previously discussed, the number of daughters is approximated by combining the number of sons and the natural sex ratio, and the total births are also inflated by including a 25 per cent (or 20 per cent) infant mortality rate.

At the same time, the number of sons recorded per marriage and per married male will also be reported. This kind of non-standard and male-relative fertility measure is applied in Clark and Cummins (2015b), when they analyse fertility in England by using males' wills. In this chapter, net fertility in terms of sons is also a valid measure to show the differences between lineages in the long-run, though it admittedly differs from the conventional female-relative fertility measures.

2.3.2 Potential biases caused by the missing records

Shiue (2016) examines the selection bias and the survivor bias in turn in the genealogical books of seven lineages in Tongcheng County and found that neither one of the bias effects was significant. I follow the same methods and report in Appendix 2.A the results regarding these two biases in the male population; in my sample, neither of the biases is significant either. All the male family members are ritualistically significant for the genealogy, regardless of wealth or status.

Although all of the male family members and their wives would have been included in the genealogies, the completeness of their records is affected by social status and certain other demographic features. Generally speaking, the females who produced more sons are more likely to have a complete birth and death year record.[24] To deal with the potential bias, I try cautiously to impute as many as possible of the birth/death years on the basis of the methods mentioned in Section 2.2.2. Despite the bias, the women selected into the sample proved to a great extent not to have been more fertile than the women who are not selected. The average number of sons per woman in the selected female sample is 1.55, while that in the entire female sample is 1.31.

An inevitable bias is that the fertility rate might be somewhat underestimated, since women with no sons would be viewed as childless in the calculation, even though they might have given birth to many daughters. Approximating the number of daughters by using the sex ratio at birth could not estimate the number of births to "sonless" mothers. However, because this method would also have overestimated the fertility of women who gave birth to sons only, the aggregate estimate of the fertility rate would not have significantly deviated from the actual fertility rate. I use the family reconstitution data of Rosny-sous-Bois, a French village near Paris, to calculate the marital fertility rates by using sons' records only and both sons' and daughters' records (Séguy 2001; Weir 1995). The two sets of estimates are entirely comparable

[24]A basic logistic regression shows that conditioning on the lineage fixed effect, if a female were to have one more son, her odds of having a complete record of both birth and death years versus having an incomplete records would increase by a factor of 1.23 (with a robust standard error 0.13).

(see Figure 2.B2 in Appendix 2.B), which shows that the method used in the chapter to calculate marital fertility rate is robust to the bias.

Another possible bias derived from the systematic under-recording of daughters' information is related to my examination of the presence of parity-dependent fertility controls. The lack of daughters' records would move forward the timing of stopping and lengthen the birth intervals, and thus bias the tests towards finding spurious evidence of fertility controls. However, my results reported in Section 2.4.2 clearly suggest that the findings are robust to the potential bias.

2.4 Results

2.4.1 Marital fertility over time

This section describes the marital fertility in the five lineages in the Ming and Qing dynasties. Table 2.3 details the recorded number of sons (net fertility in terms of sons) per married male by generation.

According to the birth records in the genealogies, the greatest number of sons that a male had was five in the Zha lineage, seven in the Zhou lineage, eight in the Huang lineage, nine in the Gu lineage and ten in the Que lineage. However, having such a big family actually was very rare for anyone in the five lineages. Table 2.3 finds a moderate level of sons per married male; the average number of sons per married male in all five lineages is 1.55. Averagely speaking, every married male had fewer than two sons, except for the Huang lineage, where an average married male had 2.03 sons averagely. The lowest number of sons can be found in the Zha Lineage, about 1.45 sons. Given that males would marry more than once in their lives, the female-related fertility would show varying patterns.[25]

[25] The proportion of married males in the five lineages are: 68.5 per cent in the Huang lineage, 65.4 per cent in the Que lineage, 63.3 per cent in the Zhou lineage, 80.8 per cent in the Zha lineage, and 68.9 per cent in the Gu lineage. Within the population of married males, 8.94 per cent of married males in the Huang lineage, 4.67 per cent in the Que lineage, 14.32 per cent in the Zhou lineage, 10.27 per cent in the Zha lineage, and 7.68 per cent in the Gu lineage married more than once.

Table 2.3 Net fertility (sons only) by generations, in the five lineages

Lineage	Generations	No. of married males	No. of sons	No. of sons per married male
Huang	1st-4th	13	32	2.46
	5th-8th	172	383	2.23
	9th-12th	581	1186	2.04
	13th-16th	386	744	1.93
	1st-16th	1,139	2,313	2.03
Que	1st-6th	27	41	1.52
	7th-12th	346	757	2.19
	13th-18th	2,244	4,909	2.19
	19th-21th	2,442	3,893	1.59
	1st-21th	5,059	9,600	1.90
Zhou	1st-6th	14	31	2.21
	7th-12th	146	253	1.73
	13th-18th	141	226	1.65
	19th-24th	244	415	1.70
	1st-24th	545	925	1.70
Zha	1st-6th	63	124	2.25
	7th-12th	973	1,657	1.73
	13th-18th	1,810	2,406	1.33
	1st-18th	2,846	4,187	1.47
Gu	17th-23rd	206	380	1.84
	24th-30th	1,273	2,195	1.72
	31st-37th	8,084	11,952	1.48
	38th-44th	2,456	2,855	1.16
	17th-44th	12,019	17,382	1.45
All Five Lineages		21,608	33,482	1.55

Note: Net fertility (sons only) refers to the total number of sons recorded in the mini-biographies of the married male, which is not adjusted by the 25 per cent or 20 per cent infant mortality rates.
Source: The lineage sample.

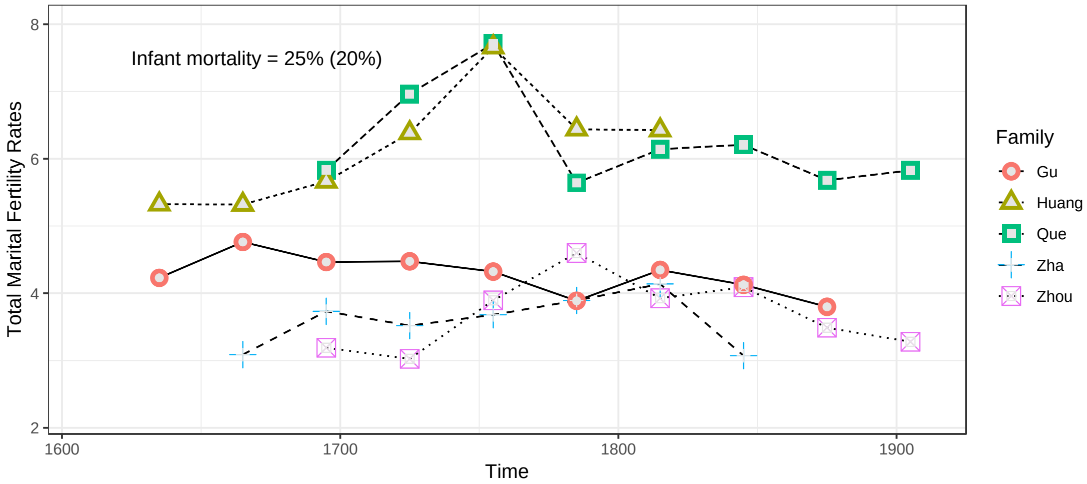

Figure 2.1 Adjusted total marital fertility rates of the five lineages, 1620-1920

Notes: 1. The numbers of births in the Zha lineage and the Gu lineage are adjusted upwardly by 20 per cent, and the births of the other three lineages are adjusted upwards by 25 per cent. 2. Limited by the completeness of records of birth and death years, the time periods of the Zhou and the Que 1680-1920, the Huang 1620-1830, the Zha 1650-1860, the Gu 1620-1890. See Table 2.4 for the values of TMFR in each 30-year period of the five lineages.

Table 2.4 Total marital fertility rates, 1620-1920

	1620 - 1649	1650 - 1679	1680 - 1709	1710 - 1739	1740 - 1769	1770 - 1799	1800 - 1829	1830 - 1859	1860 - 1889	1890 - 1920
Huang	5.32	5.32	5.66	6.38	7.66	6.44	6.42	.	.	.
Que	.	.	5.83	6.97	7.71	5.64	6.14	6.21	5.68	5.83
Zhou	.	.	3.19	3.03	3.89	4.60	3.93	4.09	3.49	3.28
Zha	.	3.09	3.73	3.52	3.68	3.89	4.14	3.07	.	.
Gu	4.23	4.76	4.46	4.48	4.32	3.89	4.35	4.13	3.80	.

Note: The rates are adjusted upwards by 20 per cent in the Zha lineage and the Gu lineage, and 25 per cent in the other three lineages.

Figure 2.1 shows the time trend of total marital fertility rates in the five lineages, and Table 2.4 details the values plotted in Figure 2.1. In general, in all five lineages, no steady upward or downward linear trend can be found. Consistent with the previous findings of net fertility, the Zhou, the Zha, and the Gu lineages had much lower marital fertility rates than the Huang and Que lineages throughout the entire period. The trends of the two elite lineages were steadier than those of the other three common lineages, with the rates mainly ranging between four and five in the Gu lineage, and between three and four in the Zha lineage. A noteworthy fact is that, compared to the other two ordinary lineages, the Zhou lineage had low marital fertility, similar to that of the Zha and the Gu.

Regarding the three ordinary lineages, though the trends are relatively unsteady, most often the rates of these three lineages did not vary significantly but fluctuated within a range of one birth. Nevertheless, in the eighteenth century, the three ordinary lineages all experienced a notable rise in marital fertility. The rate in the Zhou lineage increased from 3.03 to the highest rate of 4.60 in 1770-1799; in the Que lineage, it increased from 5.83 in 1680-1709 to the highest rate of 7.71 in 1740-1769, but dropped to 5.64 by the end of the eighteenth century. Similarly, the Huang lineage also experienced the highest rate (7.66) in the period 1740-1769, and maintained a high level for the next sixty years. As previously mentioned, it is argued by scholars that the eighteenth-century China experienced a remarkable "population boom" (Fairbank 1978; Zhao and Xie 1988; Cao 2000), and the notable rise of fertility in the three lineages conforms to the fast population growth during this period.[26]

Figure 2.2 shows the age-specific marital fertility schedule over time in the five lineages. The results shown in the figure are divided into four 50-year birth cohorts (five cohorts for the Gu lineage), in order to track the differences between different periods in each lineage.[27] Figure 2.2 suggests similar trends over time in the five lineages. The age patterns of marital fertility also demonstrate that the women from age 25 to age 34 were more fertile than women in the other age groups.[28] Moreover, the shape of the age pattern curve can also indicate whether or

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[26] See Appendix 2.B.1 for the marital fertility rates boundary of the five lineages by including different infant mortality rates.

[27] For the Zhou and the Que, the four births cohorts are 1700-1749, 1750-1799, 1800-1849, and 1850-1899; for the Huang and the Zha, the cohorts are 1650-1699, 1700-1749, 1750-1799, 1800-1850; for the Gu, the cohorts are 1650-1699, 1700-1749, 1750-1799, 1800-1850, and 1850-1899.

[28] As Liu (1995) suggests, the actual age-specific marital fertility rates of age group 15-19 should be slightly higher, because not all the married women included in the denominator for calculating the rate of this group were already married by the age of 20. However, the gap could only have been very small, because the number of births, the numerator of this group, was very low.

not the parity-dependent controls existed in pre-modern times, which is discussed in the next section.

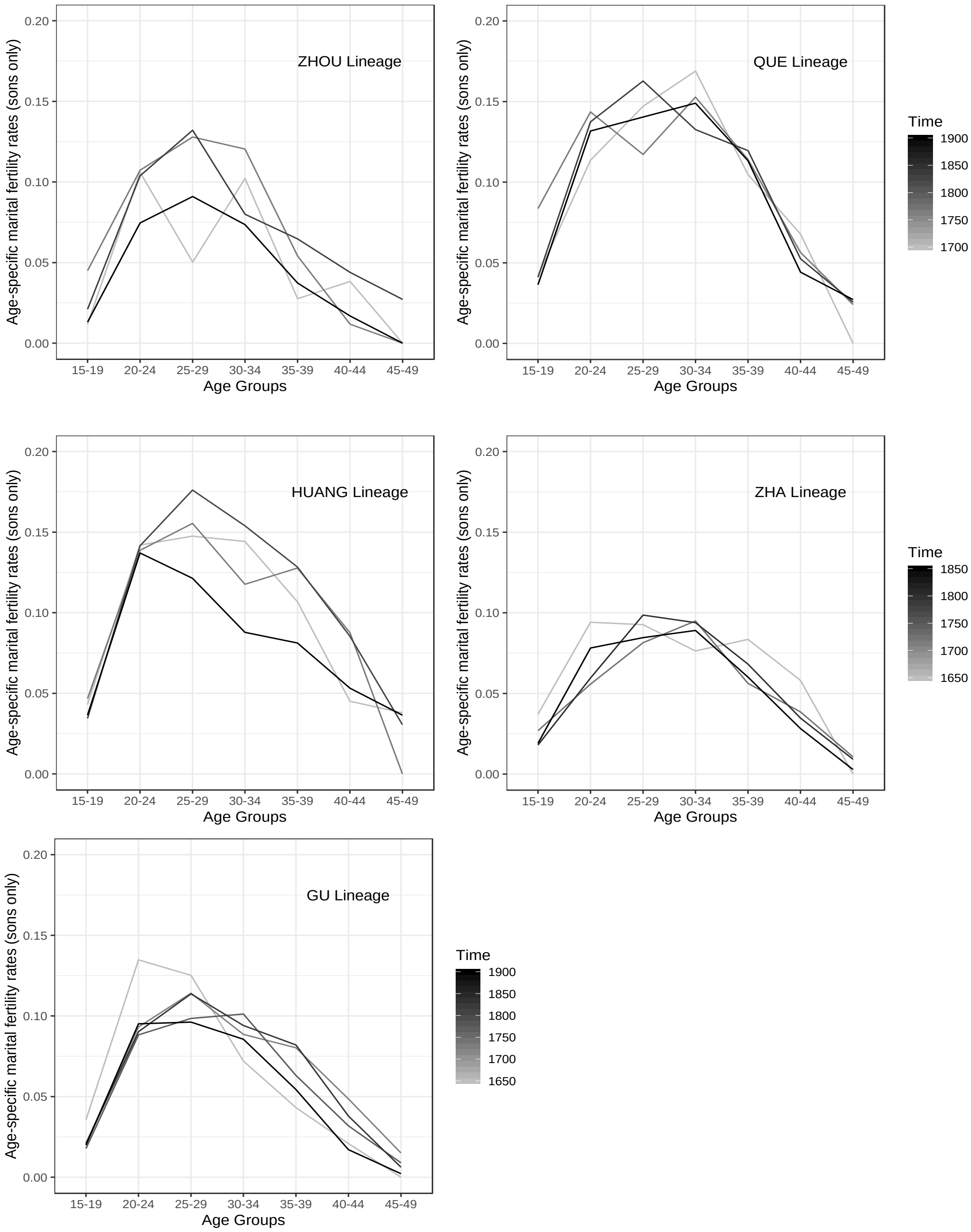

Figure 2.2 Age-specific marital fertility rates (sons only), in the five lineages

2.4.2 Fertility controls within marriage

2.4.2.1 Age pattern of marital fertility

Whether the fertility of a population is a "natural fertility" or a "controlled fertility" can be shown by the age pattern of fertility. As specified by Henry (1961), the way to distinguish these two types of fertility is to find whether the couples settle on a desired target for the number of children they will have. According to the marital fertility model, first proposed by Coale and Trussell (1974), and later developed by Wilson, Oeppen, and Pardoe (1988), the age-specific schedule of a "natural" marital fertility would follow a convex function, mainly determined by the decline of biological fecundity with age, while a "controlled" marital fertility would follow a linear, or even a concave function, with the decline of fertility at the same rate or an increasing rate, because of the use of parity-dependent controls after the maximum number of children had been reached (Knodel 1983; van Bavel 2003).

Table 2.5 lists the TMFR in the five lineages, and the five curves in Figure 2.3 demonstrate the age-specific marital fertility throughout the entire time period. The curves exhibit no clear evidence of parity-dependent fertility controls. Due to the assumed universal young marriage age of females, those in the age group 25-29 had the highest rate in all five lineages, but the declines afterwards all displayed more of a convex than a concave shape. Although the age pattern of fertility can give explicit evidence of fertility control, I show some more direct results in the next section.

Table 2.5 Total marital fertility rates (TMFR) in all five lineages

Time periods	Lineage	TMFR
1620-1830	Huang	5.95
1680-1920	Que	6.07
1680-1920	Zhou	3.76
1650-1860	Zha	3.71
1620-1890	Gu	4.09

Source: The lineage sample.

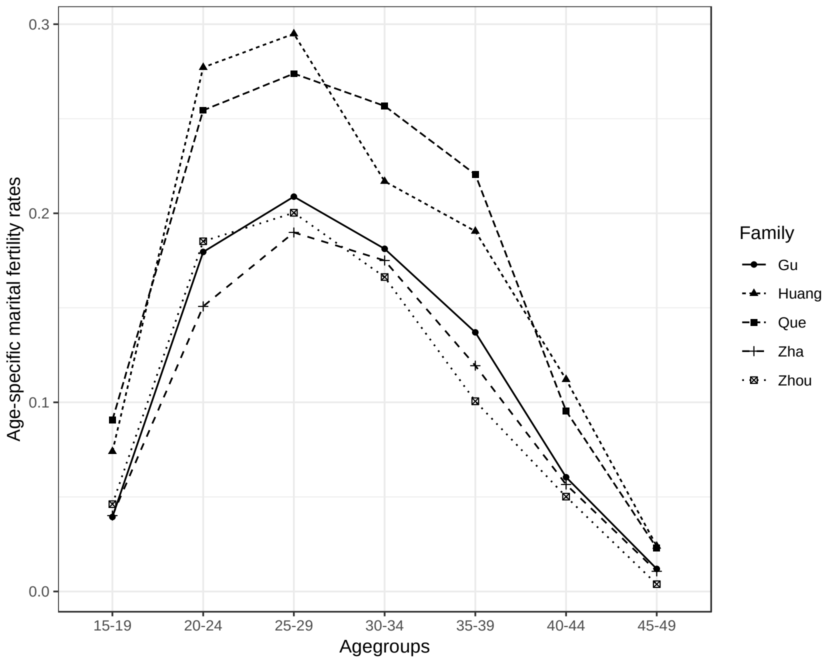

Figure 2.3 Age-specific marital fertility rates in all five lineages, 1620-1920

Note: The rates of all five lineages are adjusted by the infant mortality rates, and also take account of the numbers of daughters.

2.4.2.2 Parity-dependent early stopping

Based on the test proposed and applied by Clark and Cummins (2019a) to examine the existence in pre-industrial England of a type of parity-dependent control, early stopping, a similar test is also run in the section. I test the hypothesis that if the desired number of children existed and achieved, the couple would stop having more births. If the target number existed, the fertility patterns of groups of women with different levels of fecundity at a certain age should also be very different later on. In addition, because the age of marriage largely determines the reproduction span of women, women who married at different ages should also display different fertility patterns.

Nonetheless, given the nature of the genealogical data, I could not rigorously reproduce the test in Clark and Cummins (2019a), but had to adapt it to some extent. First, as the marriage ages of women are inaccessible from the genealogies, and as only the sons' birth years are accessible, I choose to analyse the women who gave birth to their first son before the age of 24, because these women might get married at similar ages. Second, because of the limited data on males' death years, I could not test the effect of net parity on later fecundity. As Liu (1985) suggests, I use the "sons-ever-born" method, and set the net parity by the recorded number of sons that a woman had had at the relevant age.

These women are then divided into three subgroups. The "high" group consists of women who had borne more than 3 sons before the age of 30; the "median" group comprises women who had given birth to 2 sons before the age of 30; and the "low" group contains women who had given birth to only 1 son before age 30. The age-specific marital fertility rates of the three groups are then be calculated. If the target number of children existed, the index of sons (taking marital fertility rate in the age-group 30-34 as 1) of the high group should decrease after age 34 more dramatically than the indices of the two other groups. In other words, the paralleled decreasing rates in the three groups represent the absence of early stopping in the sample population. If couples chose to avoid having more sons after reaching the maximum desired number of sons, the women in the "high", "medium", and "low" groups would have followed different fertility patterns after the age of 30-34.

The fertility patterns of women in the five plots of the five lineages in Figure 2.4 suggest that early stopping does not exist in the group of females who start having births from the age-group 20 to 24 in all of the five lineages. With higher fertility before age 30, instead of experiencing a more rapid decline, the women keep the high level of fertility later in their lives, while if they have lower fertility before age 30, they are highly likely to have lower fertility after this age. The approximate linear movement clearly indicates that there is little evidence of families setting a target number of sons, or of parity-dependent controls in general.

However, the missing information about daughters could bias the results. If the bias derived from the systematic under-recording of family members, especially daughters, in lineages over time existed, it would bias the test towards finding spurious fertility controls in Chinese fertility. However, even with the possibility of the bias, and even with data of sons alone, I cannot show evidence for the existence of early stopping in imperial China, which clearly proves that the results are robust to this bias.[29]

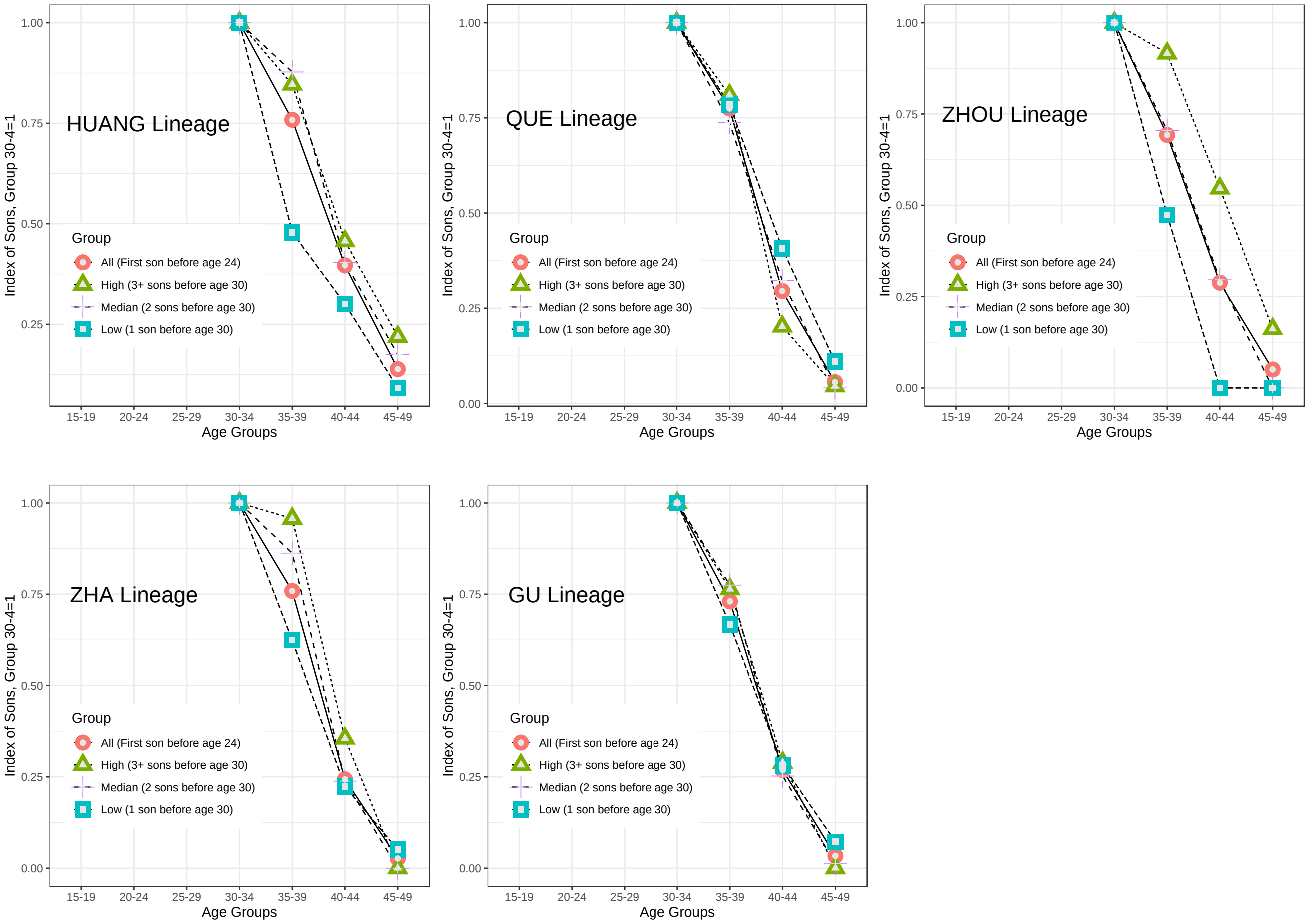

Figure 2.4 Index of sons, the five lineages, 1650-1900

[29] See Figure 2.B3 in Appendix 2.B for results of the same test, using both sons' and daughters' records of Rosny-sous-Bois, France.

2.4.2.3 Parity-dependent birth spacing

Wrigley (2004, p. 319, Table 12.1) finds that from 1700 to 1837 in England the mean birth interval was about 30 to 31 months (about 2.5 to 2.6 years).[30] Using the same dataset, Cinnirella et al. (2017) show that the number of mean spacing days from 1540 to 1850 was 924.5 days (about 2.53 years). The estimates of the five lineages are actually comparable. The average closed birth intervals between two sons in the five lineages were around 5 to 6 years, which means the birth interval between two birth should be around 2.5 to 3 years. The spacing in pre-modern China was not significantly greater than that in pre-modern England.[31]

This section focuses on another related question, how did birth spacing change with the changing stock of sons in the family. If couples adjusted their fertility choices by the stock of sons in the family and reduced the speed of having a successive birth, then parity-dependent birth spacing, another type of birth control, existed.

I use the subsample which contains 5,523 females who had at least one son and examines the birth spacing in the sample. Figure 2.5 presents the Kaplan-Meier curves for females of having another male birth before they reached the age of 49. I plot the survival curves of having a successive male birth for females of parity 1, 2, 3, and 4, as the majority of females in the sample gave birth to fewer than five sons.

I analyse both open birth intervals – intervals from the last birth to the menopause or death, and closed birth intervals – intervals between two male births. Therefore, for example, the curve for parity 1 in the figure measures the timing of the second son if the female had at least two sons. If the female only had one son over her lifetime, then it measures the interval from

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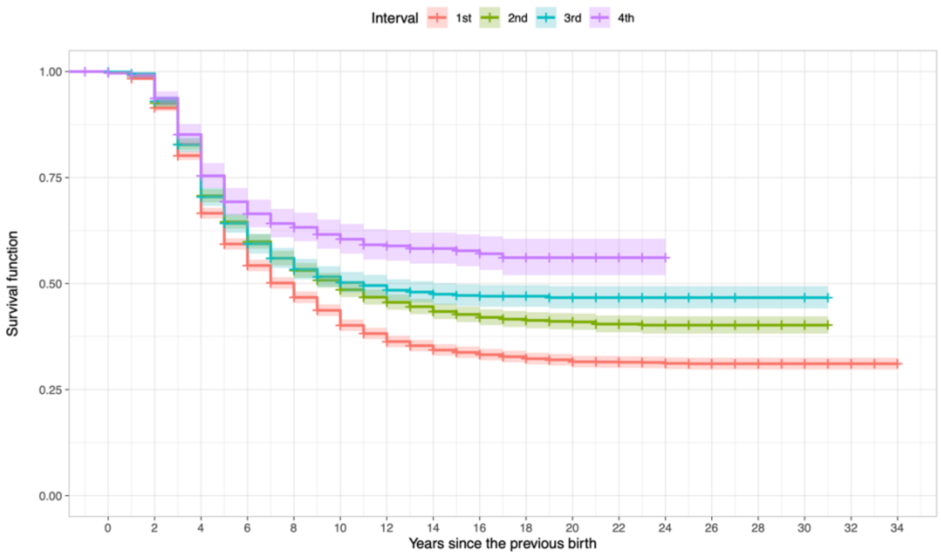
[30] Wrigley's estimation excludes the parity 0 intervals, and also the intervals following an infant death, which makes the estimation more comparable to the Chinese case here, since my calculation cannot include parity 0 intervals and intervals after infant deaths.

[31] Studies show that the common inclination to breastfeeding in the traditional Chinese culture may lengthen birth intervals. According to Bongaarts (1983), with no breastfeeding, the mean time period of post-partum amenorrhea is only about 1.5 to 2 months, while the duration of breastfeeding lengthens the duration of amenorrhea: one more month of breastfeeding causes approximately one more month of amenorrhea. As shown in Hsiung (1995), Chinese women chose to extend their breastfeeding time to more than two years, so in general, the amenorrhea interval for Chinese mothers could be about two years, which would prolong the birth interval.

the year of her first male birth to the year when she reached age 49 or her death year if she died before age 49.

As expected, the probability of having a successive male birth decreased with the increase of parity. In terms of the length of birth intervals, 50 per cent of the females of parity 1 delivered the second son within 7 years since the first male birth. The median "survival" periods of having a successive male birth for females of parity 2 and parity 3 were both about 9 years. For females who gave births to at least five sons, most of them had their fifth son within 6 years after the birth of the fourth son. In general, the birth interval between the first and the second male births was shorter than the other three intervals; the spacing between the second and the third male births and that between the third and the fourth male births were similar.



Number at risk

Interval	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
1st	5523	5332	4213	2960	2383	1969	1554	1295	1112	903	770	567	447	306	161	81	28	3
2nd	3393	3321	2702	2023	1645	1351	1079	779	557	438	312	195	106	62	19	4	0	0
3rd	1790	1757	1421	1021	816	639	502	378	271	185	103	49	17	8	2	2	0	0
4th	852	831	692	514	422	329	227	145	82	50	27	8	1	0	0	0	0	0

Years since the previous birth

Figure 2.5 Kaplan-Meier survival curves by parity

Notes: 1. The chart shows females with at least one male birth. 2. The shaded area indicates the 95% confidence interval.

To substantiate the relationship between the stock of sons and birth spacing, I follow the method used in previous studies (e.g. Cinnirella et al. 2017; Clark and Cummins 2019a).[32] I run a basic Cox proportional hazard model to estimate the hazard rates of the conception of a successive birth based on the following equation,

$$h(t|X_j) = h_o(t)\exp(X_j\beta_x). \qquad (3)$$

Individuals studied in the model are the mothers who were aged between 15 to 49 and had at least one male birth. The term $h_o(t)$ is the baseline hazard function of time, measured in years. X_j denotes the demographic covariates, and I control for the parity and mother's age in the model. Therefore, the dependent variable in this model is the birth interval, both open and closed, which is measured in years.[33]

I define parity as the number of sons that has ever born to the family by the start of the interval and I construct a dummy variable for each parity. "Mother age group", which is time varying, denotes the age of the mother in the interval. Moreover, two different levels of stratification are applied, the birth cohort stratification and the lineage stratification. To obtain the birth cohorts, I divide the birth date of the sons in the sample into eleven birth cohorts, starting with a "pre-1450" cohort, ending with a "post-1900" cohort, and with nine 50-year birth cohorts in between.

Table 2.6 details the results, and I plot the hazard ratios in each specification in Figure 2.6. Column 1 shows the results of the model with no fixed effect included. In columns 2 and 3, I

[32] I also run a logistic model to estimate the relationship between the probability of having a birth at a given year and the birth order of the birth, based on the equation,

$$Birth_{i,t} = Parity_i + Agegroup_{i,t} + Lineage_i + Cohort_i + \varepsilon_i, \quad (4)$$

where all the variables are as in the Cox proportional hazard model. I report the results in Table 2.B2 and Figure 2.B4 in Appendix 2.B. The results are consistent with those of the Cox proportional hazard model.

[33] The interval equals the birth interval between two male births minus one. Because I define the conception of the successive birth as "failure", I subtract one year from the birth interval to approximate the year of the conception of the next birth.

apply the birth cohort and the lineage stratifications respectively; the model in column 4 is stratified by cohort and lineage together. The results are much the same in the four models.

Coefficients on all the parity dummies are lower than 1, showing that compared to the reference group, *Parity 1*, women at parity higher than 1 would experience the successive birth at a significantly lower speed. However, the similar coefficients on parity 2 and the higher parities suggest the speed does not change much after parity 2. In fact, coefficients on Parity 3-6 are even larger than the coefficient on *Parity 2* in columns 1 and 2, which demonstrates a rising hazard of birth with parity, starting from parity 2. The positive hazard ratios suggest the fact that women who are more fecund have greater birth hazards (Clark and Cummins 2019a). After conditioning on the lineage fixed effects in columns 3 and 4, the difference between coefficients on parities 2 to 6+ becomes smaller. The results indicate that birth spacing (after parity 1) did not become longer with the increasing stock of sons, which also provides evidence for the absence of parity-dependent birth spacing in the five lineages.[34] The findings in this present chapter is similar to the English pattern revealed in Wrigley et al. (1997), where they also argue that "[b]irth interval lengths changed very little between parities 2 and 5."

In terms of the relationship between birth spacing and mother age, the result is consistent with the age-specific marital fertility rates in the five lineages shown in Figure 2.3. Mothers at age groups 25-29 and 30-34 always experienced higher fertility rates than mothers at other age groups, which is also confirmed by the shorter birth spacing for mothers at these two age groups.

Similar to the previous results on early stopping, the results here are also robust to potential data bias. The lack of daughters in the model would only bias it towards finding more delay in the next conception. Even with the possible bias, the model cannot find evidence of parity-dependent longer spacing.

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[34] I also follow the method used in Cinnirella et al. (2017). I report the results in Table 2.B3 in Appendix 2.B. The stratification creates strong negative effects of *Parity* on the hazard of birth. However, Clark and Cummins (2019a) have already proved that the presence of parity-dependent control found by the mother level stratification model is simply "an artifact of the empirical model".

Table 2.6 Parity-dependent birth spacing, with no stratification and stratification by cohort and lineage

	Hazard of a Birth			
		Cohort FE	Lineage FE	Cohort and Lineage FE
	(1)	(2)	(3)	(4)
Parity 2	0.395***	0.395***	0.385***	0.392***
	(0.012)	(0.012)	(0.011)	(0.012)
Parity 3	0.449***	0.446***	0.416***	0.418***
	(0.019)	(0.019)	(0.017)	(0.018)
Parity 4	0.420***	0.413***	0.368***	0.366***
	(0.027)	(0.027)	(0.023)	(0.023)
Parity 5	0.618***	0.606***	0.508***	0.499***
	(0.058)	(0.058)	(0.048)	(0.047)
Parity 6+	0.498***	0.491***	0.398***	0.384***
	(0.075)	(0.074)	(0.060)	(0.058)
Mother Age Group				
15-19	0.948	0.959	0.918	0.936
	(0.085)	(0.087)	(0.082)	(0.085)
25-29	1.145***	1.147***	1.195***	1.196***
	(0.042)	(0.042)	(0.044)	(0.044)
30-34	1.202***	1.206***	1.295***	1.301***
	(0.050)	(0.050)	(0.054)	(0.054)
35-39	1.068	1.074	1.174***	1.181***
	(0.051)	(0.051)	(0.056)	(0.056)
40-44	0.456***	0.461***	0.512***	0.525***
	(0.032)	(0.032)	(0.036)	(0.037)
45-49	0.421***	0.043***	0.048***	0.050***
	(0.009)	(0.009)	(0.010)	(0.010)
Number of Subjects	9,691	9,691	9,691	9,691

Notes: 1. "Parity 6+" includes parity 6, 7 and 8. Parity 1 and mother age group 20-24 are the reference groups. 2. Hazard ratios are reported. 3. Standard errors are shown in parentheses, clustered by mother. 4. *p<0.1; **p<0.05; ***p<0.01.

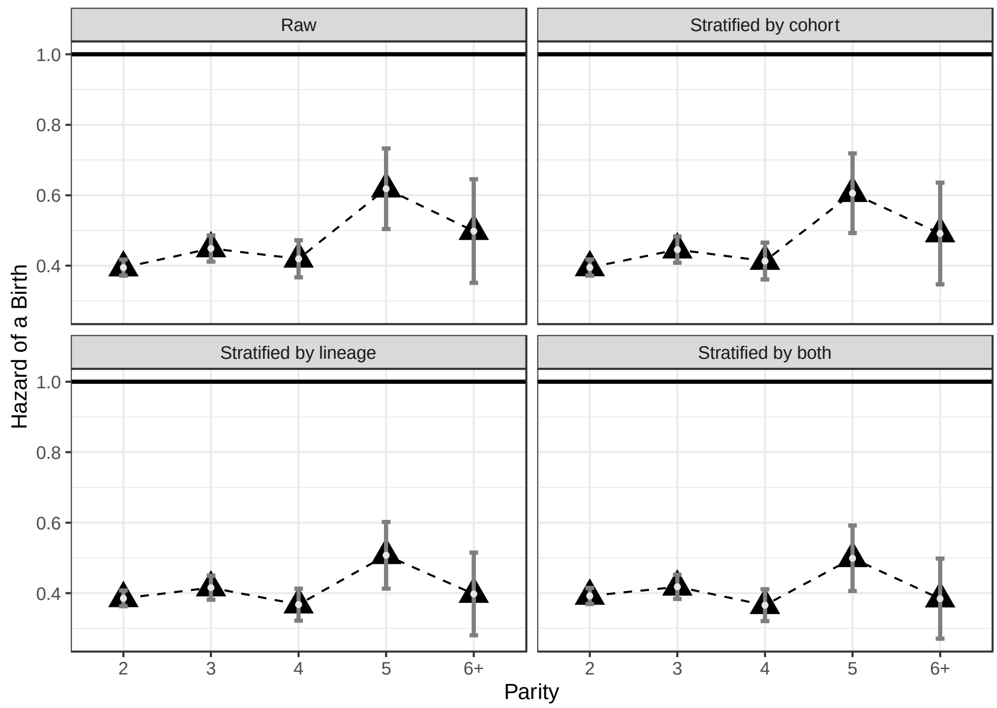

Figure 2.6 Parity hazards, with and without stratification by cohort and lineage

Notes: 1. Values are the hazard ratios presented in Table 2.6. 2. Error bars indicate 95% confidence intervals.

2.5 Discussion

The extensive literature on historical fertility in both the Chinese and the Western context allows me to compare my results from the five lineages with other results, in order to better understand the marital fertility levels in imperial China. This section compares the results of this chapter with other historical fertility studies, within China and with the West, especially Western Europe, followed by a brief discussion about the "natural" and "controlled" fertility.

2.5.1 Comparison within China and with the West

Many scholars have already estimated Chinese marital fertility in historical times. I find a similar level of marital fertility between the previous demographic studies and my study, as presented in Table 2.7 and Figure 2.7. Although the Zhou, the Zha, and the Gu had relatively lower rates, the Que and the Huang lineages had identical marital fertility rates with Ts'ui-jung Liu's estimation of other lineages in South China, and also the estimation of North China's rates by Lee and Wang. Two higher calculations were provided by Wolf (1984) and Telford (1995), but they were still lower than 8.42, the standard natural marital fertility rate estimated by Louis Henry (1961), though the estimate of Telford was exceptionally higher than the other ones.[35]

Table 2.7 Total marital fertility rates in China in previous studies

Time period	Region	TMFR
1620-1830	Zhejiang (Huang)	5.95
1680-1920	Zhejiang (Que)	6.07
1680-1920	Zhejiang (Zhou)	3.76
1650-1860	Zhejiang (Zha)	3.71
1620-1890	Jiangsu (Gu)	4.09
1296-1864	Hunan (Li)	5.98
1517-1877	Jiangsu (Zhu)	5.80
1462-1864	Anhui (Zhao)	6.11
1520-1661	Anhui	8.21
1700-1890	Beijing	5.3
1774-1873	Liaoning	6.3
1929-1931	22 Provinces	6.12
1896-1927	7 Localities	7.03

Sources and notes: The first five TMFR are the author's own calculation. Hunan, Jiangsu, and Anhui (1462-1864): genealogical studies by Liu (1995, p. 99), the Li lineage in Shaoyang County, Hunan Province, and the Zhu lineage in Jiangdu County, Jiangsu Province; Anhui (1520-1661): a total marital fertility rate in 39 genealogies studied by Telford (1995, Table 3.1, p.51); Beijing and Liaoning: Lee and Wang (1999a, Table 6.1), by using genealogical records of royal family in Beijing, and the register records in rural Liaoning); 22 Provinces: Barclay et al. (1976, Table 5); 7 Localities: Wolf (1984, Table 10). The data of 22 Provinces used in Barclay et al. comes from the land utilization survey conducted by John Lossing Bank and the research team in Nanking University in 1929 to 1931. The seven localities of Wolf's research are Beijing, Fujian, Zhejiang, Jiangsu, Shandong, Shanxi, and Sichuan.

[35] Telford (1995) studied 39 genealogies in Tongcheng County; all of the 30 total marital fertility rates that he showed were above 6.7, with only one exception, the Huang lineage, which was 5.77 (the highest one was 9.56). Liu (1995) analyses the Zhao lineage also in Tongcheng County, and reported the TMFR as 6.11. Although Liu did not include a 25 per cent infant mortality rate and a 10 per cent male-birth under-registration rate as Telford did, and although they looked at different periods, more research on Anhui Province needs to be done to account for the great difference.

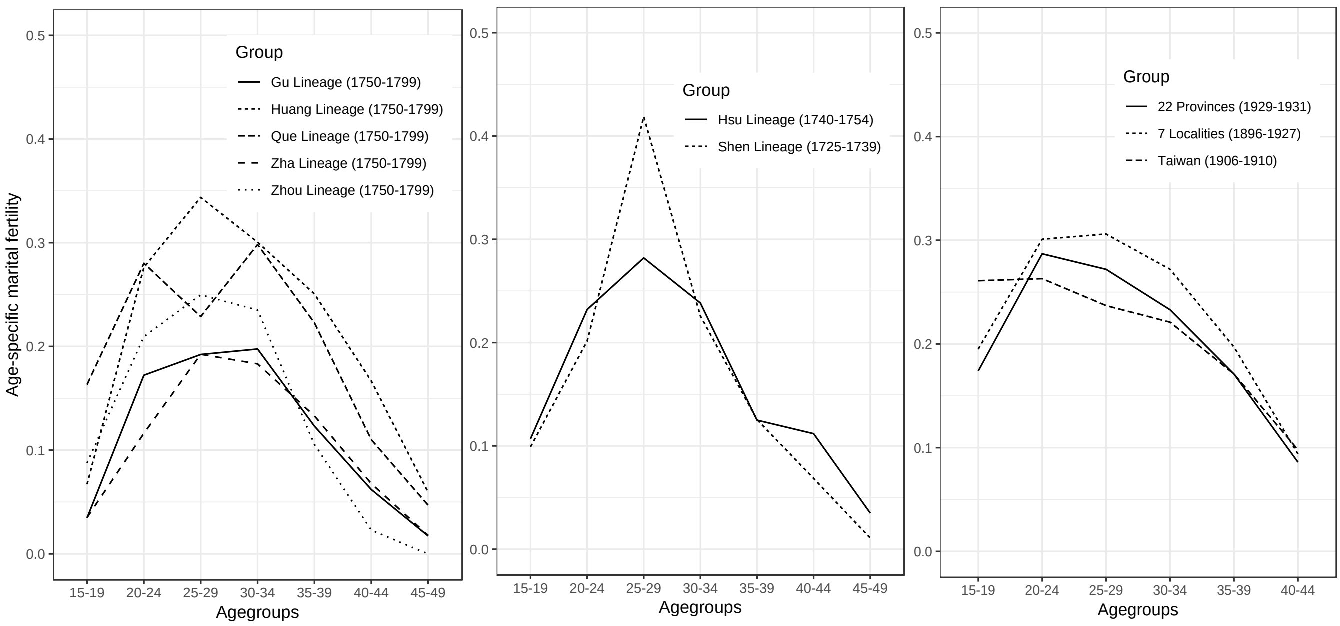

Figure 2.7 Age-specific marital fertility rates in China

Sources: Huang, Que, Zhou, Zha, Gu: authors' own calculation; Hsu and Shen lineages, Liu (1985, Table 2.9); 22 Provinces: Barclay et al. (1976, Table 5); 7 Localities: Wolf (1984, Table 10), and Wolf interviewed 580 women born in 1896-1927; Taiwan: Wolf (1984, Table 7).

The marital fertility rates in premodern China were comparable, or in most cases, much lower than the rates in pre-transitional Western Europe. Table 2.8 and Figure 2.8 show the age-specific marital fertility in the five lineages and four North-western European regions. Because of the late marriage pattern in North-western Europe, the data of its age-specific marital fertility start from the age group 20-24, while the data of the fertility of the five Chinese lineages start from the age group 15-19. As shown clearly in the table and the figure, the age-specific marital fertility rates in the five lineages from 1800 to 1829 are much lower than those of the four North-western European regions in the similar periods.

It is also worth mentioning that not only were the amplitudes of marital fertility in China and in the West different, but also the shapes of the curves (Figures 2.7 and 2.8). In a pre-modern North-western European population, the marital fertility of the age group 20-24 was always the highest, declining afterwards. However, the five Chinese lineages studied in the chapter, and also studies of Liu, Telford, and Lee all show that the age group 25-29 always has the highest marital fertility rates, and that marital fertility declines after leaving the age group 30-34, which was largely caused by the different marriage patterns in China and the West.

Table 2.8 Age-specific marital fertility (rates per 1,000 women-years)

	15-9	20-4	25-9	30-4	35-9	40-4	45-9	TMFR 20(15)-49
England (1800-24)	.	425	381	311	255	142	19	7.67
Sweden (1801-50)	.	456	374	315	237	130	25	7.69
Southwest France (1720-89)	.	410	359	336	257	141	20	7.62
Werdum (pre-1850)	.	449	376	322	256	118	17	7.69
Huang (1800-29)	90	305	308	244	212	98	28	5.98
Que (1800-29)	107	251	227	220	187	119	19	5.65
Zhou (1800-29)	45	196	226	145	91	61	22	3.93
Zha (1800-29)	40	184	199	187	147	62	9	4.14
Gu (1800-29)	41	186	217	165	169	78	13	4.35

Source: The rates of England, Sweden, Southwest France, and Werdum are from Wrigley (2004), *Poverty, Progress, and Population*, Table 15.1, p. 400.

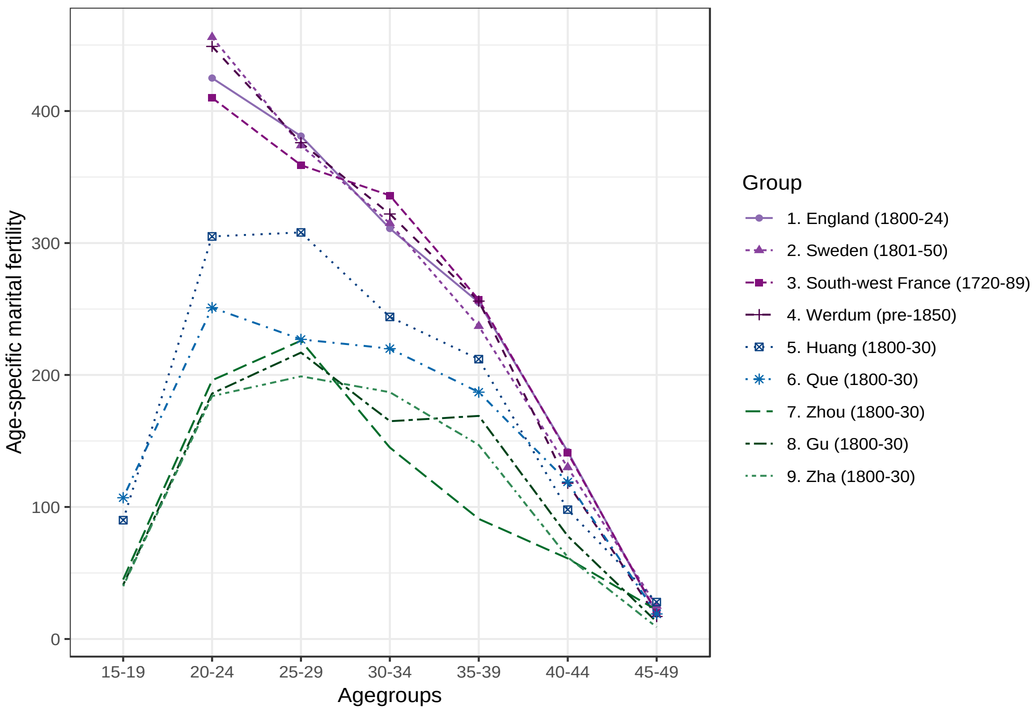

Figure 2.8 Age-specific marital fertility, England, Sweden, Germany, France, and China

Source: Estimates from Table 2.8.

2.5.2 A "natural fertility" or a "controlled fertility" regime?

The martial fertility pattern in China was unique. The results in this chapter shows that the marital fertility rates were low, but parity-dependent stopping and spacing were absent. This combination makes imperial China hardly fit into either the "natural fertility" or the "controlled fertility" regime that Henry (1953) establishes.

In fact, Henry's (1961) identification of the two categories suggests that the difference between them does not lie in the level of fertility rates, but in the existence of parity-dependent controls. Provided that deliberate stopping and spacing were not practised, fertility should be defined as "natural fertility" (Knodel 1983, see Table 2.9 in this chapter). According to the criteria, Ming-Qing China should belong to the "natural fertility" regime. However, the moderate fertility level itself still implied that Chinese historical fertility was not completely "natural". There must be some limits practised to achieve the low rates, despite the fact that the couples did not limit family size deliberately.

Table 2.9 Natural and controlled fertility as defined by the occurrence of parity-dependent controls

	Deliberate stopping		
Deliberate spacing	Absent	Without intent to limit family size	With intent to limit family size
Absent	natural fertility	ambiguous	controlled fertility
Without intent to limit family size	natural fertility	ambiguous	controlled fertility
With intent to limit family size	ambiguous	ambiguous	controlled fertility

Source: Knodel 1983, Chapter 3, Table 1.

Some studies point out the important role that the traditional culture played in lengthening birth intervals, which effectively limited marital fertility. For instance, because of the tradition of arranged marriages and minor marriages (marriages between preadolescent boys and adult females) in pre-modern China, the lack of passion between couples and the big age gaps between young husbands and elder wives both led to long birth intervals (Rindfuss and Morgan 1983; Wolf 1984). The traditional belief that longer breastfeeding was beneficial and healthy to both infants and mothers also lengthened the intervals (Hsiung 1995). Lee and Wang (1999a, pp. 90-92) argue that the longer spacing was derived from the traditional health and reproductive culture. Influenced deeply by Confucianism, Taoism, and Buddhism, the Chinese believed that having excessive sexual activities was unhealthy, so that they strictly regulated sexual activities.

Moreover, another culture-related factor, the practice of remarriages and concubinage, would also reduce the frequency of sexual activities for wives, and thus limited the marital fertility rates to some degree. Lee and Wang (1999, p.76; Wang et al. 1995) study the Qing nobility and point out that, "[m]ost polygynous men apparently slept with only one wife at a time, regardless of the total number of wives…As a result, adding one wife increased male fertility by only one child." From the perspective of the wives and concubines, this also suggests that the practice would reduce the frequency of their sexual activities, and thus limited the marital fertility rates to some degree.

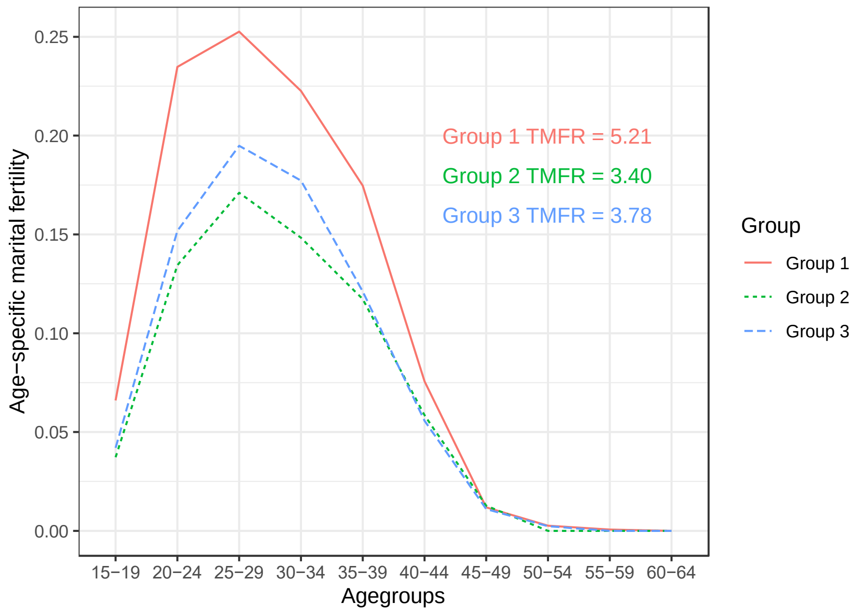

Figure 2.9 Age-specific marital fertility rates of females with different status in marriages, the five lineages

Although the proportion of "polygynous men" in my lineage sample was not as high as that in Lee and Wang's Qing nobility sample, the practice was not rare in my sample.[36] Therefore, to quantitatively support this cultural factor, I divide all the females into three groups based on their husbands' marital status and estimate the age-specific and total marital fertility rates by group. Group 1 contains 5,929 females were the wives whose husbands only married once in their lifetime. Group 2 includes 879 females were the first wives whose husbands married more than once. These females usually died at an early age or failed to have a son, which gave

[36] Within the total population of married males in the five lineages, 8.94% of married males in the Huang lineage, 4.67% in the Que lineage, 14.32% in the Zhou lineage, 10.27% in the Zha lineage, and 7.68% in the Gu lineage married more than once.

sufficient reasons for their husbands to remarry.[37] Group 3 includes 959 females who were either wives of their husbands' remarriages or concubines. In other words, females of Groups 2 and 3 shared their husbands with other women either consecutively or simultaneously, while females of Group 1 did not.

The results are shown in Figure 2.9. It demonstrates the different fertility patterns of the three groups. Females in Groups 2 and 3 had significantly lower fertility rates than the females in Group 1. The results make sense, considering the relatively shorter time that women in Groups 2 and 3 could accompany their husbands than women in Group 1. Although Group 1's TMFR was not high in historical standard either, the constant remarriages of males and the polygamy practice played an important role in limiting the number of births a married female would have.

In sum, Henry's classification of fertility is still a useful tool to describe different types of historical fertility. However, because he proposed it mainly based on a sample that consisted of European countries, applying it to non-European ones would be arbitrary sometimes. As mentioned in Saito (1996), "the ways in which a demographic regime operated were culture-bound". Considering the marriage system and reproductive culture in imperial China was distinctly different from the European ones, it makes sense that China's pattern could not perfectly fall into either category. With more detailed studies on historical fertility of non-European regions in the future, a more accurate and detailed classification could be created to enrich our understanding of human fertility at a global scale.

2.6 Conclusion

By exploiting a new genealogical dataset of five lineages in southeast China, I re-examine the historical marital fertility pattern in China. The chapter invalidates the Malthusian view on high fertility in pre-modern China by showing relatively low marital fertility rates in the five lineages, especially in the Zhou, the Zha, and the Gu lineages. Meanwhile, the chapter vindicates the traditional view that fertility was not deliberately limited in pre-modern China, by providing evidence of the absence of two effective parity-dependent fertility controls in the five lineages.

[37] The mean age at death of women in Group 2 is 33.9, while those of women in Groups 1 and 3 are 48.2 and 48.9, respectively.

Appendices

2.A Selection bias and survivor bias of the genealogical data for Chapter 2

Selection bias. To examine the selection bias, the proportion of degree holders and individuals with specific records of identity and social status is used as a measure in this chapter to show how representative the people recorded in genealogies can be. In all of the three ordinary lineages, the proportion of degree holders in the national civil service examination is not high in any generation (Table 2.A1). Moreover, in the 1,710 male members in Huang, only 19 people (1.1 per cent) have records on identity, described by phrases as "being erudite and eloquent", "being a celebrity in the town", etc., and 193 people in the 1,059 male members in Zhou have identity records, which only accounts for l8.2 per cent of the male population. These two proportions, together with the results showed in Table 2.A1, prove the genealogies are representative of the general population in the county. For the Zha lineage, the proportion of degree holders is much higher, 15.6 per cent of a total male population of 3,785, and with a nearly similar proportion of degree holders in each generation.

Survivor bias. If the effect of survivor bias is significant, then the later generations in the lineage should have many more achievements than the previous generations had. From the results of the five lineages (shown in Table 2.A1), I find no sign of survivor bias: in all the five lineages, the proportion of degree holders in the last generation(s), is not higher than the proportions in the previous generations (except for the Zha lineage with a little higher proportion in the last six generations than in the six previous generations); they are also all roughly equal to the percentage of degree holders in the total male population.

Table 2.A1 Degree holders in the Zhou, Huang, Que, Zha, Gu lineages

Lineage	Generation	Upper rank	Lower rank	Total	% of all males in the generations
Huang	1st-5th	0	0	0	2.4%
	6th-10th	0	1	1	0.29%
	11th-15th	0	3	3	0.26%
Total	1st-15th	0	4	4	0.26%
Que	1st-10th	0	0	0	0
	11th-15th	0	11	11	1.1%
	16th-18th	0	86	86	3.9%
	19th-20th	2	52	54	2.3%
Total	11th-20th	2	149	151	2.7%
Zhou	1st-5th	0	2	2	15.3%
	6th-10th	6	7	13	9.6%
	11th-15th	3	7	10	3.4%
	16th-20th	0	7	7	5.7%
	21st-25th	1	18	19	4.8%
Total	1st-25th	10	41	51	4.8%
Zha	1st-6th	2	4	6	9.5%
	7th-12th	18	137	155	15.0%
	13th-18th	44	387	431	16.0%
Total	1st-18th	64	528	592	15.6%
Gu	17th-21st	10	7	17	16.2%
	22nd-26th	13	12	25	3.5%
	27th-31st	4	24	28	1.5%
	32nd-36th	4	74	78	1.0%
	37th-44th	0	25	25	0.4%
Total	17th-44th	31	142	173	1.0%

Note: "Upper rank" degree holders are the candidates who passed the national-level and the provincial-level civil examinations, including *jinshi*, *juren*, and *gongsheng*. "Lower rank" degree holders are the candidates who passed only the county- or prefecture-level civil exams, including the *guoxuesheng*, *taixuesheng*, *lingsheng*, *fusheng*, and *zengsheng*, *xiangsheng* and *yisheng*.
Source: The lineage sample.

2.B Robustness checks for Chapter 2

2.B.1 Infant mortality rates

The 25 per cent and 20 per cent of infant mortality rates in ordinary families and elite families used in the chapter could overestimate or underestimate the situation in China. I choose to include different infant mortality rates for the ordinary families and the elite families to indicate a possible boundary of marital fertility rates in the five lineages. The results are shown in Table 2.B1 and Figure 2.B1.

Table 2.B1 Total marital fertility rates adjusted by different infant mortality rates in the five lineages

		Total marital fertility rates				
Lineage	Periods	15%	20%	25%	30%	35%
Huang	1620-1830	.	5.71	5.94	6.19	6.42
Que	1680-1920	.	5.83	6.07	6.32	6.56
Zhou	1680-1920	.	3.61	3.76	3.91	4.06
Zha	1650-1860	3.56	3.71	3.87	4.02	.
Gu	1620-1890	3.92	4.09	4.26	4.43	.

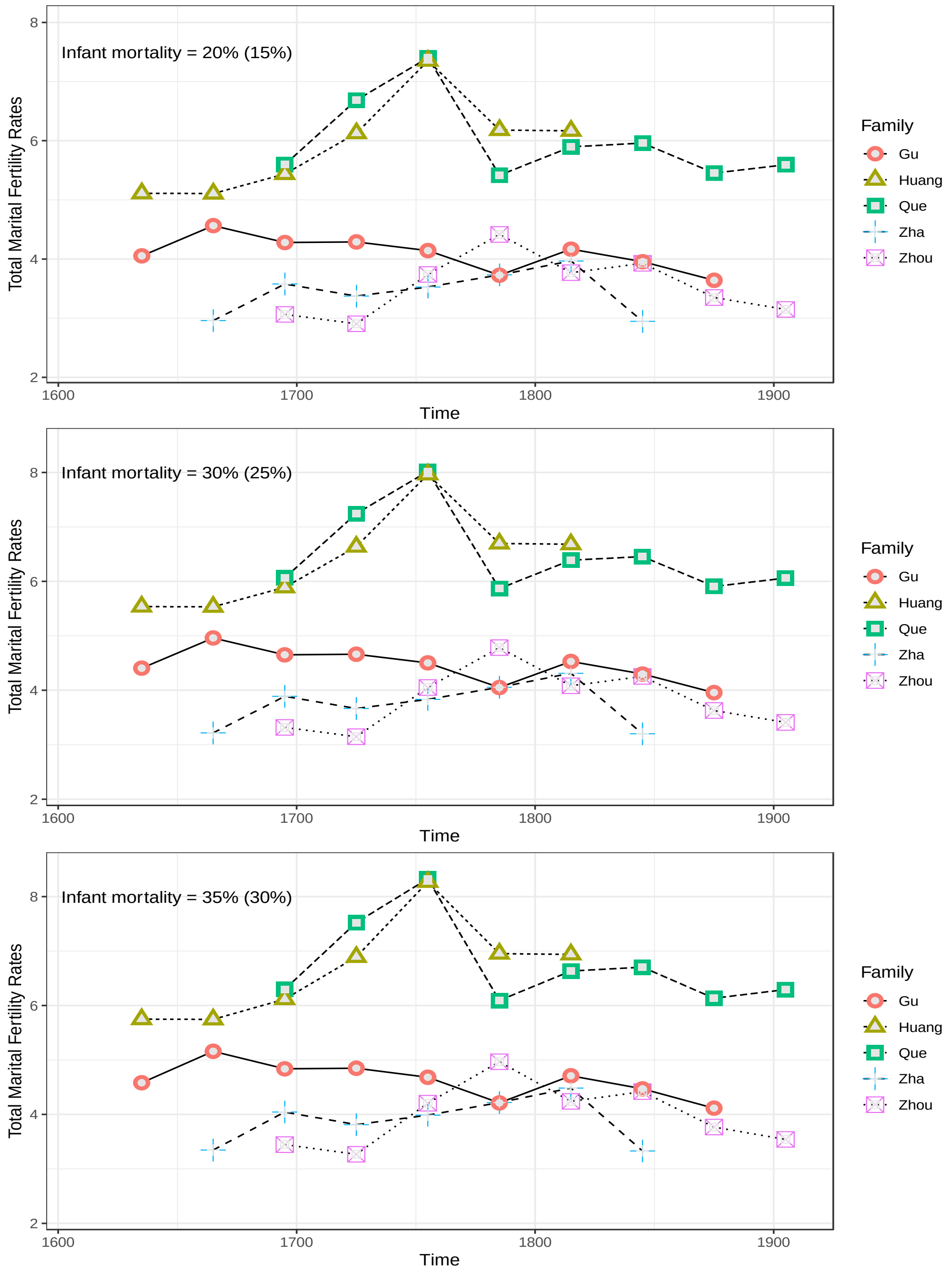

Figure 2.B1 Total marital fertility rates adjusted by different infant mortality rates, the five lineages, 1620-1920

Note: Numbers in brackets indicate infant mortality rates used for the Zha and the Gu lineages.

B.2 A case study on Rosny-sous-Bois

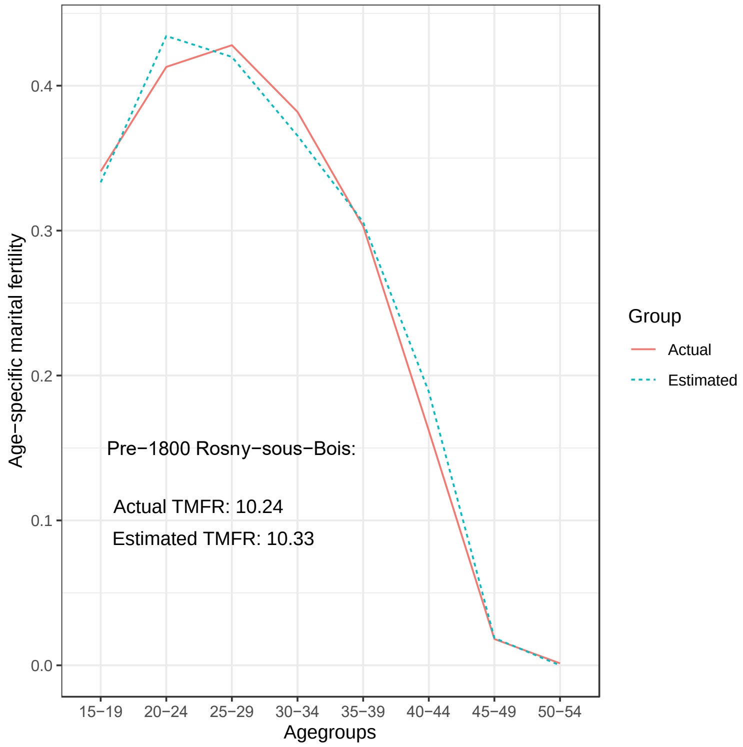

Figure 2.B2 Marital fertility rates in Rosny-sous-Bois, pre 1800

Sources: Séguy 2001; Weir 1995.

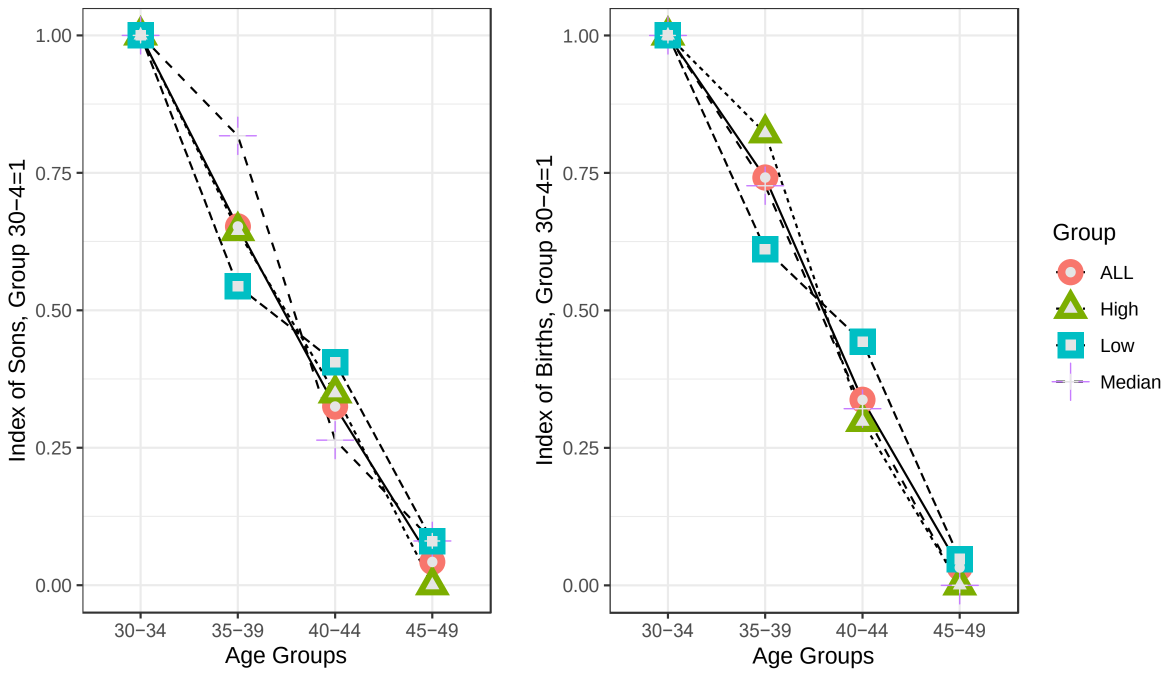

Figure 2.B3 Index of sons and index of births, Rosny-sous-Bois, pre 1800

Sources: Séguy 2001; Weir 1995.

2.B3 Parity-dependent birth spacing

Table 2.B2 Parity effects on having a successive birth, logistic regression

	Dependent Variable: Having a successive birth in a given year		
	(1)	(2)	(3)
Parity 2	0.316***	0.314***	0.305***
	(0.010)	(0.010)	(0.027)
Parity 3	0.349***	0.345***	0.318***
	(0.015)	(0.015)	(0.014)
Parity 4	0.320***	0.314***	0.272***
	(0.020)	(0.020)	(0.017)
Parity 5	0.466***	0.447***	0.360***
	(0.043)	(0.043)	(0.035)
Parity 6+	0.359***	0.349***	0.270***
	(0.052)	(0.050)	(0.040)
Age 15-19	0.586***	0.587***	0.562***
	(0.053)	(0.054)	(0.052)
Age 25-29	1.440***	1.449***	1.508***
	(0.056)	(0.056)	(0.059)
Age 30-34	1.551***	1.565***	1.684***
	(0.066)	(0.067)	(0.072)
Age 35-39	1.379***	1.397***	1.544***
	(0.064)	(0.065)	(0.073)
Age 40-44	0.579***	0.589***	0.659***
	(0.037)	(0.037)	(0.042)
Age 45-49	0.051***	0.052***	0.059***
	(0.010)	(0.010)	(0.012)
Controls			
Birth cohort FE	N	Y	Y
Lineage FE	N	N	Y
Constant	0.176***	0.625***	0.553***
	(0.005)	(0.023)	(0.032)
Observations	75,529	75,529	75,529
Pseudo R^2	0.087	0.088	0.093

Notes: 1. The coefficients are the odds ratio for the logistic model. 2. Robust standard errors are in parentheses, clustered on mothers. 3. *p<0.1; **p<0.05; ***p<0.01.

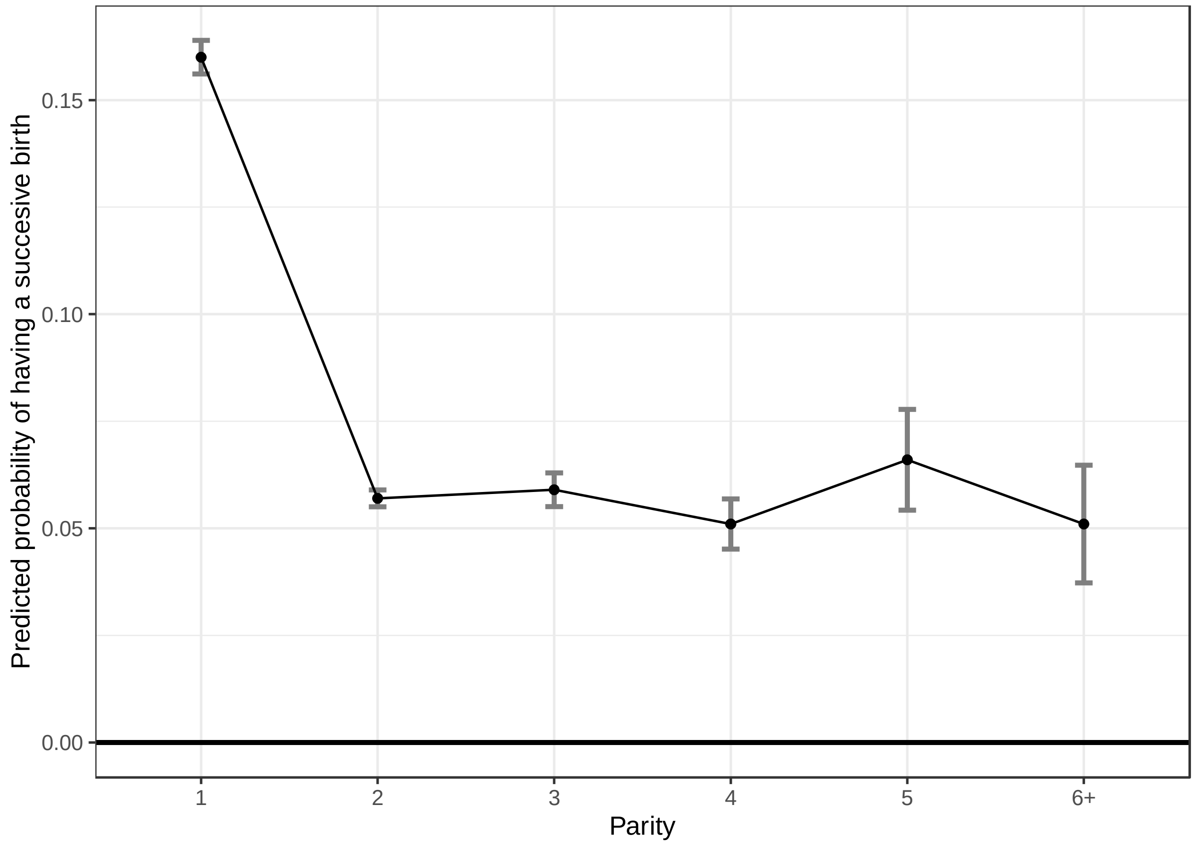

Figure 2.B4 Predicted probability of having a successive birth in a given year with a given parity

Notes: 1. Values are the average adjusted predictions, the expected probability at each parity are calculated by the logistic regression in column 3 of Table 2.B2. 2. Error bars indicate 95% confidence intervals.

Table 2.B3 Parity-dependent birth spacing, stratification by mother

	Hazard of a Birth	
	Mother FE	Cohort, Lineage, and Mother FE
	(1)	(2)
Parity 2	0.248***	0.242***
	(0.014)	(0.015)
Parity 3	0.091***	0.090***
	(0.009)	(0.009)
Parity 4	0.035***	0.033***
	(0.005)	(0.005)
Parity 5	0.023***	0.018***
	(0.004)	(0.004)
Parity 6+	0.008***	0.007***
	(0.002)	(0.002)
Age 15-19	0.427***	0.414***
	(0.061)	(0.062)
Age 25-29	2.523***	2.566***
	(0.179)	(0.196)
Age 30-34	5.396***	5.527***
	(0.568)	(0.627)
Age 35-39	8.485***	8.764***
	(1.155)	(1.286)
Age 40-44	6.197***	6.585***
	(1.047)	(1.204)
Age 45-49	1.132	1.284
	(0.327)	(0.390)
Number of Subjects	9,691	9,691

Notes: 1. "Parity 6+" includes parity 6, 7 and 8, and parity 1 group and mother age group 20-24 are the reference groups. 2. Hazard ratios are reported. 3. Standard errors are shown in parentheses. 4. *p<0.1; **p<0.05; ***p<0.01.

Chapter 3

Survival of the Confucians: Social status and fertility in Ming-Qing China

Abstract

This chapter uses the genealogical records of 36,456 men to test one of the fundamental assumptions of the Malthusian model. Did higher living standards result in increased net reproduction? An empirical investigation of China between 1350 and 1920 finds a positive relationship between social status and fertility. The gentry scholars, the Confucians, produced three times as many sons as the commoners. The positive relationship is also robust to a set of individual- and family-level socio-economic factors, including fathers' and brothers'/cousins' social outcomes. However, the strong social gradients disappear once I control for the number of marriages. Increased marriages among upper-class males drove reproductive success.

3.1 Introduction

Since the time of Malthus, economic historians have long been preoccupied with the relationship between economic growth and population growth. One of the fundamental assumptions behind the unified growth theory is that improved living standards lead to faster population growth. In the Malthusian epoch, income increase led to fertility increase and mortality decrease; thus, improved living standards lead to higher net reproduction. The growing proportion of the rich, together with a quantity-quality trade-off of children, led to the increase of human capital and finally triggered the fertility transition and modern economic growth (Galor and Moav 2002; Galor and Weil 2000; Willis 1973; Becker, Murphy, and Tamura 1990; Galor 2011).

Empirical evidence from pre-modern England supports this reasoning. Clark and Hamilton (2006) analyse more than 2,000 wills in England in 1585-1638 and find a "survival of the richest" story, that the number of descendants of the richest testators was twice that of the poorest. Boberg-Fazlic, Sharp, and Weisdorf (2011) also find a positive relationship between social class and fertility in the family reconstitution dataset of England. However, after including the rates of childlessness and celibacy, de la Croix, Schneider, and Weisdorf (2019) find that the same dataset suggests a somewhat different story –it was the middle class, rather than the rich, that had the highest reproduction rate. In addition to the evidence from England, a study by Bandyopadhyay and Green (2013) also shows a positive link between income and reproduction in colonial India.

The positive correlation between living standards and fertility has also changed over history (Skirbekk 2008; Cummins 2009). After extending the English probate data to cover a more extended period starting in the sixteenth century, Clark and Cummins (2015b) reveal that the higher net fertility of the rich did not remain stable over the entire pre-transitional period: a rapid decline in net fertility occurred first in the middle and upper classes as early as 1780, after which the lower class gradually caught up with the fertility level of the rich.

While classical research has worked on macro-population trends in the Chinese context for the same period (Ho 1959; Perkins 1969), research has also examined the effects of socio-economic factors on population growth. Harrell (1985) first examines the rate of population growth across generations at the household level by using genealogical data and observe much higher rates in wealthy segments than in poor ones within the same lineage. Telford (1995), similarly, uses genealogical records to test the relationship between fertility and population growth and find that the husband's status was a key variable in accounting for the population growth in 1520-1661. Similarly, Song, Campbell, and Lee (2015) analyse the farming population in Liaoning and the imperial lineage in 1725-1875 and find that patrilineages with high-status founders survived longer than those with low-status founders.

In terms of research on individual fertility outcome, Shiue (2017) explores genealogies in Anhui Province to test the child quantity-quality trade-off in Qing China and notes a negative relationship between sons' education and fathers' fertility before the nineteenth century. Chen, Lee, and Campbell (2010) study the official and unofficial immigrants to Shuangcheng County in Northeast China from 1866 to 1907 and reveal a positive relationship between household landholdings and female marital fertility, but an uncertain relationship between a husband's occupation and a wife's likelihood of having a registered son. Che and Cao (2011) conclude the same from using the genealogical records and land contracts of the Que lineage in Zhejiang Province after 1700 to test the effects of landholdings on fertility.

To join the discussion on the transition from Malthusian stagnation to modern economic growth from the demographic perspective, this chapter examines the status differences in China's fertility pattern. This chapter uses a range of quantitative tools to explore the relationship between status and fertility in a new dataset comprising of Chinese genealogies, which contains 36,456 males from six lineages between 1350 and 1920. Seven levels of social rank are used to measure social status, and the number of sons who survived infancy is used as a measure of net fertility.

The results demonstrate a positive association between social status and net fertility: climbing up the social ladder would increase the number of sons that a male produced. The unconditional status-fertility relationship shows that an elite of the highest rank in the sample (rank 7) could be expected to have three times as many sons as a commoner (rank 1). The positive feedback is still significant after conditioning on other individual-level and family-level factors that could affect male reproduction, including human capital, birth order, out-migration, birth cohort, and lineage fixed effects.

Controlling further for the number of marriages an adult male had, however, reduces all the fertility gradients. Males in ranks 2 and 4 retain their advantages in reproduction, but promotion from rank 1 to ranks 2 or 4 could bring about only a modest increase in net fertility; moreover, the net fertility of males in ranks 5-7 is no different from that of commoners. While restricting the sample to married males only, the coefficients on all ranks higher than 1 regain statistical significance, but the number of marriages still remains to be a crucial factor. The weakened effect of social status suggests that social status considerably increased a man's marriage chances and the number of his wives, and thus impacted on the number of sons.

I then move to analyse the key mechanism, the number of marriages. High social status males, in general, had more marriages over their lifetime than commoners had. A rank 2 man had 30 per cent more marriages than a commoner, and a rank 7 man had 70 per cent more.

I also examine the effects of kin networks on an individual's fertility and marriage outcomes. After conditioning on the social outcomes for fathers and brothers/cousins, the individual's own social rank and number of marriages are still the key determinants of his fertility outcome. Moreover, the kin group effects on marriages were different in lineages with a low proportion of gentry-scholars and ones with a high proportion of gentry-scholars. With institutional access to lineage joint properties in wealthy lineages, the social ranks of fathers, brothers, and cousins played a less significant role than they did in common lineages.

This chapter contributes to the previous literature by rigorously testing an old but fundamental question: whether higher living standards could result in increased net reproduction in a Malthusian economy. It showcases a new individual-level dataset and provides solid evidence on the social gradients in fertility in China from 1350 to 1920. Chen et al. (2010) and Song et al. (2015) both touch upon similar research questions, but the periods that they cover are mid-Qing and late-Qing, and their sample populations are different from the common population residing in China Proper. Shiue (2016, 2017) uses genealogical records to demonstrate the historical fertility in China too, but what she shows is an intergenerational relationship between parental fertility and child outcome, rather than status-fertility relationships within the same generation.

Besides, my research compares the fertility patterns in the common lineages with those in the elite lineages and points out the different effects that kin networks exerted on individual fertility outcomes in both common and elite lineages. Given the common extended family structure in imperial China, previous studies have already emphasized that family background and kin networks played an important role in individual demographic and social outcomes (see for example, Wolf and Huang 1980; Lee and Campbell 1997; Campbell and Lee 2003, 2008; Shiue 2019; Jiang and Kung 2020). The present research takes the further step of comparing its role in lineages of different type.

The rest of this chapter is structured as follows. Section 3.2 introduces the historical context of social stratification in imperial China. Section 3.3 and 3.4 outline the genealogical data and the methodology. Section 3.5 presents the status-fertility relationship, and section 3.6 reports the robustness of the results. Section 3.7 concludes.

3.2 Background

3.2.1 Social classification and *keju* in Ming-Qing China

The traditional way of describing the social hierarchy of imperial China is to refer to the occupation structure of the time. Confucian social theory divided the male population into two main classes: the elite class, which was mainly composed of gentry-scholars, and the commoner class, which contained peasants, artisans, and merchants (Brook 1990, p.28). A

Chinese man in the Ming and Qing dynasties would be lucky if he was blue-blooded, but even if he was not, he still had a chance of joining the nobility by passing the *keju* exams.

Keju (Chinese imperial examination system) was one of the most long-standing national civil service examination systems in the world. The system was initiated around 600 A.D. and abolished in 1905. During the Ming-Qing period, the format of the exam changed for several times, but at its centre was always writing essays based on the quotations from the Confucian classics.[38]

The system contained three main levels of exams and three corresponding academic degrees. A pass at the lowest – county or prefectural – level would earn one the degree of *shengyuan*. After qualifying with another exam, a *shengyuan* could then take the provincial-level exam, and if successful would become a *juren*. The *juren* from all over the country would be eligible to travel to the capital city for the national-level exam, in which the outstanding performers would be awarded the *jinshi* degree[39] As Ho (1962, pp. 26-27) puts it, becoming a *jinshi* "automatically placed a person in the middle stratum of the officialdom", and earning the intermediate *juren* degree "entitled a person to an eventual minor official appointment".

Only a small fraction of the many *shengyuan* could pass at the provincial level and the final national level of the exam.[40] A *shengyuan* degree could not substantially change a commoner's life, but the two higher degrees could. Being a *juren* or a *jinshi* brought the degree holder not only a position in the government, but many other kinds of benefits and advantages.[41] Hence, the massive improvement in social status and living standards, together with the inheritable nature of academic degrees and official positions, for centuries created a strong motive for Chinese males to climb the social ladder by attending *keju*.[42]

Keju changed the gentry-scholar class from "men of good birth to men of culture" (Elman 2000, p.14) and transformed China into a meritocracy to a certain degree.[43] Theoretically

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[38] See Elman and Woodside (1994, pp.114-121) for the changing format of the exam during the Ming and Qing dynasties.

[39] See Miyazaki (1981) for a more detailed introduction to the *keju*.

[40] Chen, Kung, and Ma (2020) calculate the passing rates of the exams and find that "at each exam about 1,241 *juren* would be selected out of 20,600 *shengyuan*, and about 220 *jinshi* would be selected out of 1,250 *juren*".

[41] A famous story about Fan Jin, a man who lived during the Ming dynasty, clearly presents the great changes in economic and social status that a *juren* degree could bring to the poor. After receiving the *juren* degree, Fan was immediately offered large houses and lands by local officials and merchants who wished to gain his protection (Ho 1962, pp.42-43).

[42] Although the sons and the grandsons of gentry scholars were more likely to earn the degree of *juren* or *jinshi*, the fact that nearly half the *juren* and *jinshi* holders were from commoner families, which suggests the popularity of taking *keju* exams among commoners (Ho 1962, pp. 114-116). Among the holders of the *shengyuan* degree, we can find a higher proportion of candidates from commoner families.

[43] This meritocracy was unique, since merit was mainly defined as mastery of the Confucian classics, rather than of administrative and management skills (Mokyr 2016, p. 303).

speaking, a commoner from an ordinary family would have as fair a chance of sitting for the exam and entering the state bureaucracy as the son of a gentry-scholar family. Ho (1962, pp. 114-116) finds that in the Ming dynasty, about 47.5 per cent of *jinshi* (the highest *keju* degree) were from commoner families which in the past three generations had no degree holders, and 2.5 per cent of them were from families which had only *shengyuan* but no higher degree holders. These two percentages changed in the Qing dynasty to 19.1 per cent and 18.1 per cent, respectively. In general, Ho's estimates imply high social mobility in the last two imperial dynasties. However, recent studies on social mobility in China also suggest the important role that family background played in determining social outcomes (Campbell and Lee 2003; Shiue 2019; Jiang and Kung 2020). Given the time and financial resources needed for males to take the exams, those who were from scholar-officials' families would be more likely than others to be in the running.

3.2.2 Incentives to reproduction in Ming-Qing China

Mencius, the greatest Confucian philosopher second only to Confucius himself, believed that, "There are three things which are unfilial, and to have no posterity is the greatest of them."[44] His belief has deeply influenced the Chinese for two millennia, and in traditional China ensuring male heirs undoubtedly becomes the priority of the Chinese males. This strong incentive to beget sons has also been documented extensively in the literature.

Tawney (1932, p. 104) in his book on Chinese land and labour, also wrote that "sentiment, hallowed by immemorial tradition, [made] it a duty to have sons." As Waltner (1990, p.2) describes, in traditional China, "[r]eproduction was not seen as a matter of simple biology. Offspring were granted as a reward and withheld as punishment, not only in response to the acts of the individual concerned, but in response to the acts of his ancestors as well." Mallory (1926, pp.88-92) also comments that the pursuit of sons was an intrinsic element of "Chinese habit and doctrine", and also argues that ancestor worship was one of the strongest ways to explain the vigour of the pursuit. Wolf and Huang (1980) observe that even a poor farmer in rural Taiwan in the late nineteenth century "had to consider his duty to his forebears…and had to produce at least two sons."

[44] The original Chinese text of this sentence is, "不孝有三，无后为大". The English translation is quoted from the Chinese Text Project. URL: https://ctext.org/text.pl?node=1696&if=en.

From the lineage perspective, providing sons is not only important ritualistically, but also a pragmatic obligation because it relates to the survival of the lineage. Traditional Chinese society is a typical patrilineal society where lineages were traced only through male family members; thus, a lack of sons in one generation would be viewed as an extinction of the entire bloodline (Almond, Edlund, and Milligan 2013). Since for every lineage, "the continuity and growth of the patriline was the overriding focus of family strategies" (Song et al. 2015), every male family member in the lineage, whether rich or poor, high-social-status or low-social-status, was equal in terms of fulfilling his family duty by providing sons for the lineage.

3.3 Data

3.3.1 The sample: genealogical books of six Chinese lineages

In Shiue's three most recent works (2016, 2017, 2019), she exploits the genealogical data of several lineages in Tongcheng County, Anhui Province, Southeast China. In this chapter, I also focus on Southeast China, but on two neighbouring provinces of Anhui, Zhejiang and Jiangsu.

I transcribe and construct a sample containing detailed individual information about six lineages from 1350 to 1920.[45] A total of 41,407 male mini-biographies appeared in these 96 volumes of genealogical books. Records of all six lineages start before 1400. Since this chapter is concerned with the Ming and Qing dynasties, I exclude from the sample males born before 1350 and after 1920. Besides, as the time of the last compiling of the Huang, Gu, and Zhuang genealogies took place before 1900, I also eliminate males from the last few generations in the three lineages whose fertility records are incomplete. My criterion is also whether or not the compilers recorded a mini-biography as an incomplete one. If the compilers were unable to record accurate details, especially information on the number of sons, they would mark a mini-biographies with the phrase "failed to trace the information" (*shixiu*, *失修* or *shikao*, *失考*). After this process of elimination, the sample contains information on 36,456 males in total.

Of the 36,456 males, 23,098 had explicit birth date records. With these records, I can impute an approximate birth cohort for the relatives of these males who had no birth year recorded. Finally, I manage to classify 31,197 males into twelve birth cohorts, starting with a "pre-1400" cohort, ending with a "post-1900" cohort, and with ten 50-year-long cohorts in between.

[45] See Section 1.4 in Chapter 1 for a detailed introduction to the six lineages and the region.

3.3.2 Status records in the genealogical books

Social status in imperial China was primarily determined not by the usual determinants of a man's status in European societies, such as inherited wealth and landed estates, but by academic degrees earned through *keju* exams (Ho 1962, p.40).

Detailed *keju* results in the genealogy of every lineage make comparisons between lineages possible.[46] Table 3.1 lists a detailed classification of the social levels cited in this chapter.

Based on the hierarchy of *keju* and also the bureaucratic system, the classification includes three broad classes and seven social ranks. Both the non-gentry and the near-gentry classes include males without an academic degree, but the near-gentry males, at least, had other non-*keju* status indicators. The gentry group includes all the degree holders and males who managed to attain official positions. Ranks 3 and 4 represent all the lower degree holders who failed to obtain office after earning the degree. They are the lower-class in the gentry group. A male from rank 5 could be a lowest-ranking employee in the bureaucratic system, a prospective official who was in the waiting list for an official position, or a middle-class gentry-scholar who failed to obtain office. Ranks 6 and 7 denote the upper-class gentry-scholars. In the present chapter, males in the near-gentry and the gentry groups (ranks 2-7) are considered "Confucians".[47]

[46] One of the concerns regarding the status records in the genealogies is that the compilers might incline to exaggerate the status records of their family members. Thanks to the generous help from the Lee-Campbell research group (Ren et al. 2016; Campbell et al. 2019), I manage to match thirty-one officials from the Zha genealogies to *Jin Shen Lu* (the Qing China Government Employee Records, *缙绅录*). I find their records of official positions in the two types of sources are the same, proving that the status records in the genealogies are reliable. I also thank the institutions, including HKUST, that provided them with the funding, HK RGC GRF 16601718: Family Background Influences on the Appointment and Career Mobility of Qing Officials with Examination Degrees. PI. 2018-2021, which made the database could be accessible to the public.

[47] Esherick and Rankin (1990, p.2) point out that the Chinese gentry class embodied the Confucian culture. The word "Confucian" in this chapter refers to the literate men who were deeply influenced by Confucian ideology and who acquired either rudimentary or comprehensive knowledge of the Confucian classics. In traditional China, the first book that every child would ever read is the *Three Character Classic* (*三字经*), and it is a book which expresses and teaches Confucian morals and ethics. "Confucian" here bears no religious meaning. After all, Confucianism has never been a "religion" in the Chinese context.

Table 3.1 Classification of social ranks

Rank	Description	Count	Per cent
Non-gentry			
1	No status	34,555	94.79%
1	Honoured by later generations with poems or discourses		
Near-gentry			
2	Literate and educated but without a degree (teacher in the village school or editor of genealogical books)	233	0.64%
2	Lineage chief; donor to the lineage and the county		
2	Given an award by the emperor for having Confucian virtues		
Gentry			
3	Lower degree holder (Normal *shengyuan*)	387	1.06%
4	Students at the Imperial Academy (*taixuesheng*, *guoxuesheng*); civil *shengyuan* (*lingsheng*, *zengsheng*, *jiansheng*)	623	1.71%
5	Clerks (*wei'ruliu*); prospective officials (*houbu*)	245	0.67%
5	Intermediate degree holders (*juren*, *gongsheng*), without official position		
6	Low-ranking civil official (bureaucratic strata 8 and 9), with lower degree	333	0.91%
6	Intermediate degree holder, with an official position; medium-ranking local official (bureaucratic strata 4 to 7); low-ranking court official		
7	Higher degree holder (*jinshi*); high-ranking local official (bureaucratic strata 1 to 3); medium-ranking court official	80	0.22%
7	High-ranking court official; *jinshi* with an official position		
7	Top-level post in the state bureaucracy		

Sources: Ho 1962, Chapter 1; Telford 1995, p.92, Appendix 3A; Shiue 2017, p. 364, Table 1.
Notes: There were nine main ranks in the bureaucracy of Ming and Qing China, the lowest being the ninth and the highest the first. Ho (1962, pp.24-46) divides the nine ranks into three strata. The highest stratum included officials of the first, second, and third ranks; the middle stratum consisted of all the officials from the fourth rank to the seventh rank; and the lowest stratum were officials of the eighth and ninth ranks.

3.4 Methodology

Here I describe the empirical methods. Given that the outcome of interest is an over-dispersed count variable (mean = 1.13, variance = 1.85), I mainly used the negative binomial regression based on:

$$S_i = \alpha + \rho Rank_i + \gamma Marriage_i + W_i\beta + \varepsilon_i, \qquad (1)$$

where *S* is the recorded number of sons that a male produced, *i* denotes male individuals who survived to adulthood, α is the constant, and *Rank* is a set of categorical variables ranging from 1 to 7 that measure the males' social ranks as expressed in Table 3.1. *Marriage* is the total number of marriages the male had, including both marriages in sequence (wives non-concurrently) and concurrent marriages (wives and concubines at the same time). *W* denotes the independent variables that would be successively controlled for, including the male's human capital, whether he was the first son or the only son in his family, whether he migrated out of his village, whether he reached adulthood, the number of brothers he had, the social ranks of his father and brother/cousin, his birth cohort, and the lineage that he belonged to. β represents the set of respective coefficients for these variables. ε is the error term.

Table 3.A1 in Appendix 3.A presents the summary statistics of the variables. Figure 3.1 shows the distribution of observations of each social rank in the six lineages and the distribution of observations of each social rank over time.

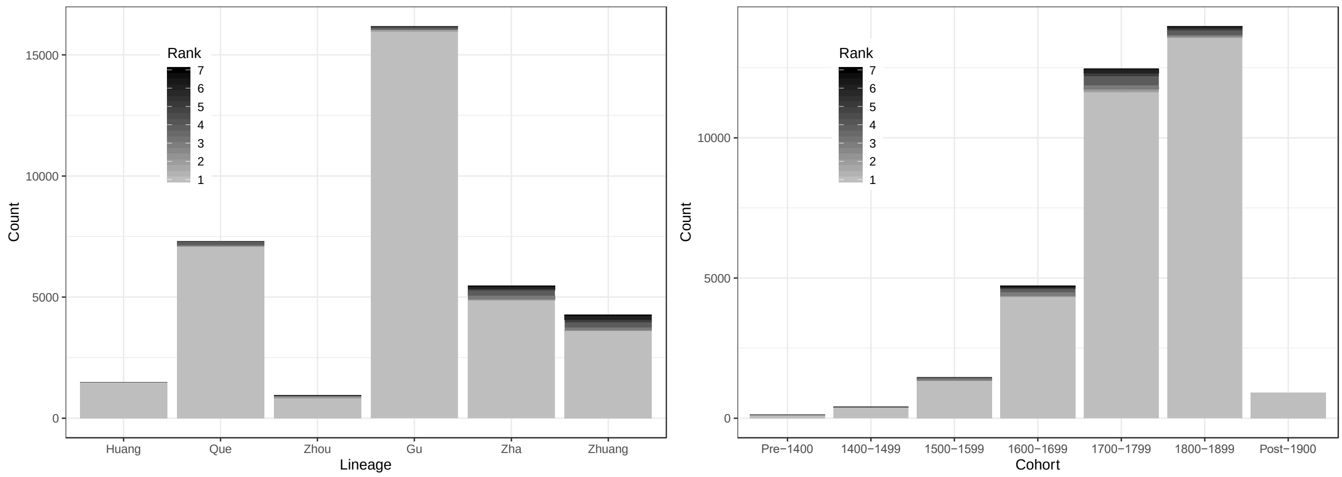

Figure 3.1 Rank distribution by lineage and century

Source: The lineage sample.

3.4.1 Description of variables

Number of sons. This is the dependent variable in the model. To measure net reproduction, I used the recorded number of sons per male, which equals the number of sons who survived infancy.

The two main reasons for this choice are as follows. On the one hand, all daughters, and sons who died in infancy are under-recorded in genealogical books. On the other, Clark and Cummins (2015b) employ this kind of male-relative fertility measure to examine fertility in England by using probate records. Though it differs from the conventional female-relative fertility measures, as they acknowledge, "there is no conceptual reason not to treat this measure of fertility as a valid measure of long-run fertility changes" (Clark and Cummins 2015b).

Social ranks. Social status is the key variable in the model. The classification of social ranks is presented in Table 3.1.

Number of marriages. The marriage system in imperial China was a system between monogamy and polygamy where men were officially allowed to have only one wife at a time but multiple concubines at the same time. Whilst concubines were inferior to wives in status, their children were considered legitimate and therefore were recorded in the genealogies. Still, the data suggests that having concubines was more of an upper-class privilege than universal practice. In my lineage sample, 3,049 males (8.36%) married more than once, and only 509 of them had concubines (where the wives of the remaining 2,540 men were the result of consecutive marriages).[48]

The number of marriages is treated as a continuous predictor because the main incentive for Chinese men to marry again was to produce more sons. Hence, every one-unit change in the number of marriages should bring the same amount of change in the number of sons. However, as a robustness check, I also show the results of treating the number of marriages as an ordinal variable in Section 3.6.4.

Zi and *Hao*. I use the two dummies to measure human capital, which cannot be fully captured by the *keju*-related social ranks. *Zi* (courtesy name, 字) and *hao* (pen name, 号) are two types of particular name that show respect and a higher level of literacy; they were used widely among literate people in traditional China. Males were given *zi* by their fathers or their teachers when they turned twenty *sui*, which is approximately equivalent to nineteen years old.

[48] This proportion of remarriage is comparable to the findings from previous genealogical studies. Liu (1995, p. 105) reports the proportion of remarried men in her sample which ranged from 8.4% to 26.1%. In Telford (1992, p.27, Table 2), 580 (6.99%) of the sample had more than one wife.

Hao was the pen name that a highly educated male would give himself and always use when he was writing in either prose or poetry.

Father effects and brother/cousin effects. I condition on the social ranks of the male's kin group to identify the effects of his attained social rank on fertility. I test three types of kin relationship, namely, father, brother, and first cousin-brother. In terms of the father effects, I include in the model the number of brothers that a male had and his father's social rank. Regarding the brother/cousin effects, I control for the highest social rank achieved among his brothers' and cousins' social ranks. In addition, I include a dummy *Brother Dummy* to indicate whether the highest social status was achieved by his brother or his cousin in order to distinguish the brother effects from the cousin effects.[49]

First-born. Following traditional Chinese practice, a first-born son is usually expected to take greater responsibility than his younger brothers in family events and maintaining the patriline. I use the dummy to indicate whether the male was the first-born (or the only) son in his family of origin.[50]

Out-migration. *Out-migration* is a dummy used to control for a possible omission of information because the individual concerned was away from home. It equals one if the individual was out of the village and never came back, or if he was removed from the lineage due to disobedience to family rules. In these cases, genealogy compilers were unable to acquire updated information, which caused an inevitable gap between the actual number of sons and the recorded number of sons.

Survival to adulthood. Lifespan affects fertility. Since less than one-third of the males in the genealogies had a complete set of vital statistics, the lifespan of most of the sample cannot be conjectured. However, males who failed to survive to adulthood (nineteen-year old) are specially marked in their mini-biographies; 3,218 males were thus marked. I condition on *Survival to adulthood* by either excluding these males or including the variable in the model to control for the strong negative impact of a short lifespan on fertility.

Birth cohort. I control for the time fixed effects on net reproduction and social ranks by including a set of birth cohorts in the model. I group the males into twelve half-century-long birth cohorts as discussed in Section 3.3.1.

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[49] I consider only the male's first male cousins, the male cousins who had the same grandfather as the male of interest.

[50] Such "demographic privilege" enjoyed by the first-born has been demonstrated before in China (Lee and Campbell 1997; Li and Zhen 2015).

Lineage. Because of the varying amounts of resources that common lineages and elite lineages could access, along with some other family-related biological and cultural characteristics, lineage fixed effects are also included.

3.4.2 Selection biases

The foremost concern in using genealogical records is with the quality of the data. The continuing editing and compiling of genealogies ensure their reliability. Every lineage formulates clear rules for compiling genealogies; one common rule is that family members should compile the genealogy every sixty years (or every three to five generations). The interval between two large-scale compilations of the six lineages is on average shorter than sixty years. During the interval, family members would record all the changes in the lineage in handwritten *caopu* (draft books, *草谱*). Yet, as Harrell (1995, p.5) reminds us, "…genealogies are compiled for ritual rather than demographic reasons"; hence, the voluntary selection in genealogies could bias the test towards finding spurious fertility gradients.

One inevitable bias is the omission of daughters and children who died in infancy.[51] Many genealogical studies show that the inclusion of individuals in the genealogies was mainly on ritualistic considerations (Harrell 1995; Shiue 2016). In traditional Chinese culture, all men were ritualistically significant, and so were their wives, in that they produced the descendants for the family. Daughters were not significant because once they married they were no longer members of their original family. Children who died in infancy were also insignificant as regards the continuation of the family line. The incomplete records of gross fertility limit this chapter, then, to examining the male descendants who survived infancy, and I use this sons-only net fertility to measure net reproduction. In order to record the patrilineal history, the essential information for inclusion in the genealogical books is the number of sons who survived infancy that each male family member produced, and this would not be affected by the male's social status. Similarly, the number of marriages is also a ritualistically important type of information, and thus would not be omitted in any case.[52]

[51] Only 9,636 daughters were recorded in the sample, compared with 41,145 sons.
[52] In the preface of the Zha genealogies, it states that if a female is betrothed to a male family member, either married or not married, and either divorced or remarried, she should be recorded in the male's entry ("配氏未婚书，聘再娶书，继明正嫡也，或所娶非吾族匹书，娶氏没其姓不正其为配也续非以礼聘书，娶某氏不予其为继也，夫亡弃子他适者书…妾书…").

Although every male, whatever his wealth and status, was qualified in the rituals of ancestor worship, the records may still have been biased towards high-status males, causing the omission of records of low-status males. On the one hand, the representation of different social ranks in the sample suggests that the compilers did not exclude low-status males from the genealogies. According to Chang's estimates (1955, p. 114), before 1850, the percentages of gentry-scholars in total population were about 1.3% in Jiangsu Province and 1.4% in Zhejiang Province; after 1850, the percentages increased to 2.5% and 5.0%, respectively. About 95% of the male population in the sample were commoners, and less than 2% of the males held office during their lifetime. I also compared the proportion of degree holders and civil officials in my sample with the proportion in the Tongcheng sample studied in Shiue (2017, Table 1). Applying the status classification used in this chapter to the Tongcheng sample, 90.53% of the 8,892 males were of rank 1, 1.75% of them were of rank 2, and 7.72% of them were of ranks 3-7. This distribution of different ranks is comparable with the distribution of my lineage sample (see Table 3.1).

On the other hand, systematic under-reporting of the birth and death years of the low-status males is evident. High-social status and more fecund males are more likely to be recorded with their birth and death years than the low-status and heirless males (Table 3.A2).[53] Therefore, the exclusion of males without complete life statistics would strongly bias the results. To overcome this bias, I either include the variable "survival to adulthood" or exclude the males who failed to reach adulthood to control for the effects that a short lifespan had on net fertility. Nevertheless, as a robustness check I also run the model with the control of the accurate lifespan (see Section 3.6.2).

3.4.3 A reverse causality problem

If having more sons can increase a father's social status, there is a risk of reverse causality. Although sons were forbidden to inherit *keju*-related status from fathers, one practice in imperial China was for the Emperor to reward the father of a high-ranking official with an official position or an honorary title to acknowledge the official's outstanding performance.

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[53] To test the selection for recording complete vital statistics in genealogical books, I run a Logistic regression in this form:

$$D_i = \alpha + \rho Rank_i + \gamma Son_i + W_i\beta + \varepsilon_i, \qquad (4)$$

where D is a dummy variable that indicates whether the male had: 1) a record of his birth date; 2) a complete record or his birth and death dates. The other notations are as in Equation (1). The results of the Logistic regression are presented in Table 3.A2.

In the sample, twenty-five males were rewarded with titles of honour because of their sons or grandsons. Eighteen of them received this reward posthumously, and the social ranks and fertility that they attained were unaffected by it. The remaining seven males were rewarded with these honorary positions while they were still alive, but because the genealogies did not record when they received them, I excluded them from the sample to deal with the endogeneity problem.

3.5 Results

3.5.1 Baseline results

I first report the descriptive evidence on the relationship between social status and fertility. As shown in Figures 3.2 and 3.3, 44.11% of all the males (39.13% of the males who reached adulthood) failed to produce any son, and most of these heirless men were from the rank 1 group.[54] The average number of sons for men of rank 1, men of ranks 2-6 and men of rank 7 are about one, two, and three, respectively.

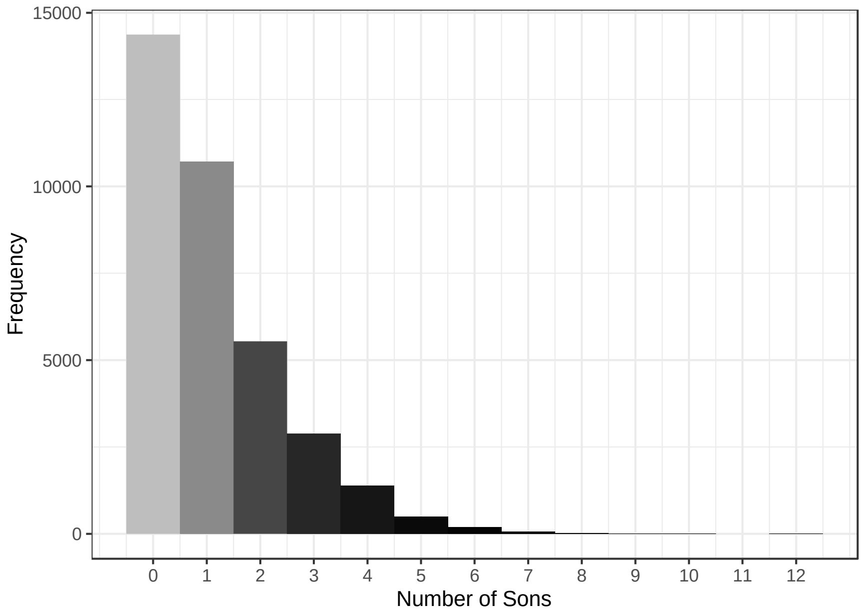

Figure 3.2 Distribution of the recorded number of sons, all males

Source: The lineage sample.

[54] Many of these men could have had un-recorded daughters, so the proportion of childless men would have been much lower than 44.11%.

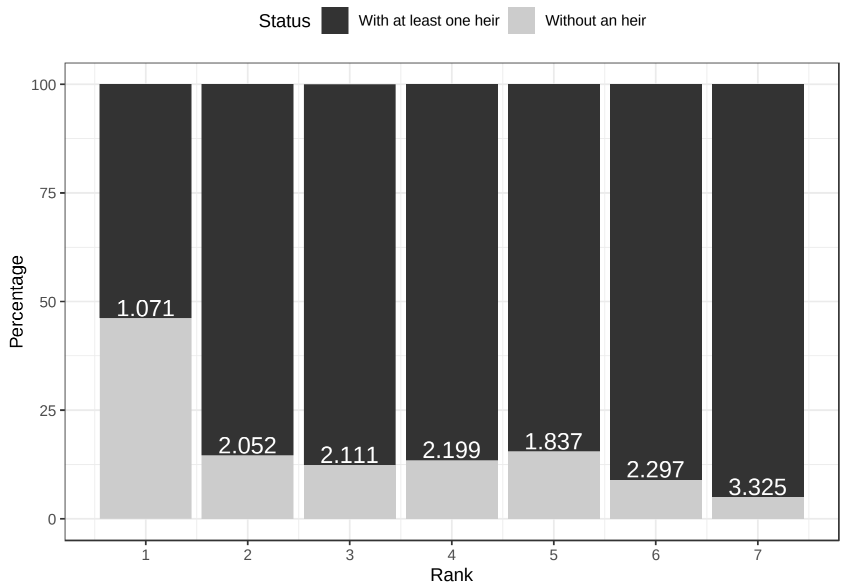

Figure 3.3 Proportion of the heirless by rank

Note: The value in each bar shows the mean number of sons by rank.
Source: The lineage sample.

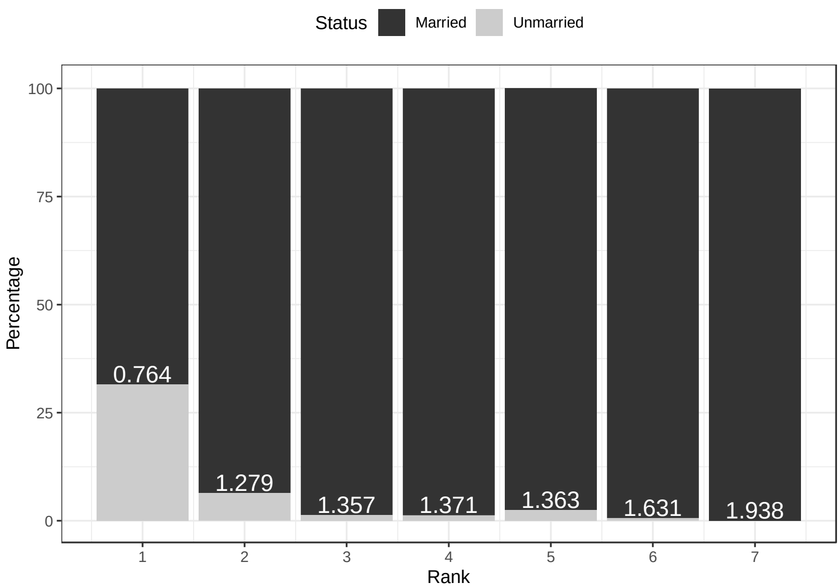

Figure 3.4 Proportion of the unmarried by rank

Note: The value in each bar shows the mean number of marriages by rank.
Source: The lineage sample.

As Figure 3.4 shows, the high proportion of men without heirs is primarily due to bachelorhood. 29.98% of the males in the sample remained single all their lives, and 23.78% of the males who reached adulthood remained single; most of them were also non-degree holders.[55] For males of the near-gentry and gentry classes, the average number of marriages is greater than one, and all the rank 7 males succeeded in marrying at least once.[56] Of the 25,125 married males, 5,261 (20.61%) produced no sons.[57]

To rigorously show the social gradients in fertility, I report the results of Equation (1) in Table 3.2 under the OLS regression (columns 1 to 3) and the negative binomial regression (columns 4 to 6). Figure 3.5 plots the unconditional rank effects by showing the predicted number of sons by social rank calculated by the negative binomial results of the males who survived to adulthood and the married males in columns 5 and 6.

The results of the two models are closely comparable. All the "rank" coefficients are statistically and quantitatively significant, and the rank effects are mainly linear, as also displayed in Figure 3.5, with only relatively lower rank 5 coefficients. Moreover, given that only 1 per cent of the ranks 2-7 males failed to survive to adulthood and 98.1 per cent of them were married, the predicted results for them shown in the two plots in Figure 3.5 are basically the same.

In general, higher social ranks did translate into more recorded sons. The OLS coefficients in columns 2 and 3 suggest that the predicted number of sons of a rank 1 male who survived to adulthood was 1.18, and that of a married rank 1 man was 1.56. Men of ranks 2-6 could be expected to have about two sons. Rank 7 had the largest positive effect, and a rank 7 male was expected to have about three sons.

The reason for the lower rank 5 coefficients in all models lies in the fact that all the rank 5 males were in a difficult situation. Of the 245 males in rank 5, 139 of them were prospective officials, who were waiting for vacancies in the positions for which they were hired; 92 of them were the lowest-ranking employees in the bureaucratic system; the last 14 of them were median degree holders who failed to get an official position. Although the social status of rank 5 males was higher than that of males in ranks 3 and 4, they were tied to the bureaucratic system and had no any additional monetary benefits for their status. In contrast, for the males of ranks 3

[55] This proportion of the unmarried is also comparable with those reported in other genealogical research. Telford (1995, pp.76-77, Table 3.5) notes the proportions of the unmarried in 41 lineages in Tongcheng in 1520-1661, which ranged from 8.09% to 38.06%, with an average of 22.10%.

[56] Chinese genealogical books record only legitimate births, but illegitimate births (out-of-wedlock births) were rare in China. Lee and Wang (1999a, p. 88, p.161, and p. 188) mention that in the historical population of China the share of illegitimate births was nearly zero. Bastardy existed, as shown in Sommer (2015), but only among extremely poor people.

[57] The percentage of married males without heirs shown in Telford (1995, pp.76-77, Tables 3.2 and 3.5) and in Liu (1995, pp.102-105, Table 4.3) are both around 20%.

and 4, having received a low-level degree, often chose not to waste more time on the highly competitive *keju* exams and made a career shift out of government service. [58]

Table 3.2 Unconditional Status-Fertility Relationship

	Dependent Variable:					
	Number of Sons					
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS			Negative Binomial		
	All males	Adults	Married	All males	Adults	Married
Rank 2	0.981***	0.927***	0.629***	1.916***	1.787***	1.402***
	(0.091)	(0.091)	(0.090)	[0.650]	[0.580]	[0.338]
				(0.045)	(0.043)	(0.041)
Rank 3	1.040***	0.960***	0.575***	1.972***	1.815***	1.368***
	(0.079)	(0.079)	(0.079)	[0.679]	[0.596]	[0.313]
				(0.038)	(0.037)	(0.037)
Rank 4	1.128***	1.037***	0.664***	2.054***	1.880***	1.425***
	(0.067)	(0.067)	(0.067)	[0.720]	[0.631]	[0.354]
				(0.031)	(0.031)	(0.030)
Rank 5	0.766***	0.666***	0.319***	1.715***	1.565***	1.204***
	(0.089)	(0.089)	(0.090)	[0.540]	[0.448]	[0.186]
				(0.049)	(0.049)	(0.048)
Rank 6	1.227***	1.130***	0.748***	2.146***	1.958***	1.478***
	(0.093)	(0.093)	(0.093)	[0.763]	[0.672]	[0.391]
				(0.041)	(0.041)	(0.040)
Rank 7	2.254***	2.146***	1.761***	3.105***	2.821***	2.127***
	(0.256)	(0.256)	(0.256)	[1.133]	[1.037]	[0.755]
				(0.077)	(0.077)	(0.077)
Constant	1.071***	1.179***	1.564***	1.073***	1.179***	1.564***
	(0.007)	(0.008)	(0.009)	[0.068]	[0.164]	[0.447]
				(0.007)	(0.077)	(0.006)
N	36,456	33,238	25,526	36,456	33,238	25,526
R^2/Pseudo R^2	0.035	0.032	0.019	0.008	0.008	0.005

Notes: 1. Rank 1 is the reference group. 2. Robust standard errors are in parentheses 3. Coefficients in columns 4 to 6 are incidence rate ratios (IRR) for the negative binomial model. The original coefficients are shown in square brackets. 4. *p<0.1; **p<0.05; ***p<0.01.

[58] Brook (1990, p.31) mentions several examples of lower degree holders, such as *gongsheng* and *shengyuan*, who turned into merchants for their living in Ningbo, Zhejiang Province, in the Qing dynasty.

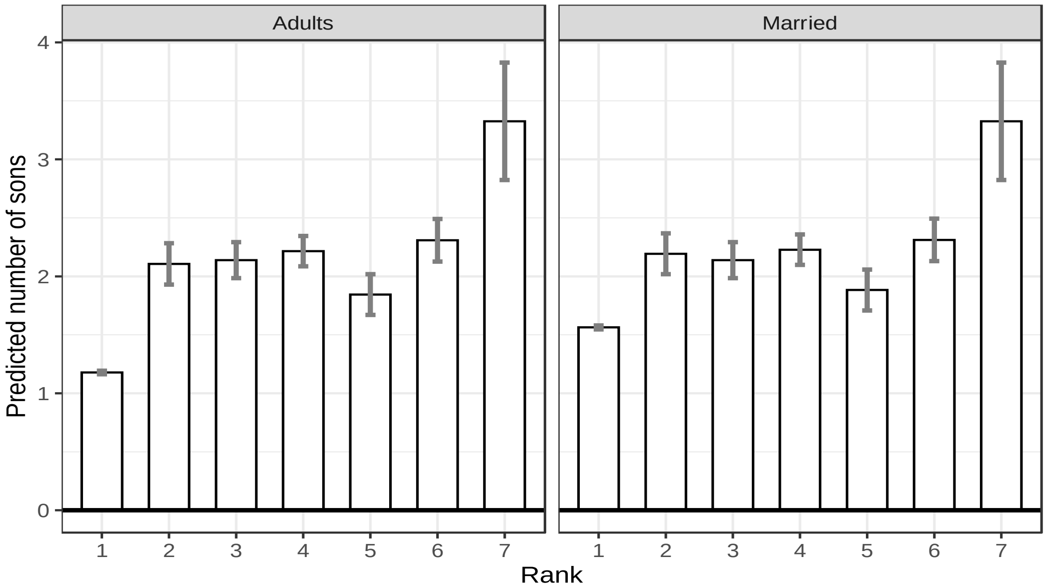

Figure 3.5 Unconditional status-fertility relationship, males who survived to adulthood and married males

Notes: 1. Values are the average adjusted predictions, the expected number of sons at each level of rank calculated by the negative binomial regression in columns 5 and 6 of Table 3.2. 2. Error bars indicate 95% confidence intervals.

3.5.2 Status-fertility relationships conditioned on socioeconomic factors

To further examine the status-fertility relationship, I include in the analysis the set of socioeconomic covariates that could also affect net reproduction. In this section and also in the following analyses on fertility, I exclude all the males who died before adulthood and focus only on the males who survived to adulthood.

Table 3.3 details the status-fertility relationships conditioned on the set of control variables. As columns 1 and 4 show, if conditioned on birth cohort and lineage fixed effects, whether a male was first-born, and whether he out-migrated, the relationships are all similar to the unconditional relationship shown in Table 3.2.

Controlling for human capital and marriages noticeably reduces the effects of *Rank*. When controlling for *zi* and *hao* in columns 3 and 6, all the rank gradients decline, but they remain statistically significant, and the scale of the decline is modest. A rank 7 male could still have been expected to have about twice as many sons as a rank 1 male had.

Comparing the results in column 6 and column 7 clearly illustrates that the number of marriages is the key mechanism through which social status could increase the number of sons. The two plots in Figure 3.6 provide a stark contrast between the two sets of rank effects. Before including the number of marriages (column 6), the rank coefficients are all significant and large.

Ranks higher than 1 were expected to increase the number of one's sons by about 35 per cent to 87 per cent.[59] After including the number of marriages, only ranks 2 and 4 still hold statistical significance and positive effects on the number of sons, yet these ranks would have increased the expected number of sons by only about 18 per cent and 12 per cent, respectively (column 7). The overly wide confidence intervals of the coefficients on ranks 5-7 prevent me from identifying any appreciable effects of rank. The dramatic decline of the effects of *Rank* shows that the men in ranks 5-7 also had more surviving sons than the non-gentry men had, but they did so primarily by having more marriages.[60]

In column 8, I restrict the sample to married men who reached adulthood. Compared to the results in column 7, the number of marriages is still a strong factor in increasing net fertility, but social status also contributes a great deal. Men of a social rank higher than 1 were more likely to have more sons than rank 1 men did (about 20 per cent more for ranks 2 and 4, about 10 per cent more for ranks 3 and 5, 27 per cent more for rank 6, and 54 per cent more for rank 7).

This pattern is unclear in column 7 because the substantial difference in the likelihood of getting married between rank 1 men and ranks 2-7 men makes *Marriages* a much stronger variable than *Rank*. When focusing on married men only, it is clear that, with higher socio-economic status, the men from ranks 2 to 7 could leave more surviving sons per marriage than the rank 1 men, a pattern also suggested by Clark and Hamilton (2006) for the pre-modern English society. Moreover, the coefficient on *Marriages* decreases in size in column 8, but still remains a strong factor that determines the number of sons.

[59] If the findings are driven by the fact that the number of commoners' sons was under-recorded, the positive feedback between social status and number of sons would not change after controlling for marriages, since the number of sons per wife among commoners should still be lower than in their high-status counterparts. The similar net fertility at each level of rank shown in the left plot of Figure 3.6 confirms that the findings are robust to this potential bias.

[60] According to Arthi and Fenske (2018), polygamy in Nigeria increased child mortality. I use my sample to test the relationship between the number of father's marriages and the son's chance of dying before adulthood, and find no positive relationship.

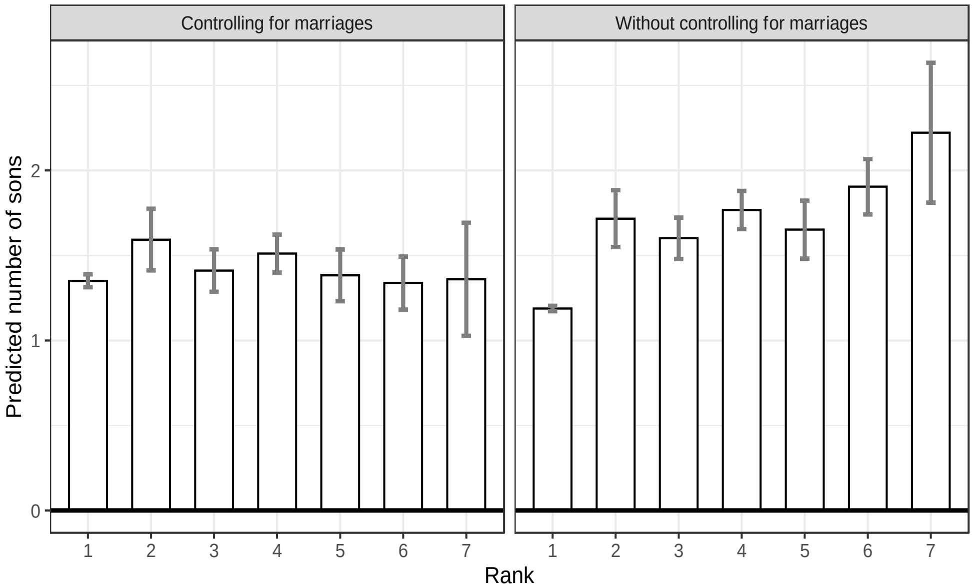

Figure 3.6 Rank effects before and after controlling for the number of marriages.

Notes: 1. Values are the average adjusted predictions, predicted number of sons of males who survived to adulthood at each level of rank, of the models shown in column 6 and column 7 of Table 3.3. 2. Error bars indicate 95% confidence intervals.

Table 3.3 Estimating the recorded number of sons of males who survived to adulthood, negative binomial regression

	Dependent Variable: Number of sons							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
								Married males
Rank 2	1.765***	1.319***	1.443***	1.766***	1.321***	1.445***	1.179***	1.240***
	(0.086)	(0.077)	(0.073)	(0.086)	(0.077)	(0.073)	(0.069)	(0.055)
Rank 3	1.722***	1.198***	1.354***	1.712***	1.194***	1.347***	1.045	1.126***
	(0.068)	(0.055)	(0.054)	(0.067)	(0.055)	(0.053)	(0.048)	(0.041)
Rank 4	1.880***	1.272***	1.488***	1.877***	1.272***	1.487***	1.118***	1.185***
	(0.060)	(0.048)	(0.050)	(0.060)	(0.048)	(0.050)	(0.043)	(0.036)
Rank 5	1.771***	1.165***	1.397***	1.762***	1.163***	1.390***	1.024	1.102**
	(0.093)	(0.066)	(0.074)	(0.092)	(0.066)	(0.074)	(0.058)	(0.053)
Rank 6	2.104***	1.143**	1.605***	2.099***	1.143**	1.602***	0.990	1.272***
	(0.088)	(0.068)	(0.071)	(0.088)	(0.068)	(0.071)	(0.059)	(0.052)
Rank 7	2.610***	1.208	1.881***	2.596***	1.206	1.870***	1.007	1.535***
	(0.232)	(0.149)	(0.179)	(0.230)	(0.148)	(0.177)	(0.125)	(0.118)
Marriages		2.291***			2.284***		2.207***	1.133***
		(0.035)			(0.035)		(0.034)	(0.013)
Zi			1.429***			1.426***	1.260***	1.126***
			(0.022)			(0.022)	(0.020)	(0.016)
Hao			1.350***			1.352***	1.196***	1.211***
			(0.031)			(0.031)	(0.030)	(0.025)
Firstborn				1.032***	1.021	1.040***	1.026**	0.994
				(0.013)	(0.013)	(0.013)	(0.013)	(0.011)
Out-migration				0.369***	0.504***	0.398***	0.516***	0.839
				(0.065)	(0.081)	(0.067)	(0.082)	(0.101)
Controls								
Birth cohort FE	Y	Y	Y	Y	Y	Y	Y	Y
Lineage FE	Y	Y	Y	Y	Y	Y	Y	Y
Constant	1.429***	0.663***	1.176**	1.411***	0.659***	1.159***	0.596***	1.554***
	(0.100)	(0.053)	(0.080)	(0.100)	(0.053)	(0.080)	(0.047)	(0.098)
N	28,181	28,181	28,181	28,181	28,181	28,181	28,181	21,235
Pseudo R^2	0.035	0.102	0.044	0.036	0.102	0.045	0.106	0.043

Notes: 1. Rank 1 is the reference group. 2. Only males who survived to adulthood are included. 3. The coefficients in the table are IRR. 4. Robust standard errors are in parentheses. 5. *p<0.1; **p<0.05; ***p<0.01.

3.5.3 Effects of kin network on individual fertility outcome

I then account for the effects of extended families and kin networks on an individual's fertility outcome by controlling for fathers' effects, brothers' effects and cousins' effects. Table 3.4 reports the results, and standard errors are clustered by household (defined by father).

As shown in columns 1 to 2, before controlling for the individual's own socio-economic characteristics, having a father or a brother who had a social rank higher than 1 would significantly increase the male's fertility outcome. In column 3, I include the cousins' effects. The coefficients are much the same as those in column 2, and although the *Brother Dummy* is not statistically significant, it is very close to 1. These findings imply that having either a brother or a cousin of high social rank had similar positive effects on the number of sons that a male could have.

In columns 4 to 6, I control for the fathers' effects and brothers'/cousins' effects together with the individual's own characteristics. After controlling for the individual's own characteristics, the coefficients on fathers' and brothers'/cousins' social ranks changed fundamentally. Unexpectedly, the results in columns 4 to 6 show that the coefficients on father's ranks 5 to 7 are all smaller than 1, which suggests that if a male's father were an office holder, he would be more likely to have fewer sons than a male whose father was a commoner. However, if his father was a lower degree holder (rank 3), he would have 10 per cent more sons than a male whose father was of rank 1 would have (columns 5 and 6). The coefficients on brothers'/cousins' ranks also decline greatly, and only ranks 3 and 4 still retain the statistical significance. In general, as demonstrated by the prior literature (see, for example, Lee and Campbell 2003; Jiang and Kung 2020), although the social outcomes of the individual's kin group were also positively correlated with the individual's social outcome in the six lineages (see Table 3.A3 in Appendix 3.A), their relationships with individuals' fertility outcomes were intricate.

Table 3.4 Effects of kin networks on fertility, negative binomial regression

	Dependent Variable: Number of Sons					
	(1)	(2)	(3)	(4)	(5)	(6)
	Father	Brother	Brother and Cousin	Kin networks		
						Married
NBrothers	1.029***	1.017**		1.020***	1.011*	1.002
	(0.006)	(0.008)		(0.007)	(0.006)	(0.005)
Father's rank						
Rank 2	1.421***			1.218***	1.055	1.063
	(0.083)			(0.073)	(0.063)	(0.050)
Rank 3	1.439***			1.175**	1.097**	1.101**
	(0.073)			(0.060)	(0.050)	(0.042)
Rank 4	1.493***			1.177***	1.055	1.023
	(0.054)			(0.046)	(0.040)	(0.032)
Rank 5	1.258***			0.939	0.863*	0.894*
	(0.083)			(0.068)	(0.067)	(0.055)
Rank 6	1.284***			0.875**	0.801***	0.872***
	(0.066)			(0.048)	(0.044)	(0.039)
Rank 7	1.837***			1.078	0.899	1.030
	(0.116)			(0.075)	(0.069)	(0.065)
Brothers'/Cousins' highest rank						
Rank 2		1.433***	1.159***	1.079	0.976	0.949
		(0.094)	(0.061)	(0.056)	(0.047)	(0.038)
Rank 3		1.465***	1.430***	1.271***	1.091*	1.097**
		(0.078)	(0.075)	(0.069)	(0.054)	(0.046)
Rank 4		1.643***	1.663***	1.346***	1.122***	1.077***
		(0.062)	(0.056)	(0.047)	(0.037)	(0.029)
Rank 5		1.344***	1.312***	1.075	0.989	0.942
		(0.094)	(0.070)	(0.057)	(0.052)	(0.041)
Rank 6		1.605***	1.480***	1.112**	1.000	1.016
		(0.081)	(0.063)	(0.053)	(0.048)	(0.040)
Rank 7		1.789***	1.737***	1.093	1.009	1.014
		(0.141)	(0.120)	(0.077)	(0.070)	(0.062)
Brother dummy			1.004	0.992	0.992	0.992
			(0.016)	(0.016)	(0.015)	(0.013)
Individual's rank						
Rank 2				1.679***	1.174**	1.240***
				(0.089)	(0.076)	(0.059)
Rank 3				1.463***	1.016	1.107**
				(0.067)	(0.052)	(0.045)
Rank 4				1.583***	1.077*	1.147***
				(0.060)	(0.052)	(0.040)
Rank 5				1.578***	1.077	1.100*
				(0.096)	(0.072)	(0.061)
Rank 6				1.926***	1.046	1.295***
				(0.103)	(0.074)	(0.064)
Rank 7				2.654***	1.150	1.701***
				(0.270)	(0.161)	(0.152)

Table 3.4 Continued

	(1)	(2)	(3)	(4)	(5)	(6)
	Father	Brother	Brother and Cousin	Kin networks		
						Married
Marriages					2.234***	1.128***
					(0.043)	(0.013)
Zi					1.255***	1.127***
					(0.022)	(0.017)
Hao					1.202***	1.213***
					(0.034)	(0.028)
Controls						
Firstborn	Y	Y	Y	Y	Y	Y
Out-migration	Y	Y	Y	Y	Y	Y
Birth cohort FE	Y	Y	Y	Y	Y	Y
Lineage FE	Y	Y	Y	Y	Y	Y
Constant	1.381***	1.435***	1.532***	1.428***	0.606***	1.639***
	(0.112)	(0.129)	(0.124)	(0.118)	(0.059)	(0.118)
N	28,094	21,653	24,756	24,756	24,756	18,618
Pseudo R^2	0.032	0.032	0.031	0.036	0.105	0.043

Notes: 1. Rank 1 is the reference group. 2. Males included are all males who survived to adulthood. 3. The coefficients in the table are IRR. 4. Robust standard errors are in parentheses, clustered on fathers. 5. *p<0.1; **p<0.05; ***p<0.01.

On the one hand, the coefficients on the individual's rank, human capital, and number of marriages in columns 4 to 6 in Table 3.4 are all similar to those in columns 4, 7, and 8 in Table 3.3, indicating that the previous status-fertility relationships for the adult males and the married males are robust to kin network effects, and the number of marriages is still the main mechanism through which social status affected fertility. [61]

[61] Moreover, I test the impacts of different ranks on individual net fertility within the same household. I use differences in net fertility between brothers to see if the ranks they attained still had an effect on the number of sons, despite family background. I run the following model to test the relationship between the difference in attained social ranks and the difference in net fertility between brothers:

$$Dif\_Sons_p = \alpha + \rho Dif\_Rank_p + \beta_1 \text{FatherRank}_p + \beta_2 \text{BirthCohort}_p + \beta_3 \text{Lineage}_p + \varepsilon_p, \quad (5)$$

where *Dif_Sons* is the variable indicating the difference in the number of sons that two brothers had, and *Dif_Rank* equals the difference in the social ranks of the two brothers. p denotes the pair of brothers. I also control for the father's social rank, the birth cohort of the brothers, and the lineage they came from. Table 3.A4 in Appendix 3.A reports the results. The results indicate that the difference in the net fertility of two brothers came from the difference in their attained social ranks, which supports the results shown here.

3.5.4 Number of marriages as the key mechanism through which social status impacted on fertility

The results from the previous sections identify the number of marriages as a key mechanism through which social rank impacted on net fertility. This section substantiates this status-marriage relationship.

Table 3.5 Distribution of number of marriages by rank

	Rank 1		Ranks 2-7	
	N	%	N	%
Number of total marriages, all males				
0	10,894	31.53	36	1.89
1	21,237	61.46	1,240	65.23
2	2,134	6.17	466	24.51
>2	290	0.84	159	8.36
Total	34,555	100.00	1,901	100.00
Number of remarriages, married males only				
0	21,437	90.60	1,416	75.92
1	2,003	8.47	368	19.73
>1	221	0.93	81	4.34
Total	23,661	100.00	1,865	100.00
Number of concubines, married males only				
0	23,394	98.87	1,623	87.02
1	248	1.05	197	10.56
>1	19	0.08	45	2.42
Total	23,661	100.00	1,865	100.00

Notes: 1. "Remarriage" means marriage after the death of the previous wife. 2. "All males" in the table includes males who died before adulthood. Of the 3,218 males who failed to reach adulthood, 193 were married.

The marriage patterns of different social ranks shown in Table 3.5 demonstrate an unequal Chinese society. Only 8.36% of males in the sample married more than once. In contrast to the English elites in the eighteenth century, who had high rates of celibacy and childlessness (de la Croix et al. 2019), the gentry class in imperial China was very likely to get married. Of the commoners who had more than one wife, most remarried only after their first wife died early or failed to produce male heirs. Many more were incapable of marrying again and died without heirs.[62] Higher-social-class males were less constrained, on average, to have more concubines, even if their first wives had already given birth to sons.

The descriptive results suggest two strong correlations: first, between social ranks and marital status, and second, between social ranks and the number of marriages. Therefore, I first run a logistic regression in the form of Equation (2) to identify the effects of social ranks on the likelihood that a male could get married at least once in his lifetime. Then, as the number of marriages is also a count variable (mean = 0.80, variance = 0.40), I run a Poisson regression in the form of Equation (3):

$$Married_i = \alpha + \rho Rank_i + W_i\beta + \varepsilon_i, \qquad (2)$$

$$Marriage_i = \alpha + \rho Rank_i + W_i\beta + \varepsilon_i, \qquad (3)$$

in which *Married* is a dummy that indicates whether the male was once married or not, and *Marriage* indicates the total number of marriages, and the other notations are as in Estimation Equation (1).

The estimation results are shown in Table 3.6. Columns 1-3 report the logistic estimates, and columns 4-6 report the Poisson estimates. Columns 2 and 3, and columns 5 and 6 demonstrate the different effects of social ranks in the two types of lineage, and the effects are also demonstrated in Figures 3.7 and 3.8. There are three noteworthy findings. First, a male would be more likely to be married and have more marriages if he achieved a social rank higher than 1, and his social status mattered more than all the other factors. Second, belonging to an elite lineage brought a higher probability of being married and more marriages to men of all social ranks than belonging to a common lineage did. Third, kin networks exerted a more powerful effect in common lineages than in elite lineages.

In general, all the coefficients on individuals' ranks in both models in Table 3.6 are strong and positive. The coefficients on ranks in column 1 confirm the implication carried in Section 3.5.2 that achieving higher social status would substantially increase an individual's odds of being married versus being single. The strong effect is especially evident for ranks 6 and 7. The results in column 4 suggest that rank 2 males could have an average 30 per cent more

[62] As Lee and Wang (1999a, p. 64) remark, "The shortage of women, exacerbated by the practice of polygyny and the discouragement of female remarriage, prevented a significant proportion of Chinese males in the past…from ever marrying." This may largely account for the universality of adoption in pre-modern China mentioned in Lee and Wang (1999a, Chapter 7). Many males with no heir could not afford to marry again, so they would have chosen to adopt a brother's son to continue their own family lines.

marriages than rank 1 males had, and rank 7 males could be expected to have nearly twice as many marriages as rank 1 males had. The social gradients decrease only slightly after I include the kin group effects.

In the common lineages, higher social rank did not necessarily translate into a higher probability of getting married and a greater number of marriages. Being in the ranks 4 to 7 in the common lineages would carry a high probability of being married, but had a minimal effect on the number of marriages; males in ranks 2 married more times than males in other ranks did. Of the twenty-six males of ranks 6-7 in the common lineages, six married twice, and the others had only one marriage in all. Although the small sample size of the top-ranking males is not representative enough to justify a strong conclusion, the result suggests that, for the degree holders and office holders in the common lineages, having more marriages was not their primary strategy to achieve reproductive success.

In contrast, the status-marriage relationship in the elite lineages is mainly linear. Although rank 3 men could enjoy a greater probability of being married than the men of ranks 4 and 5, averagely speaking, ranks 4 and 5 men were able to marry more times than men of rank 3 (Figures 3.7 and 3.8). Rank 6 men could have 0.5 more marriages than rank 1 men, and rank 7 men could have 0.7 more marriages, on average.

Not only did the individual's own social rank have different effects in the common and the elite lineages; the effects of kin group were also different. In the three common lineages, a man with a rank 4 father would have a significantly increased probability of marrying; having either a rank 2 or a rank 4 father could increase the number of marriages he could have, but only slightly. Having a brother or a cousin of higher rank than 1 was more beneficial: it would increase the individual's odds of being married by a factor of 1.8 to 2.6, and the number of his marriages by about twenty per cent. In the three elite lineages, nearly all the coefficients on fathers' social ranks in the two models are not significant. Moreover, having a rank 6 father would even decrease the probability that a man would get married. In terms of the brothers'/cousins' effects, the men who had brothers or cousins of rank 4 were more likely to get married than men who only had brothers or cousins of rank 1. Having a brother or a cousin with a lower degree would increase the number of a man's marriages by about fifteen per cent, and if the brother or the cousin was an office holder, it would increase the number by ten per cent.

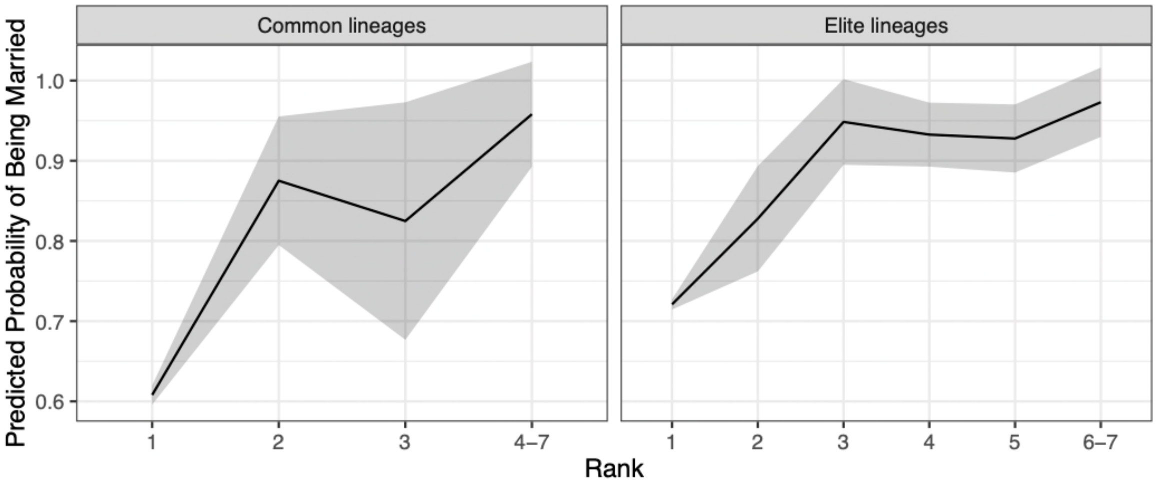

Figure 3.7 Predicted probability of getting married, Estimation Equation (2), by lineage type

Notes: 1. Values are the average adjusted predictions, the predicted probability of all males at different ranks of the models shown in column 2 (common lineages) and column 3 (elite lineages) of Table 3.6. 2. Shaded areas indicate 95% confidence intervals.

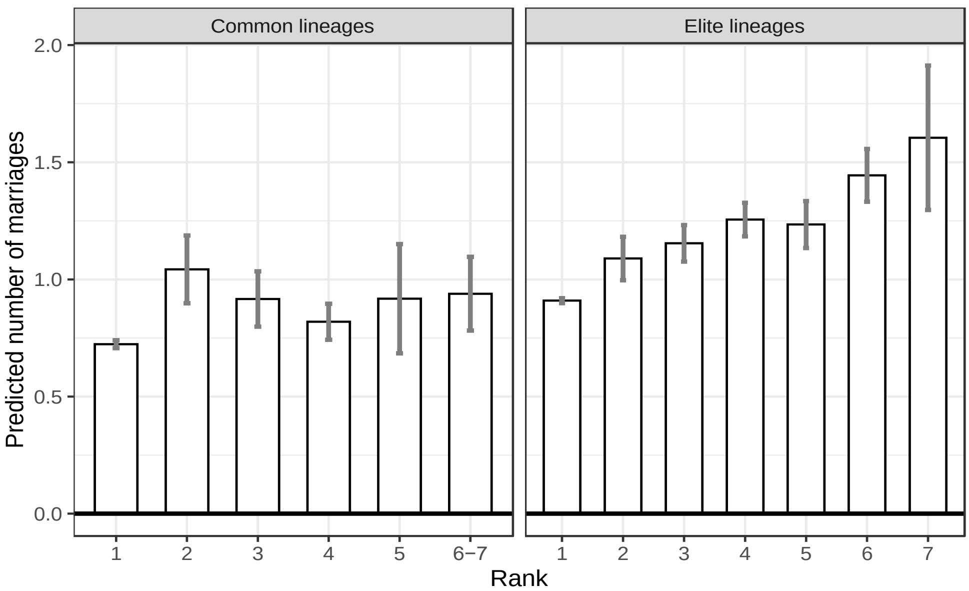

Figure 3.8 Predicted number of marriages, Estimation Equation (3), by lineage type

Notes: 1. Values are the average adjusted predictions, the predicted number of marriages of males who survived to adulthood at each level of rank of the models shown in column 5 (common lineages) and column 6 (elite lineages) of Table 3.6. 2. Error bars indicate 95% confidence intervals.

Table 3.6 Estimating the social gradients in the number of marriages (Logit and Poisson)

	DV=Married (Logit)			DV=Marriage (Poisson)		
	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample	Common lineages	Elite lineages	Full sample	Common lineages	Elite lineages
Individual's rank						
Rank 2	4.696***	6.529***	2.884**	1.286***	1.441***	1.198***
	(1.577)	(3.088)	(1.250)	(0.049)	(0.103)	(0.052)
Rank 3	12.271***	3.964**	32.793***	1.248***	1.267***	1.269***
	(6.633)	(2.592)	(28.514)	(0.039)	(0.084)	(0.045)
Rank 4	20.120***	29.026***	20.681***	1.320***	1.132**	1.380***
	(9.782)	(0.032)	(11.315)	(0.034)	(0.055)	(0.042)
Rank 5	18.642***	.	18.208***	1.336***	1.268*	1.357***
	(10.433)		(10.145)	(0.054)	(0.165)	(0.057)
Rank 6	77.296***	.	85.540***	1.538***	1.297***	1.588***
	(82.835)		(94.964)	(0.060)	(0.111)	(0.065)
Rank 7	.	.	.	1.675***	.	1.764***
				(0.162)		(0.174)
Zi	3.149***	4.462***	2.647***	1.280***	1.521***	1.214***
	(0.166)	(0.462)	(0.167)	(0.015)	(0.045)	(0.015)
Hao	1.965***	3.394***	1.784***	1.142***	1.125***	1.145***
	(0.256)	(1.051)	(0.256)	(0.020)	(0.044)	(0.023)
NBrothers	1.090***	1.104***	1.059**	1.020***	1.035***	1.012***
	(0.020)	(0.028)	(0.025)	(0.004)	(0.009)	(0.004)
Father's rank						
Rank 2	1.320	1.339	1.203	1.046	1.144*	0.997
	(0.294)	(0.379)	(0.402)	(0.041)	(0.089)	(0.041)
Rank 3	1.222	1.166	1.053	1.010	0.994	1.020
	(0.219)	(0.300)	(0.217)	(0.031)	(0.059)	(0.038)
Rank 4	1.508***	1.826***	1.259	1.060**	1.114**	1.014
	(0.207)	(0.417)	(0.200)	(0.027)	(0.061)	(0.029)
Rank 5	0.820	1.205	0.805	0.985	1.074	0.980
	(0.154)	(0.491)	(0.166)	(0.041)	(0.115)	(0.044)
Rank 6	0.550***	0.572	0.625**	0.967	0.912	0.971
	(0.105)	(0.251)	(0.131)	(0.035)	(0.113)	(0.037)
Rank 7	1.038	.	1.188	1.047	.	1.068
	(0.515)		(0.555)	(0.054)		(0.056)
Brothers'/Cousins' highest rank						
Rank 2	1.671***	1.928***	1.408	1.058*	1.171**	1.007
	(0.284)	(0.459)	(0.339)	(0.032)	(0.076)	(0.031)
Rank 3	1.686**	2.565***	1.223	1.154***	1.215**	1.164***
	(0.349)	(0.907)	(0.291)	(0.039)	(0.098)	(0.043)
Rank 4	2.384***	2.630***	1.794***	1.183***	1.234***	1.147***
	(0.343)	(0.496)	(0.343)	(0.026)	(0.050)	(0.030)
Rank 5	1.434**	1.912**	1.223	1.068**	1.194**	1.043
	(0.252)	(0.519)	(0.254)	(0.034)	(0.098)	(0.036)
Rank 6	1.164	1.828*	1.029	1.092***	1.103	1.083**
	(0.187)	(0.655)	(0.181)	(0.031)	(0.072)	(0.034)
Rank 7	2.126*	.	1.922	1.107**	.	1.105**
	(0.823)		(0.766)	(0.049)		(0.051)
Brother dummy	1.006	0.988	1.029	1.003	0.987	1.010
	(0.039)	(0.063)	(0.050)	(0.010)	(0.023)	(0.011)

Table 3.6 Continued

	DV=Married (Logit)			DV=Marriage (Poisson)		
	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample	Common lineages	Elite lineages	Full sample	Common lineages	Elite lineages
Controls						
Firstborn	Y	Y	Y	Y	Y	Y
Out-migration	Y	Y	Y	Y	Y	Y
Survival to adulthood	Y	Y	Y	Y	Y	Y
Birth cohort FE	Y	Y	Y	Y	Y	Y
Lineage FE	Y	Y	Y	Y	Y	Y
Constant	0.028***	0.059***	0.008****	0.055***	0.091***	0.077***
	(0.010)	(0.023)	(0.006)	(0.006)	(0.016)	(0.015)
N	27,187	9,123	18,042	27,187	9,123	18,064
Pseudo R^2	0.278	0.167	0.339			
Log pseudolikelihood				-26576.41	-8803.78	-17697.16

Notes: 1. Rank 1 is the reference group. 2. Coefficients in columns 1-3 are odds ratios, and in columns 4-6 are incidence rate ratios (IRR). Robust standard errors are in parentheses, clustered on fathers. 3. Ranks 6 and 7 are combined in columns 1, 3, and 5 because everyone in rank 7 succeeded in marrying at least once and also because of the limited observations in the three common lineages. Ranks 5, 6, and 7 are combined together with rank 4 in column 2 because all the males of rank higher than 4 in the three common lineages were married. 4. Father's ranks 6-7, and brothers'/cousins' highest ranks 6-7 are combined together also because of the limited observations in columns 2 and 5. 5. *p<0.1; **p<0.05; ***p<0.01.

In Clark and Hamilton (2006), the nature of the probate records makes the role played by marriage unclear in the English case. In the Chinese context, the effects of marriages are clear. The number of marriages does most to explain the reproductive success of the Confucian elites in Ming-Qing China: high-ranking males, especially those from the elite lineages, were wealthier and thus able to marry more women to increase the number of their male descendants. Moreover, the social status that they attained, rather than the social status of their kin, played the determining role in affecting their marriage choices.

Examining 3,119 cases between 1736 and 1896 recorded in the Qing Criminal Archive (*xinke tiben*, *刑科题本*), Chen et al. (2018) find that the average bride price was 19.3 silver taels, and the annual wage for a farm worker in the Qing dynasty was about 3 to 5 silver taels. Zhao (1983, pp. 55-56) estimates that a farm worker in the Yangzi Delta could earn around 2 to 5 silver taels in cash per year, and Pomeranz (2000, p. 95) supports this estimate. According to these estimates, the average farm worker in the Qing dynasty needed at least four years to save enough money to pay for a wife.

If he were a Qing bureaucrat, he could earn much more than five taels a year. For the lowest-ranking civil official, the annual income was about thirty-three silver taels, nearly ten times greater than that of a peasant worker (Chang 1962; see Table 3.7). Middle- and high-ranking local officials could also receive a substantial amount of "yang-lien allowance" (integrity allowance, *养廉银*) every year.[63] The high annual income guaranteed that even a low-ranking officeholder could afford more marriages.

Table 3.7 Annual regulated salary of Qing officials, by official rank

Official rank	Capital officials	Local officials
1	307.8	180
2	256.5	150
3	222.3	130
4	179.5	105
5	136.8	80
6	102.6	60
7	76.9	45
8	68.4	40
9	54.4	33.114

Notes: 1. Official rank 1 is the highest rank and official rank 9 is the lowest. 2. Official ranks 1-7 capital officials and 1-3 local officials correspond to Rank 7 in the sample. Official ranks 8-9 capital officials and official ranks 4-9 local officials correspond to Rank 6 in the sample.
Source: Chang (1962, pp.35-36).

Put more generally, a comparison between the effects of kin networks on fertility and on marriages shown in Tables 3.4 and 3.6 indicates first, that the effects of kin group were limited on both of the individual outcomes; second, that brothers and cousins caused stronger effects on individuals than fathers did. The effects were not as strong as we would expect in traditional Chinese society, where the extended family structure largely prevailed.

Many previous studies view an individual's marriage and reproduction as "a consequence of familial status and position" and "instruments of family policy" (Lee and Campbell 1997, p.23; Wolf and Huang 1980, p.57). It is true that family background contributed much to every family member's demographic achievements, but it did not do so directly. As shown in Table 3.A3 in Appendix 3.A, father's social rank and brothers'/cousins' social ranks contributed substantially to an individual's social rank, which validates the point that ancestry, in other words, family background was one of the deciding factors that affect an individual's social outcome in Ming-Qing China (Campbell and Lee 2003; Shiue 2019; Jiang and Kung 2020). However, the weak effects of the social outcomes of fathers, brothers and cousins shown in

[63] The integrity allowance was several times greater than the regulated salary. For example, a governor of Jiangsu Province (a second-ranking local official) could receive an integrity allowance as high as 12,000 silver taels, and a seventh-ranking local official in Zhejiang Province could receive an allowance somewhere between 500 and 1,800 taels (Chang 1962, pp.12-13).

Tables 3.4 and 3.6 clearly indicate that the kin network was important, but it mainly affected an individual's demographic outcome through two mechanisms, one of which was the individual's social outcomes.

Moreover, whereas some research also emphasizes that senior kin mattered more than kin of the same generation (see, for example, Campbell and Lee 2008), the present chapter shows a different pattern. Given the relatively short lifespan in the pre-modern era, fathers' social outcome would contribute more to sons' education outcome in their childhood and adolescence, but not so much to events once they were adults, such as remarrying. Therefore, as the social outcomes for kin of the same generation, those of brothers and cousins, would contribute more to individuals' demographic outcomes. Within the patrilineal lineage structure, male members of the same generation would establish close and intimate associations with one another from birth, and thus would exert reciprocal positive effects when they achieved high social status.

However, if two males were of the same rank, why could the one from the elite lineages marry more times than his common-lineage counterpart? This relates to the other mechanism through which kin network could take effect, the lineage fund practice. In Ming-Qing China, lineage was, for one thing, a combination of families who shared the same ancestor and the same surname, but it was also a combination of families who co-owned various types of property. In addition to compiling genealogical books, since the Song dynasty, another common practice in the lineages was "sequestering a portion of the patrimony of each generation as lineage trusts", and most of the endowments were landed estates (Zelin 2009, 2019). While most common lineages were not rich enough to own land, most elite lineages not only owned land but also used their profits from the landed estates in many other lineage activities, including the most important ancestor-honouring rituals and the education of boys in the lineage (Zheng 2001; Freedman 1958). Thus, males from elite lineages were enabled to marry by making use of the lineage fund and the high reputation attached to their family name, something their common-lineage counterparts could never afford.

This institutionalized access to lineage resources also explains why in the elite lineages, father effects and brother/cousin effects were both not as significant as in the common lineages. [64] With the joint ownership of lineage properties in wealthier lineages, the transmission of material resources was not person-to-person and not exclusive to the next of

[64] However, the effects of kin network on the individual's social outcome were stronger in the elite lineages than in the common lineages, especially if the father, the brother and the cousin had a high social rank (ranks 4-7). This may relate to the "tacit knowledge" or "cultural capital", other than human capital itself, that high-social-ranking kin could transmit to individuals so that they could attain higher social status (Jiang and Kung 2020). This type of capital was hard to share around all the male members of the lineage; it was exclusive to the next of kin.

kin, but was through channels organized by the lineage and shared by all male members.[65] Nevertheless, in less wealthy lineages, the lack of common properties constrained the transmission of resources to close kin. This may also account for the strong kin connections that Campbell and Lee (2008) find in a farming population in Northeast China, where most of the households are common ones.

3.6 Robustness

This section presents the robustness of the previous results to (1) sub-periods, (2) controlling for lifespan, (3) an alternative classification of social status, (4) categorizing *Marriages* as an ordinal variable, and (5) an alternative estimation model (the zero-inflated negative binomial model). Table 3.B1 in Appendix 3.B presents the summary statistics for the new variables used in this session.

3.6.1 Social gradients in fertility over time

Although the analysis accounts for the birth cohorts, it is interesting to ask whether the social gradients in fertility changed over time. I examine Equation (1) by four sub-periods, with results listed in Table 3.B2. Because only four rank 7 males were born during the nineteenth century, I combine ranks 6 and 7 in the period 1800-1920.

The results by century in Table 3.B2 are largely comparable to those in Table 3.3. As we would also expect, after including marriages, most of the positive effects disappeared. Results in column 1 show that for males who were born before 1600, their human capital, rather than their social status, could explain much of their fertility difference. After 1600, however, the coefficients on social status are always significant before conditioning on marriages.

The rank coefficients in 1800-1920 are much higher than those in 1350-1799, due to the low net fertility of rank 1 males in the nineteenth century. Owing to the Taiping Rebellion, a massive civil war in the late Qing period, the Lower Yangtze region experienced a dramatic population loss in the late 1850s and early 1860s (Cao and Li 2000; Li and Lin 2015).[66] The conflict shortened the average length of men's lives and thus decreased the average number of

[65] As discussed in Zelin (2019), "Household and *tang* assets were organic constructs. A male member of a kinship line did not need to do anything to partake of these assets. And any additions to the property of a household or a higher-level kinship association accrued to all members, whatever their participation in their accumulation."
[66] Estimates suggest that the total population lost in China could have been more than 70 million (Li and Lin 2015). In the six lineages, the Gu and Zhuang lineages suffered the most in these conflicts. Of all the Gu and Zhuang males with death year records, 845 died in 1860-1863, 810 of them being commoners. Figure 3.B1 shows the marked increase of deaths in 1860-70 in the two lineages.

sons they produced. The large coefficient on the number of marriages in the period 1800-1920 can also be explained by this population loss.

3.6.2 Additional control: lifespan

A male's lifespan could be a confounding factor that affected his fertility behaviour and his likelihood of remarrying. Using a sub-sample of 11,106 males who reached age 15 with full life records, I control for male's age at death, and find an unaffected status-fertility relationship (Table 3.B3). I also demonstrate the social gradients in lifespan in Table 3.B4. Males of ranks 2-7 did have longer lifespan than rank 1 males, but the effects of social status on lifespan are moderate.

3.6.3 An alternative classification of social status

The social gradients shown in Table 3.3 could be spurious because of the broad classification of social status. Therefore, I construct a more detailed classification containing twelve levels of status (see Table 3.B5) to check for the robustness of the one presented in Table 3.1. Table 3.B6 reports the results of Equation (1) using the new social status variable. The main results are robust to the new classification. The results confirm those in columns 7 and 8 of Table 3.3. Status 5, 7, and 8, which altogether form rank 5, had the modest effects on fertility.

3.6.4 Classifying *Marriages* as an ordinal variable

Because the marginal effects of having one more wife for a single male and a married male could be different, I change *Marriages* into an ordinal variable, containing five wife groups (0, 1, 2, 3, and 4+ marriages). The coefficients on the wife groups shown in Table 3.B7 also suggest that the number of marriages has a linear effect on the number of sons. The coefficients on ranks for married males are similar to the results shown in column 8 of Table 3.3.

3.6.5 Zero-inflated negative binomial model: the excessive zero counts

Because of the excess zeroes in the dependent variable, I apply the zero-inflated negative binomial regression to see if the relationship still held. Since having a wife is the prerequisite for having a son, the number of marriages is used to predict the "always zero" in the model (Greene 1994; Lambert 1992).

Table 3.B8 details the results. The number of marriages is a significant predictor of the membership in the "always zero" group. If a male were to have one more wife, the odds that he would be in the "always zero" group would decrease by a factor of 31.37 in column 1 and a factor of 37.44 in column 2. The coefficients on *Rank* in column 2 are also nearly the same as the ones in column 8 in Table 3.3.

3.7 Conclusions

Using detailed genealogical records of six Chinese lineages, this chapter reveals a positive relationship between net fertility and social status in Ming-Qing China. Overall, compared with the non-gentry class, the near gentry and the gentry classes were more likely to have more sons who survived infancy through having more marriage; this Malthusian mechanism continued to function until the end of the Qing dynasty. Kin networks were important, but they were important through affecting individuals' social outcomes, rather than directly affecting individuals' demographic outcomes. Since higher social status resulted in greater human capital and income in imperial China, this chapter provides empirical support for "survival of the richest", or more precisely, "survival of the Confucians" in the Chinese context. Remarriages and the practice of polygamy made the primary strategy adopted by the Chinese elites for the sake of reproductive success different from that of their Western European counterparts.

Appendices

Appendix 3.A Extra Tables and Figures for Chapter 3

Table 3.A1 Summary statistics for Chapter 3

Statistics	N	Mean	Std.	Min	Max
Number of sons	36,456	1.13	1.36	0	12
Social rank	36,456	1.17	0.77	1	7
Number of marriages	36,456	0.80	0.63	0	10
Courtesy name (*zi*)	36,456	0.38	0.48	0	1
Pen name (*hao*)	36,456	0.06	0.24	0	1
Firstborn	36,456	0.50	0.50	0	1
Out-migration	36,456	0.01	0.07	0	1
Survival to adulthood	36,456	0.91	0.28	0	1
Number of brothers	36,456	2.72	1.49	1	12
Father social rank	36,456	1.30	1.03	1	7
Brother social rank	27,318	1.29	1.01	1	7
Brother/Cousin social rank	31,664	1.43	1.24	1	7
Birth cohort	31,197	8.92	1.87	1	12
Lineage	36,456	3.83	1.35	1	6

Notes: 1. Number of zero counts in "Number of sons" is 16,189. 2. Number of zero counts in "Number of marriages" is 10,930. 3. "Number of brothers" equals the number of father's sons, which includes the individual himself.

Table 3.A2 Logistic regression on the completeness of vital statistics

	Dependent Variable:	
	Having birth date record	Having birth and death date record
Rank 2	3.530***	6.047***
	(0.694)	(1.043)
Rank 3	2.269***	3.824***
	(0.445)	(0.509)
Rank 4	4.491***	3.626***
	(0.850)	(0.385)
Rank 5	4.283***	1.970***
	(1.112)	(0.307)
Rank 6	2.685***	2.137***
	(0.569)	(0.300)
Rank 7	2.985**	7.792***
	(1.417)	(3.463)
Number of Sons	1.034***	1.453***
	(0.010)	(0.014)
Controls		
Firstborn	Y	Y
Out-migration	Y	Y
Survival	Y	Y
Lineage FE	Y	Y
Constant	2.134***	0.167***
	(0.140)	(0.012)
N	36,456	36,456
Pseudo R^2	0.187	0.155

Notes: 1. Coefficients are the odds ratios for the logistic model and robust standard errors are in parentheses. 2. *p<0.1; **p<0.05; ***p<0.01.

Table 3.A3 Effects of kin groups on an individual's social outcome

	Dependent Variable: Rank			
	OLS	Poisson		
	(1)	(2)	(3)	(4)
	Full sample	Full sample	Common Lineages	Elite Lineages
NBrothers	0.0002***	1.000	0.996***	0.999
	(0.006)	(0.004)	(0.003)	(0.007)
Father's rank				
Rank 2	0.287***	1.254***	1.195***	1.294***
	(0.059)	(0.049)	(0.069)	(0.068)
Rank 3	0.311	1.262***	1.314***	1.241***
	(0.061)	(0.046)	(0.079)	(0.056)
Rank 4	0.468**	1.382***	1.274***	1.434***
	(0.055)	(0.042)	(0.062)	(0.055)
Rank 5	0.815***	1.633***	1.309**	1.663***
	(0.101)	(0.072)	(0.155)	(0.080)
Rank 6	1.066***	1.749***	1.543***	1.766***
	(0.110)	(0.076)	(0.157)	(0.085)
Rank 7	2.032	2.220***		2.224***
	(0.204)	(0.126)	.	(0.136)
Brothers'/Cousins' highest rank				
Rank 2	0.088**	1.084**	1.031	1.096*
	(0.041)	(0.037)	(0.045)	(0.054)
Rank 3	0.324***	1.292***	1.295***	1.293***
	(0.064)	(0.052)	(0.086)	(0.066)
Rank 4	0.507***	1.438***	1.416***	1.449***
	(0.052)	(0.044)	(0.062)	(0.060)
Rank 5	0.590***	1.495***	1.399***	1.532***
	(0.075)	(0.034)	(0.124)	(0.069)
Rank 6	0.954***	1.718***	1.165	1.761***
	(0.101)	(0.077)	(0.154)	(0.087)
Rank 7	1.389***	1.915***		1.930***
	(0.186)	(0.111)	.	(0.117)
Brother dummy	0.045***	1.036***	1.021	1.044***
	(0.011)	(0.009)	(0.014)	(0.012)
Controls				
Firstborn	Y	Y	Y	Y
Out-migration	Y	Y	Y	Y
Survival to adulthood	Y	Y	Y	Y
Birth cohort FE	Y	Y	Y	Y
Lineage FE	Y	Y	Y	Y
Constant	1.047***	1.040***	1.280**	1.128
	(0.065)	(0.098)	(0.130)	(0.419)
N	27,187	27,187	9,123	18,064
R^2/ log pseudolikelihood	0.337	-30702.81	-9807.61	-20870.82

Notes: 1. Rank 1 is the reference group. 2. Coefficients in columns 2-4 are incidence rate ratios (IRR) and robust standard errors are in parentheses, clustered on fathers. 3. Ranks 6 and 7 are combined together in column 3, given the limited number of observations. 4. *p<0.1; **p<0.05; ***p<0.01.

Table 3.A4 Effects of differences in attained social ranks on differences in net fertility between brothers, OLS regression

	Dependent Variable:	
	Difference in number of sons between brothers	
	(1)	(2)
Rank difference		
= -1	-0.371**	-0.388**
	(0.178)	(0.174)
= -2	-0.410**	-0.437***
	(0.165)	(0.165)
= -3	-1.034***	-1.061***
	(0.162)	(0.161)
= -4	-0.218	-0.235
	(0.195)	(0.199)
= -5	-0.854***	-0.854***
	(0.247)	(0.249)
= -6	-1.358***	-1.351***
	(0.473)	(0.475)
= 1	0.537***	0.526***
	(0.140)	(0.140)
= 2	0.511***	0.492***
	(0.159)	(0.153)
= 3	0.976***	0.952***
	(0.147)	(0.150)
= 4	0.804***	0.793***
	(0.173)	(0.176)
= 5	1.632***	1.634***
	(0.222)	(0.241)
= 6	2.690**	2.700**
	(1.167)	(1.185)
Controls		
Father ranks	N	Y
Birth century	Y	Y
Lineage FE	Y	Y
Constant	-0.067	-0.049
	(0.259)	(0.259)
N	24,988	24,950
R-squared	0.020	0.020

Notes: 1. Rank difference=0 is the reference group. 2. Robust standard errors in parentheses, clustered on fathers (8,566 clusters). 3. *p<0.1; **p<0.05; ***p<0.01.

Appendix 3.B Robustness checks for Chapter 3

Table 3.B1 Summary statistics of variables in robustness checks for Chapter 3

Statistics	N	Mean	Std.	Min	Max
Age	11,344	50.02	17.61	1	105
Age-squared	11,344	2811.61	1743.04	1	11025
Status	36,456	1.23	1.18	1	12
Birth century	24,988	5.13	0.99	1	7
Difference in sons	25,861	-0.007	1.75	-9	11
Difference in ranks	25,861	0.007	0.85	-6	6

3.B.1 Social gradients over time

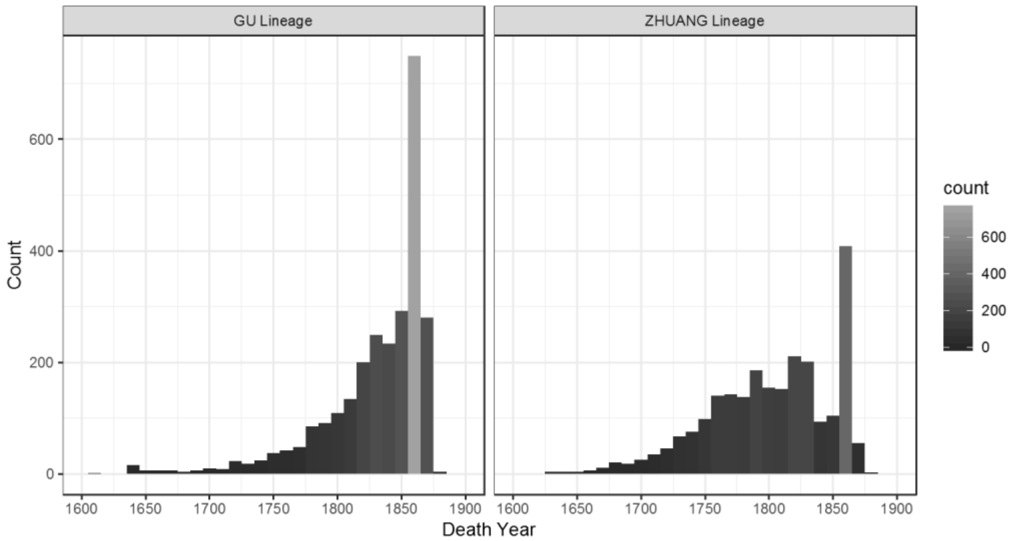

Figure 3.B1 Frequency of death year in the Gu and the Zhuang lineages, 1600-1900

Note: The figure plots only males whose death year is recorded.

Table 3.B2 Rank effects on fertility by sub-period, negative binomial regression

	Dependent Variable:							
	Number of Sons							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Birth period	1350-1599		1600-1699		1700-1799		1800-1920	
Rank 2	1.343***	1.185	1.250**	1.135	1.339***	1.167*	2.009***	1.247
	(0.145)	(0.138)	(0.133)	(0.137)	(0.093)	(0.093)	(0.301)	(0.244)
Rank 3	1.064	0.961	1.103	0.972	1.325***	1.121	1.612***	1.052
	(0.094)	(0.086)	(0.077)	(0.062)	(0.086)	(0.090)	(0.154)	(0.125)
Rank 4	0.961	0.893	1.246***	1.098	1.412***	1.041	1.811***	1.311***
	(0.111)	(0.098)	(0.085)	(0.079)	(0.065)	(0.054)	(0.142)	(0.115)
Rank 5	0.902	0.846	1.278**	0.990	1.306***	1.034	2.125***	1.172
	(0.135)	(0.123)	(0.156)	(0.136)	(0.093)	(0.081)	(0.243)	(0.129)
Rank 6	1.167	0.931	1.463***	1.226*	1.471***	0.804**	2.481***	1.269*
	(0.113)	(0.124)	(0.147)	(0.146)	(0.094)	(0.068)	(0.069)	(0.166)
Rank 7	1.311**	0.870	1.653***	1.331*	1.766***	0.757	.	.
	(0.170)	(0.149)	(0.209)	(0.227)	(0.316)	(0.189)		
Zi	1.500***	1.368***	1.547***	1.414***	1.378***	1.199***	1.305***	1.153***
	(0.076)	(0.069)	(0.060)	(0.053)	(0.034)	(0.028)	(0.040)	(0.036)
Hao	1.237***	1.179***	1.262***	1.171***	1.400***	1.195***	1.432***	1.267***
	(0.068)	(0.065)	(0.061)	(0.060)	(0.050)	(0.046)	(0.073)	(0.069)
Marriages		1.482***		1.552***		2.132***		3.136***
		(0.051)		(0.057)		(0.048)		(0.096)
Controls								
Firstborn	Y	Y	Y	Y	Y	Y	Y	Y
Out-migration	Y	Y	Y	Y	Y	Y	Y	Y
Birth cohort FE	Y	Y	Y	Y	Y	Y	Y	Y
Lineage FE	Y	Y	Y	Y	Y	Y	Y	Y
Constant	1.787***	1.233**	1.062	0.753***	0.972	0.565***	0.276***	0.151***
	(0.172)	(0.122)	(0.062)	(0.047)	(0.049)	(0.027)	(0.044)	(0.022)
N	1,704	1,704	4,052	4,052	10,724	10,724	11,701	11,701
Pseudo R^2	0.050	0.083	0.031	0.062	0.022	0.084	0.046	0.127

Notes: 1. Rank 1 is the reference group. 2. Only males who survived to adulthood are included. 3. The coefficients in the table are IRR. 4. Robust standard errors are in parentheses. 5. *p<0.1; **p<0.05; ***p<0.01.

3.B.2 Lifespan

Table 3.B3 Lifespan effects on the number of sons, negative binomial regression

	Dependent Variable:			
	Number of Sons			
	(1)	(2)	(3)	(4)
Rank 2	1.092*	1.106*	1.087*	1.108**
	(0.056)	(0.059)	(0.055)	(0.057)
Rank 3	1.074*	1.047	1.077*	1.048
	(0.044)	(0.046)	(0.044)	(0.046)
Rank 4	1.137***	1.089**	1.140***	1.088**
	(0.058)	(0.042)	(0.040)	(0.041)
Rank 5	1.037	1.002	1.019	0.982
	(0.058)	(0.065)	(0.056)	(0.063)
Rank 6	1.056	1.058	1.054	1.053
	(0.055)	(0.066)	(0.055)	(0.065)
Rank 7	1.108	1.228*	1.110	1.228*
	(0.109)	(0.138)	(0.106)	(0.138)
Age	1.095***	1.095***		
	(0.004)	(0.004)		
Age-squared	0.999***	0.999***		
	(0.00003)	(0.0003)		
Age group 15-19			0.175***	0.141***
			(0.051)	(0.051)
25-29			1.976***	2.099***
			(0.192)	(0.231)
30-34			3.048***	3.281***
			(0.281)	(0.342)
35-39			3.952***	4.313***
			(0.347)	(0.430)
40-44			4.196***	4.494***
			(0.368)	(0.449)
45-49			5.184***	5.629***
			(0.451)	(0.559)
50-54			5.179***	5.579***
			(0.449)	(0.551)
55-59			5.577***	6.014***
			(0.483)	(0.594)
60-64			5.510***	5.968***
			(0.476)	(0.588)
65+			5.589***	6.055***
			(0.479)	(0.593)
Marriages	1.303***	1.317***	1.291***	1.302***
	(0.021)	(0.024)	(0.020)	(0.023)
Zi	1.065***	1.063***	1.065***	1.063***
	(0.023)	(0.025)	(0.023)	(0.025)
Hao	1.192***	1.191***	1.187***	1.182***
	(0.031)	(0.033)	(0.030)	(0.032)
Controls				
Fathers' ranks	N	Y	N	Y
Brothers'/cousins ranks	N	Y	N	Y
Brother dummy	N	Y	N	Y
Firstborn	Y	Y	Y	Y
Out-migration	Y	Y	Y	Y

Table 3.B3 Continued

	Dependent Variable:			
	Number of Sons			
	(1)	(2)	(3)	(4)
Controls				
Birth cohort	Y	Y	Y	Y
Lineage	Y	Y	Y	Y
Constant	0.100***	0.087***	0.336***	0.274***
	(0.016)	(0.012)	(0.050)	(0.037)
N	11,086	9,948	11,086	9,948
Pseudo R^2	0.098	0.100	0.105	0.107

Notes: 1. Males who died after age 15 were selected for this sub-sample. 2. Rank 1 is the reference group. Age group 20-24 is the reference group in columns 3 and 4. 3. The coefficients are IRR. 4. Robust standard errors are in parentheses, clustered on fathers. 5.*p<0.1; **p<0.05; ***p<0.01.

Table 3.B4 Social gradients in lifespan, negative binomial regression

	Dependent Variable:	
	Lifespan	
	(1)	(2)
Rank 2	1.268***	1.208***
	(0.027)	(0.023)
Rank 3	1.105***	1.043**
	(0.022)	(0.019)
Rank 4	1.136***	1.084***
	(0.016)	(0.014)
Rank 5	1.142***	1.105***
	(0.027)	(0.024)
Rank 6	1.223***	1.176***
	(0.022)	(0.020)
Rank 7	1.317***	1.205***
	(0.030)	(0.027)
Controls		
Firstborn	N	Y
Out-migration	N	Y
Survival	N	Y
Birth cohort FE	N	Y
Lineage FE	N	Y
Constant	48.953***	16.027***
	(0.199)	(1.230)
N	11,323	11,323
Pseudo R^2	0.003	0.064

Notes: 1. Rank 1 is the reference group. 2. The coefficients are IRR. 3. Robust standard errors are in parentheses, clustered on fathers. 4.*p<0.1; **p<0.05; ***p<0.01.

3.B.3 Alternative classification of social status

Table 3.B5 Alternative classification of social status

Status	Count	Percent	Description
1	34,555	94.79%	No status; honoured by later generations with poems or prose discourses
2	188	0.52%	Literate and educated but without degree (teacher of the village or editor of genealogical books); lineage chief; donor to the lineage and the county
3	487	1.34%	Lower degree holder
4	522	1.43%	Students at the Imperial Academy
5	34	0.09%	Intermediate/high degree holder, but no official position
6	66	0.18%	Awarded by the emperor with official titles, with no academic degree
7	120	0.33%	Prospective officials
8	91	0.25%	Clerks; the lowest-ranking official, with no degree
9	106	0.29%	Low-/medium-ranking local official and low-ranking court official, with no academic degree record or normal and civil *shengyuan* degree
10	128	0.35%	Low-/medium-ranking local official and low-ranking court official, with the degree of studentship at the Imperial Academy
11	82	0.22%	Low-/medium-ranking local official and low-ranking court official, with intermediate/high degree
12	77	0.21%	High-ranking local official and medium/high-ranking court official

Table 3.B6 Effects of status on the recorded number of sons, negative binomial regression

	Dependent Variable:		
	Number of Sons		
	(1)	(2)	(3)
			Married
Status 2	1.481***	1.163**	1.231***
	(0.086)	(0.077)	(0.062)
Status 3	1.366***	1.072*	1.146***
	(0.050)	(0.044)	(0.038)
Status 4	1.493***	1.102**	1.176***
	(0.054)	(0.047)	(0.039)
Status 5	1.324**	0.933	1.140
	(0.177)	(0.160)	(0.137)
Status 6	1.541***	1.301**	1.355***
	(0.142)	(0.141)	(0.109)
Status 7	1.262***	0.940	1.003
	(0.100)	(0.072)	(0.074)
Status 8	1.450***	1.040	1.123*
	(0.106)	(0.091)	(0.075)
Status 9	1.504***	1.004	1.188**
	(0.123)	(0.109)	(0.090)
Status 10	1.753***	0.994	1.410***
	(0.119)	(0.096)	(0.090)
Status 11	1.532***	1.033	1.212***
	(0.112)	(0.105)	(0.080)
Status 12	1.833***	0.957	1.499***
	(0.180)	(0.123)	(0.118)
Marriages		2.208***	1.132***
		(0.034)	(0.013)
Zi	1.425***	1.259***	1.125***
	(0.022)	(0.020)	(0.016)
Hao	1.354***	1.199***	1.212***
	(0.031)	(0.030)	(0.025)
Controls			
Firstborn	Y	Y	Y
Out-migration	Y	Y	Y
Birth cohort	Y	Y	Y
Lineage	Y	Y	Y
Constant	1.164**	0.595***	1.564***
	(0.080)	(0.047)	(0.099)
N	28,181	28,181	21,235
Pseudo R^2	0.045	0.106	0.043

Notes: 1. Status 1 is the reference group. 2. Males included are all the males who survived to adulthood. 3. The coefficients in the table are IRR. 4. Robust standard errors are in parentheses. 5.*p<0.1; **p<0.05; ***p<0.01.

3.B.4 *Marriages* as an ordinal variable

Table 3.B7 Effects of rank and wife on the recorded number of sons, negative binomial regression

	Dependent Variable: Number of Sons	
	(1)	(2) Married males
Rank 2	1.240***	1.240***
	(0.055)	(0.055)
Rank 3	1.124***	1.124***
	(0.041)	(0.041)
Rank 4	1.184***	1.184***
	(0.036)	(0.036)
Rank 5	1.101**	1.101**
	(0.053)	(0.053)
Rank 6	1.273***	1.273***
	(0.053)	(0.053)
Rank 7	1.573***	1.572***
	(0.123)	(0.123)
Wife Group 0	0.0003***	
	(0.0002)	
Wife Group 2	1.142***	1.142***
	(0.019)	(0.019)
Wife Group 3	1.253***	1.253***
	(0.048)	(0.048)
Wife Group 4	1.510***	1.501***
	(0.121)	(0.121)
Controls		
Zi	Y	Y
Hao	Y	Y
Firstborn	Y	Y
Out-migration	Y	Y
Birth cohort FE	Y	Y
Lineage FE	Y	Y
Constant	1.757***	1.758***
	(0.108)	(0.108)
N	28,181	21,235
R-squared/Pseudo R^2	0.227	0.043

Notes: 1. Rank 1 and wife group 1 are the reference groups. 2. Males included are all the males who survived to adulthood. 3. Robust standard errors are in parentheses in column. 4. The coefficients are IRR. 5. *p<0.1; **p<0.05; ***p<0.01.

3.B.5 Zero-inflated negative binomial model

Table 3.B8 Rank effects on the number of sons, zero-inflated negative binomial regression

	Dependent Variable:	
	Number of sons	
	(1)	(2)
Rank 2	1.393***	1.240***
	(0.057)	(0.055)
Rank 3	1.373***	1.126***
	(0.050)	(0.041)
Rank 4	1.426***	1.185***
	(0.043)	(0.036)
Rank 5	1.196***	1.101**
	(0.057)	(0.052)
Rank 6	1.476***	1.272***
	(0.060)	(0.052)
Rank 7	2.113***	1.534***
	(0.163)	(0.118)
Marriages		1.133***
		(0.013)
Zi		1.126***
		(0.016)
Hao		1.211***
		(0.025)
Controls		
Firstborn	N	Y
Out	N	Y
Birth cohort FE	N	Y
Lineage FE	N	Y
Constant	1.574***	1.551***
	(0.009)	(0.098)
Inflate		
Marriages	-31.368***	-37.439***
	(0.719)	(0.712)
Constant	8.028***	7.815***
	(0.707)	(0.707)
N	33,238	28,181

Notes: 1. Rank 1 is the reference group. 2. Only males who survived to adulthood are included. 3. The coefficients are IRR. 4. Robust standard errors are in parentheses. 5. *p<0.1; **p<0.05; ***p<0.01.

Chapter 4

The Darwinian and the Beckerian Trade-offs of Children in Ming-Qing China

Abstract

This chapter uses the genealogical records of 36,456 males from six lineages in Ming-Qing China to investigate the reproductive success in a multi-generational model. I first test for a Darwinian trade-off between short-run reproduction and long-run continuity in bloodlines. The empirical results indicate that in the six lineages, high fertility could be transmitted across generations, and the optimal level of fertility was nine sons. I then examine the mechanisms of fertility transmission by analysing the presence of the Beckerian child quantity-quality trade-off. Quality in sons are measured by two indicators: whether they could get married and whether they were literate. Because that the practice of offering sons for adoption induced a random variation in family size, I instrument family size with the adoption practice. The IV estimates find that having more brothers in 1600-1800 would reduce the probability that a male would be literate, and in 1800-1900 would make him less likely to marry. Nevertheless, it was not family size so much as father's human capital that was of the central importance in affecting a son's quality.

4.1 Introduction

High fertility rates do not always translate into high rates of survival. David Lack (1954) first demonstrates the existence of regulations in a "natural population" of birds, stating that the clutch size has been evolved to suit the largest number of surviving descendants. Later developing into the life-history theory in evolutionary biology, the trade-off between fertility and different biological traits with the aim of increasing the survival rate has long been studied by zoologists and biologists (Stearns 1989; Williams 1966, Chapter 6). Anthropologists and demographers, too, have examined different types of Darwinian trade-off within the human species. Their detailed studies on relationships between female fertility and offspring survivorship, parental fertility and next generation fertility, and the optimal level of fertility and long-run reproductive success have suggested different patterns in different societies (Hill and Hurtado 1996; Strassmann and Gillespie 2002; Borgerhoff Mulder 2000; Kaplan 1996; Kaplan et al. 1995).

To ensure greater continuity in bloodlines, high survival in only one generation is not enough; most importantly, the reproductive success in one generation has to be transmitted across generations. Galor and Klemp (2014) address the question that how the fertility of ancestors affected the fertility of descendants by using the genealogical data of half a million residents over four generations in pre-industrial Quebec and find a hump-shaped relationship between fecundity and long-run reproductive success. They conclude that moderate fecundity, coupled with a higher level of education, was more conducive for the continuity of the lines of descent; the negative effects on survival of larger family sizes also suggest the presence of child quantity-quality trade-offs (Galor and Klemp 2014). The empirical findings also support their evolutionary growth theory that the survival pattern of the human species during the Malthusian epoch was shaped by the forces of natural selection and played a major role in the transition from Malthusian stagnation to sustained economic growth (Galor and Moav 2002; Galor 2011).

Therefore, if high fertility could be transmitted across generations in pre-modern societies, what were the mechanisms through which parental fertility affected next generation fertility? A plausible mechanism is that the parents' choices on their family size and their investment in offspring would significantly affect offspring's quality, which would furtherly affect offspring's demographic outcomes. Economists have studied this type of child quantity-quality trade-off since Becker (1960, 1981; Becker et al. 1990) first inserted fertility decisions into the economic analysis and argued that parents would sacrifice the number of children they could have for higher quality in the children they had. A considerable amount of empirical literature also tries to support or to challenge this Beckerian argument in both historical and modern times (see the examples of India: Rosenzweig and Wolpin 1980; of Thailand: Knodel, Havanon, and Sittitrai 1990; of Norway: Black, Devereux, and Salvanes 2005; of Prussia: Becker, Cinnirella, and Woessmann 2010, 2012; of France: Diebolt, Mishra, and Perrin 2015; of England: Clark and Cummins 2019b; Klemp and Weisdorf 2019; of Brazil: Ponczek and Souza 2012; of the USA: Tan 2019; of Korea: Lee and Park 2019).

Shiue (2017) uses genealogical data from Tongcheng County, Anhui Province and tests the trade-off in Qing China, finding a negative relationship between family size and sons' education before 1800 that disappeared afterwards.[67] Song et al. (2015) also speculate that in the mid-Qing period, the child quantity-quality trade-off is a strategy that the high-status founders may have adopted to achieve continuity in their bloodlines.

To contribute to the previous literature, I use a new genealogical dataset containing 36,456 males to exploit the multigenerational associations in fertility in six Chinese lineages from 1350 to 1920. I intend to show the reproductive success of Chinese males in a multi-generational model by analysing the pattern and the mechanisms of fertility transmission. Because only patrilineal male descents are officially recorded in the genealogical books, this chapter focuses on all the male family members in the six lineages.

I first test for the presence of the Darwinian trade-off by examining the optimal level of fertility for long-run reproductive success in the six lineages. I estimate the relationship between the number of sons and the number of male descendants in the three following generations that a male had to test whether high reproduction in the first generation could translate into high reproduction in the three that would ensue. The estimation results show that there was an optimal level of fertility for long-run reproductive success. A male had to have nine sons to have the most grandsons, great-grandsons, and great-great-grandsons.

I then analyse the possible mechanisms through which parental fertility could affect next generation fertility. The adverse effects of high fertility on the continuation of the male line indicate that the six lineages may show Beckerian trade-offs between child quantity and quality. The family size of the first generation could affect the quality of the second generation, and thus affect the likelihood of the second generation to produce male descendants in subsequent generations.

I use the number of brothers that a male had to measure completed family size, and I use two indicators to measure child quality. The first measure is whether the male could reach adulthood and have at least one marriage before he died. The logistic regression results reflect

[67] The evidence from contemporary China is conflicting. Qian (2005) and Li, Zhang, and Zhu (2008) both exploit the 1990 population census, but find a contradictory relationship between family size and children's educational attainment. Liu (2014) finds a strong negative relationship between family size and children's height. Rosenzweig and Zhang (2006) also find an extra child at lower parities would decrease the quality of all children in the family.

that the number of brothers possessed by a male could significantly increase the likelihood of his getting married; the positive relationship is more evident in 1600-1900, than in 1400-1600. Sons who were from larger families enjoyed a higher probability of entering into marriage, which was a prerequisite in traditional China for leaving male descendants.

The second indicator is male literacy. Based on the literacy-related information recorded in the genealogies, 3,008 males in the sample are classed as "literate". The logistic estimation indicates that, before conditioning on father's and grandfather's literacy, family size was positively correlated with sons' literacy, but the positive effects disappeared after conditioning on the two variables. However, for the 1600-1800 period in particular, even after controlling for father's and grandfather's literacy, the positive correlation between family size and son's literacy is still strong.

Nevertheless, because of the potential endogeneity issue that both family size and son's quality are affected by unobservable parental preference and household characteristics, establishing a causal relationship is challenging and the correlation may be biased. Therefore, I instrument the number of brothers a male had with whether the male lost brothers for adoption or not. The instrument is valid because the event negatively affected family size, and was not related to the father's own preference, nor could it directly affect the male's quality.

The instrumental variable results indicate an uncertain relationship between family size and the likelihood that a son would marry, but there is a clear trade-off between family size and a son's literacy: a male was about two percentage points less likely to be literate if he were to have one more brother. The negative effects of family size on literacy, again, are statistically significant for the 1600-1800 period only.

The contradictory results between logistic and IV estimations show that the unobserved parental preference and household characteristics which positively correlated with a son's marriage probability and literacy biased the coefficients of family size in the logistic regression towards the positive. However, for males born in the period 1400-1600, both estimation models suggest that family size was not related to a son's quality.

This chapter contributes to the previous literature in two ways. On the one hand, this chapter illustrates the story of reproductive success of Chinese males in a multi-generational model. It presents the first empirical evidence on the optimal level of fertility for long-run reproductive success in the historical Chinese context. On the other, by examining the fertility-marriage and the fertility-literacy relationships in an intergenerational model, I show that family size affected child quality in different ways. This chapter also provides a new instrumental variable that could tackle the endogeneity issue in examining the relationship between child quantity and child quality.

The rest of the chapter is structured as follows. Sections 4.2 describes the genealogical data. Section 4.3 introduces the empirical strategies and Section 4.4 reports the results about the long-run reproductive success and the child quantity-quality trade-offs. Section 4.5 is a discussion about the results, and Section 4.6 concludes.

4.2 Data and main variables

4.2.1 The lineage sample

The primary data used in this chapter come from the genealogical books of six lineages in Southeast China; the sample includes 36,456 males born in the period 1350 to 1920. Genealogies of a lineage always record a family tree which includes all the male members, and a series of detailed entries for each male descendant in the family. The family tree and sons' names recorded under the fathers' entries enable us to link male family members easily across generations.

Although the genealogical data are very useful in examining fertility and survival, they are not free from selection biases. The previous two chapters have presented detailed discussions about the selection biases in this sample. The main bias that would affect the empirical estimation in this chapter is the lack of information about daughters in the genealogies. Due to the strong preference for sons in imperial China, daughters are highly under-reported. The sample included 41,145 sons in total, but only 9,636 daughters. Given that the number of sons who survived infancy is completely recorded for every male's entry, I use this number in the present chapter to measure fertility and family size.

4.2.2 Dependent and independent variables

In the main analysis of the optimal level of fertility, the dependent variable is the recorded number of grandsons, great-grandsons, and great-great-grandsons of the "ancestors" in the sample. "Ancestors" here denote the males whose male descendants of the four following generations were completely recorded in the genealogies. The independent variable in this analysis is the number of a male's sons who survived infancy.

In the analysis that examines the child quantity-quality relationship, which is the mechanism through which parental fertility affected next generation fertility, the dependent variables are two dummy variables that measures two indications of quality in males, their marital status (*Marriage*) and their human capital (*Literacy*). The independent variable is the number of brothers who survived infancy that a male had, that is, the number of sons who survived infancy, both biological and adopted, that the male's father had. In other words, the number measures the completed family size in terms of male births.

Since the long-run reproductive success is measured in this chapter by the number of male descendants a male could have, the two variables indicate a male's quality in terms of his capability of leaving male descendants. Both of the two quality measures are also closely related to the male's parents' investment on him. First, *Marriage* is considered a valid measure in this context, because entering into marriage is the prerequisite for males to have male descendants. The shortage of women in Ming-Qing China, caused mainly by female infanticide and polygamy, made the marriage market seriously unbalanced (Lee and Wang 1999a). A substantial proportion of males, especially males from impoverished families and low-social-status males, failed to ever marry. Thus, the "quality" of the male largely determined whether he could marry or not. Second, *Literacy* matters because it largely determined the number of male descendants a male could leave. It is also commonly applied to measure human capital in pre-modern societies.

Based on the social status records in the genealogies, I divide all the males in the sample into 15 levels of social status, and construct the variable *Literacy* based on their social status to measure their human capital (see Table 4.1).[68] In the Ming-Qing period, education was closely related to social status and wealth, for education could bring people high social status and considerable wealth because of *keju*, the national civil examination system.[69] The exam mainly tested candidates' knowledge of the Confucian classics. All male commoners, including peasants, artisans, and merchants could attend the civil examinations, and academic degrees on three levels — *shengyuan*, *juren*, and *jinshi* — would reward those who could pass the

[68] The classification in Table 4.1 is different and more detailed than the one in Table 3.1, because the main criterion used in Table 4.1 is literacy rather than social status. Two people could share the same social status, but one of them was literate for sure, and the other was not. Another difference is that I add the ownership of *Hao* into the classification in Table 4.1.

[69] *Keju* was initiated in 600 AD and abolished in 1905. Its presence changed imperial China into a meritocracy. In the tenth century, Emperor Zhenzong of the Song dynasty (960-1276) once wrote "There is no need to buy farmland, for books will get you a position with a high salary;/ There is no need to build a house, for books will bring you a luxurious residence with golden walls."

corresponding county-level, the provincial-level, and the national-level exams. Candidates who failed in the exams could also repeatedly re-take them.

Table 4.1 Literacy and social status classification

Literacy	Status	Count	Percent	Description
0	1	33,320	91.39%	No status
1	2	1,281	3.51%	*Hao* (pen name) owner
0	3	78	0.21%	Lineage chief; donor to the lineage and the county (without *hao*)
1	4	80	0.22%	Literate and educated but without degree (teacher of the village or editor of genealogical books)
0	5	53	0.15%	Awarded official titles by the emperor, with no academic degree (without *hao*)
1	6	487	1.34%	Lower degree holder (normal *shengyuan* and civil *shengyuan*)
1	7	522	1.43%	Students at the Imperial Academy (lower degree)
1	8	34	0.09%	Intermediate/high degree holder (*juren*, *gongsheng*, *jinshi*), but with no official position
1	9	52	0.14%	Prospective officials (*houbu*), with no academic degree
1	10	67	0.18%	Prospective officials (*houbu*), with degree
1	11	92	0.25%	Clerks (*wei'ruliu*); the lowest-ranking official (*cong jiupin*), without degree
1	12	106	0.29%	Low-/medium-ranking local official and low-ranking court official, without a degree, or with normal and civil *shengyuan* degree
1	13	128	0.35%	Low-/medium-ranking local official and low-ranking court official, with a degree of studentship at the Imperial Academy
1	14	82	0.22%	Low-/medium-ranking local official and low-ranking court official, with an intermediate/high degree
1	15	77	0.21%	High-ranking local official and medium/high-ranking court official

Sources: Ho 1962, Chapter 1; Telford 1995, p.92, Appendix 3A; Shiue 2017, p. 364, Table 1.

Thus, I code all the schoolteachers, compilers of genealogies, *keju* degree holders, and office holders with 1 for *Literacy*. Besides, I also use the ownership of *hao* (pen name) to distinguish between the literate and the illiterate. *Hao* is a name that an educated male would give himself in imperial China when writing either prose or poetry. Males who owned *hao* but did not have a *keju* degree, official position, or any other formal qualification are also coded with 1. In total, 3,008 (8.4 per cent) of the males in the sample are considered literate.

4.3 Empirical strategy

4.3.1 The Darwinian trade-off：the relationship between fertility and long-run reproductive success

4.3.1.1 The model

To test the presence of the optimal level of fertility for long-run reproductive success, I apply a multigenerational model, following the methods in Kaplan et al. (1995) and Galor and Klemp (2014).

The sample used in this analysis consists of 9,364 "ancestors" in the six lineages. Males with incomplete records of male descendants in the subsequent four generations are excluded. Because the number of grandsons (mean = 2.9, variance = 8.9), the number of great-grandsons (mean = 3.6, variance = 26.8), and the number of great-great-grandsons (mean = 3.9, variance = 61.1) are all count variables and over-dispersed, I mainly employ negative binomial regression to test the relationship between the number of sons and the number of male descendants in the following three generations based on the following equation:

$$Descendants_i = \alpha + \beta_1 Sons_i + \beta_2 Sons_i^2 + \delta P_i + \varepsilon_i, \qquad (1)$$

where *Descendants* is the number of male offspring that a male (Generation 1) had in the three generations after his sons' generation (i.e. grandsons, great-grandsons, and great-great-grandsons); *i* denotes male individuals. *Sons* is the number of sons that a male had, and $Sons^2$ is the square term of *Sons*.[70] The reason for including $Sons^2$ is that the relationship between *Sons* and *Descendants* may not be linear as suggested in previous research (Galor and Klemp 2014). Too many sons in one generation may reduce each of the son's survival chance.

P is a set of control variables that would also affect the number of grandsons and the number of great-grandsons. ε is the error term. If the optimal level of fertility did exist, a negative β_2 would be expected. Having more sons than the optimal number would lead to fewer male descendants in the following generations.

[70] I also employ OLS regression as a robustness check (see Table 4.A2 in Appendix). To better fit the OLS regression model, I log-transform *Descendants*, and, to keep all the zero observations, make the outcome variable used in the OLS model is $ln\ (Descendants_i+1)$.

4.3.1.2 The control variables

I condition on seven control variables in the model to establish the causal relationship between fertility and long-run reproductive success.

Literacy and *Marriages*. In pre-modern China, education, wealth, and social status were closely related. The number of marriages that a male had was also positively associated with his social status and wealth. Thus, *Literacy* and *Marriages* are controlled for the effects of the male's socio-economic characteristics on his long-run reproductive success.

Firstborn. Based on the traditional Chinese culture, the firstborn son has to take the greatest responsibility for leaving male descendants, which would be positively related to the continuity of the bloodline.

Survival to adulthood. Lifespan is closely related to fertility. Only about one third of the males in the genealogies had complete vital records, but males who died before adulthood would also be marked in the genealogies. Thus, I use the dummy *Survival* to distinguish males who could not reach their reproductive age from the other males.

Out-migration. If a male were out migrated to another villages, it was hard for the compilers of the genealogy to update the information on him. I include *Out-migration* to control for the negative effect that this move could have on the number of male descendants recorded in the genealogy.

Birth cohort and *Lineage*. The birth cohort and also the lineage that the male belonged to would have effects on his fertility and also on the continuity of the long-run succession of his bloodline. Of the 36,456 males in the sample, only 23,098 had birth year recorded. With these birth year records, I impute an approximate birth cohort for the relatives of these males who were not recorded with birth year. I classify 31,197 males into twelve birth cohorts, starting with a "pre-1400" interval (1350 to 1400), ending with a "post-1900" interval (1900-1920), and with ten half-century-long cohorts in between.

4.3.2 The Beckerian trade-off: mechanisms through which fertility affected long-run reproductive success

4.3.2.1 Baseline model

I first run the logistic regressions based on the following equation:

$$Quality_i = \alpha_1 + \beta_1 Brothers_i + \delta_1 P_i + \gamma_1 W_i + \varepsilon_i, \qquad (2)$$

where *Quality* denotes the male individual's quality, and *i* denotes male individuals. I use two indicators to measure quality, *Marriage* and *Literacy*. *Marriage* equals one if the male was married at least once, and *Literacy* equals one if the male was literate. $\alpha_1$is the constant. As the number of daughters is incomplete in the genealogies, I use *Brothers* to measure the quantity of children. It equals the number of brothers (including himself) in a male's generation of his family of origin, in other words, the number of sons who survived infancy that his father had.

P denotes the same set of control variables used in Equation (1), and *W* includes a set of other factors that would affect one's marriage and literacy. ε is the error term. If the trade-off existed, a negative β_1 would be expected, because it represents that the parents choose between the quantity and quality of their sons.

The additional control variables I condition on include the male's lifespan, his father's literacy and lifespan, and his grandfather's literacy and number of sons.

Lifespan and *father's lifespan*. I follow Shiue's (2017) model here by conditioning on the age at death of the male individual and also his father's age at death to control for the health-related factors that could affect the quality of the male. However, only about one third of the males in the sample had the age at death recorded.

Father's literacy. For each individual I control for the father's literacy to reflect the socio-economic characteristics of his family of origin.

Grandfather's literacy and *Number of uncles*. Moreover, I include the effects of the grandfather in the model to address the endogeneity issue. The major difficulty in establishing the causal relationship between family size and child quality is the omitted variable bias. The effects of unobserved household features and parental preference on child quantity and quality would obscure the existence or the absence of a child quantity-quality trade-off. In a male-dominant society that values filial piety, the couple's preference would be influenced by the husband's parents' decisions. Therefore, I control for the literacy of the grandfather of every male individual, and also the number of uncles that he had, in other words, the number of sons his grandfather produced, to partly tackle the endogeneity. Table 4.A1 in the Appendix reports the summary statistics of the sample.

4.3.2.2 Instrumental variable model

As mentioned before, the unobservable parental preference and household features that would affect both quality and quantity of children would bias the effects of family size on child quality.

To address the concern of omitted variable bias, I construct an instrumental variable based on the practice of offering sons for adoption.

The custom of adoption has a long tradition in China. In a society that values filial piety highly, having a male heir to continue the bloodline is the priority for every male. However, not every male could fulfil the task; hence adoption between brothers and cousins was practised. The earliest official regulations on adoption are found in the *Tang Code* published in 653 A.D. (Chen 2017). There are also strict regulations on the sequence chain for adoption recorded in the *Ming Code* and the *Qing Code*. The article states that "The heirless male is allowed to adopt. The adoptee should be chosen on the basis of the degree of consanguinity, starting from his brothers' sons, to his first cousins' sons, to his second cousins' sons, and finally to his third cousins' sons. If then he still cannot find an appropriate boy to adopt, he is allowed to find a boy with the same surname who is a more distant relation of his".[71]

Given the significance of male heirs to the lineage, choosing an adoptee was not a simple negotiation between the two families involved, but a business of mutual concern that needed discussion and decision by the whole lineage. In some cases, the local magistrates had the final say on the adoptee (Wang 2016; Gao, Zhang, and Peng 2018). In an edict during the Hongzhi reign (1488-1505), it was written that "if the adoptee was of the same surname, the adoptive father's kinsmen could not raise objections to the adoption"; another edict of the Jiajing reign (1522-1566) stated the warning again (Waltner 1990, p.55). An heirless male was not free to adopt whomever he pleased and his brother or cousin whose son was adopted had to accept the order to surrender a son for adoption and could not reject a lineage decision either.

Another characteristic of the practice is that it was not a commercial transaction if the two involved males were close relatives. According to Wolf and Huang (1980, p.110), residents in Haishan, a small county in Taiwan, "did not ask compensation for a child taken by a recognized agnate". There were cases that the father who surrendered a son would ask for a payment, but "adoption only became a commercial transaction when the parties were strangers or distant relatives who no longer observed the formalities of kinship" (Wolf and Huang 1980, p.110).

In my sample, 18,927 males have biological sons, and 2,056 of them surrendered one or more sons. After transferring sons between families, 20,342 males have sons in total, and 2,188 of them adopted one or more sons. Of the 41,145 sons, 2,280 in total are adoptees, and 2,255 of them have clear records on both biological fathers and stepfathers. In terms of the

[71] The original Chinese article is "凡无子者，许令同宗昭穆相当之侄承继，先尽同父(衰)亲，次及大功、小功、缌麻，如俱无，方许择立远房及同姓为嗣者".

relationship between fathers and stepfathers, 1,457 (64.6%) of the 2,255 pairs are brothers, 493 (22.2%) of them are first cousins. The rest 305 pairs are second cousins or more distant relatives, but they shared the same surname.

Moreover, in my sample, the correlation between biological father's literacy and the probability that he would surrender a son is positive, albeit relatively small (0.02), while the correlation between stepfather's literacy and the probability that he would adopt a son is negative (-0.02). The results suggest that the adoption practice in traditional China was not a strategy that the poor families utilized to sell sons to the rich families for money or resources. Instead, it was more common that the rich families would surrender sons to the poor families to help them continue their bloodlines.

A father would yield a son only if he was asked to do so by an heirless brother or male cousin. He could hardly predict that his brother or cousin would end up having no son and prepare for the adoption in advance. Thus, the variation that induced by the practice of adoption is a random shock to the family size. I then instrument the number of brothers that a male had by the exogenous variation induced by whether or not the male lost brothers to adoption.

Therefore, having a brother who was put up for adoption is a valid instrumental variable because it was strongly correlated with the number of brothers a male had. It did not directly affect his quality as no money was involved in the practice, but only indirectly through the channel of the decreasing family size (see Figure 4.1 and Table 4.A3).

A related concern is that if the son was adopted out in his adulthood, the actual effects that the changing family size had on the quality of his biological brothers, especially his elder brothers stayed in the family of origin would be negligible. Although the age of adoption for sons are not recorded in the genealogical books, Wolf and Huang (1980, pp. 211-212, Table 15.4) show that in Haishan between the years 1906 and 1935, about two thirds of the adoptees were moved to the foster families by age 2, and nearly all of the adoptees were younger than age 10 when they were adopted out. Given the similar cultures in South China, I assume that most adoptees would be moved to the new families by age 10 in the six lineages, which means most of the adoptions would happen before or at least during the "quality" formation periods of the adoptees and also their biological brothers.

Moreover, the intentions of the families involved do not matter in this situation, so losing brothers for adoption is not correlated with the error term. One might still worry that the fathers who were chosen to give up sons might share some intrinsic characteristics that correlated with the practice of adoption. In all the specifications of the IV estimation, I directly control for the father's and the grandfather's literacy to deal with the concern.

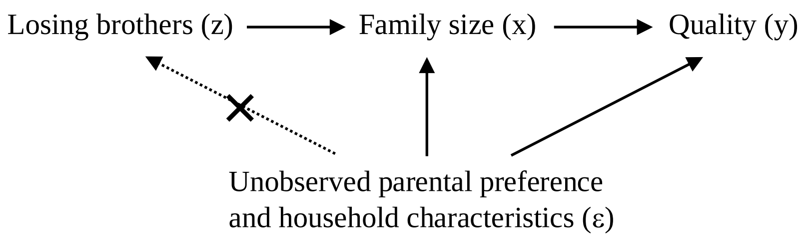

Figure 4.1 The validity of the instrument variable

Hence, I then instrument the number of brothers that a male had by the exogenous variation induced by whether or not the male lost brothers to adoption. It is worth noting that the sample in this part of the analysis excluded all the adoptees. I am not looking at families that were expanded because of adoption, but only at the families that experienced a decrease in family size and the unaffected families. I use an OLS regression and a Probit regression to estimate Equations (3) and (4), respectively,

$$Brothers_i = \alpha_2 + \beta_2 AdoptOut_i + \delta_2 P_i + \gamma_2 W_i + \varepsilon_i, \quad (3)$$

$$Quality_i = \alpha_3 + \beta_3 \widehat{Brothers}_i + \delta_3 P_i + \gamma_3 W_i + \varepsilon_i, \quad (4)$$

in which the dummy *AdoptOut* equals one if a male individual had brothers who were adopted out, and it equals zero if none of his brothers was adopted out. *Brothers* still denotes the final family size. The other notations are as in Equation (2).

4.4 Results

4.4.1 The optimal level of fertility for long-run reproductive success

The results of regressions based on Equation (1) show that there was a Darwinian trade-off between parental fertility and next generation fertility in the six lineages (see Table 4.2).[72] The square term of *Sons* maintains the negative and statistically significant effects on fertility of the subsequent three generations in all columns in all three specifications, which indicates the

[72] I report the OLS results in Table 4.A2 in Appendix 4.A.

presence of an optimal level of net fertility for long-run reproductive success. The fitness for long-run survival would diminish beyond a certain level of fertility.

Conditioning on all factors, if a male were to have one more son, his rate for the number of male offspring in generations 3-5 would be expected to increase by a factor of about 1.7 (columns 7 to 9). Figure 4.2 shows the predicted number of grandsons, great-grandsons, and great-great-grandsons that a male in the sample could have at each level of fertility. The estimated optimal number of sons that a male should have if he wanted the greatest number of male descendants in the long run is nine.[73]

As Figure 4.3 demonstrates, only 165 males (1.76%) from the "ancestor" sample had more than five sons. Therefore, for most of the sample, more sons could directly translate into more grandsons, great-grandsons, and great-great-grandsons. The result is different from the findings of Galor and Klemp (2014) in Quebec from the sixteenth to the eighteenth centuries, where the optimal level of fertility was below the population median. Although the optimal level of fertility is beyond the fertility of the majority in the six lineages, fertility still retains a hump-shaped effect on long-run survival, which suggests that larger family size had an adverse effect on child quality which in turn could negatively affect the long-run reproductive success.

Moreover, the statistically significant coefficients on *Literacy* in columns 7 to 9 also indicate that literate males could leave more male descendants than illiterate males could in subsequent generations. In the previous chapter, I demonstrate that if a male were of higher social status, in other words, if a male were literate, he could be expected to leave more sons than an illiterate male. The coefficients on *Literacy* in this chapter substantiate this positive effect one step further. The literacy of a male could affect not only his fertility, but also the fertility of at least the next two generations. The persistent effect of human capital shown in the six lineages also validates what Song et al. (2015) find in North China from 1725 to 1875 and Lee and Park (2019) find in pre-modern Korea.

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[73] Figure 4.2 also shows overly wide confidence intervals for the predicted numbers of great-grandsons and great-great-grandsons at high fertility levels (8-12 sons). It is due to the very limited observations (22 males had more than 7 sons in total) and great variations in the number of great-grandsons and great-great-grandsons they had. For example, 2 of the 22 males ended up with having no great-grandsons and 3 of them had no great-great-grandsons; while the one who had 12 sons, had 71 great-grandsons and 50 great-great-grandsons.

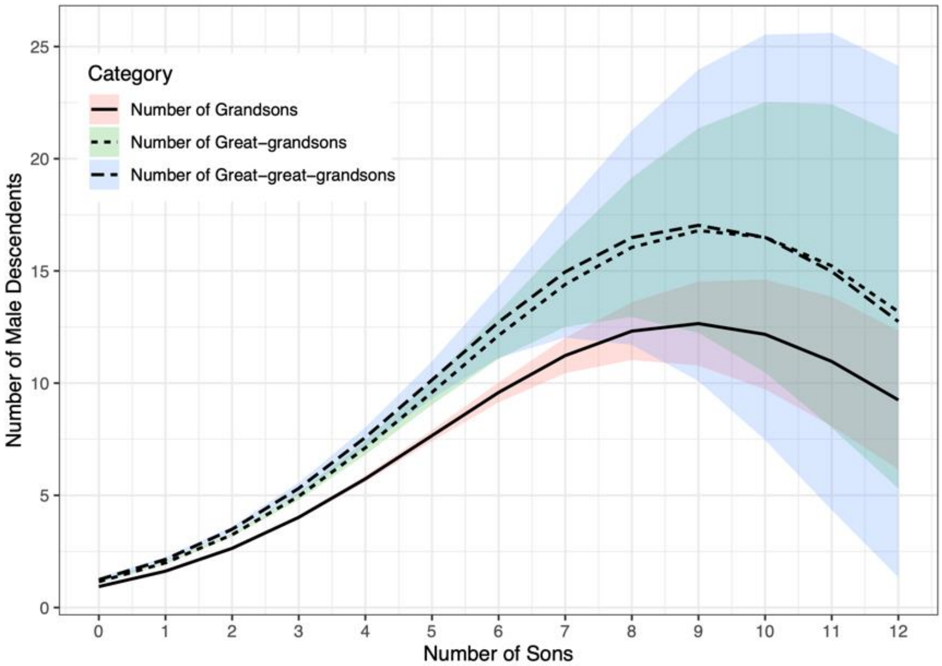

Figure 4.2 Predicted number of male descendants in the three generations at each level of fertility, unconditional relationship

Notes: 1. The predicted values are calculated from the results in columns 1-3 of Table 4.2. 2. The shaded area represents the 95% confidence interval for the predicted curve.

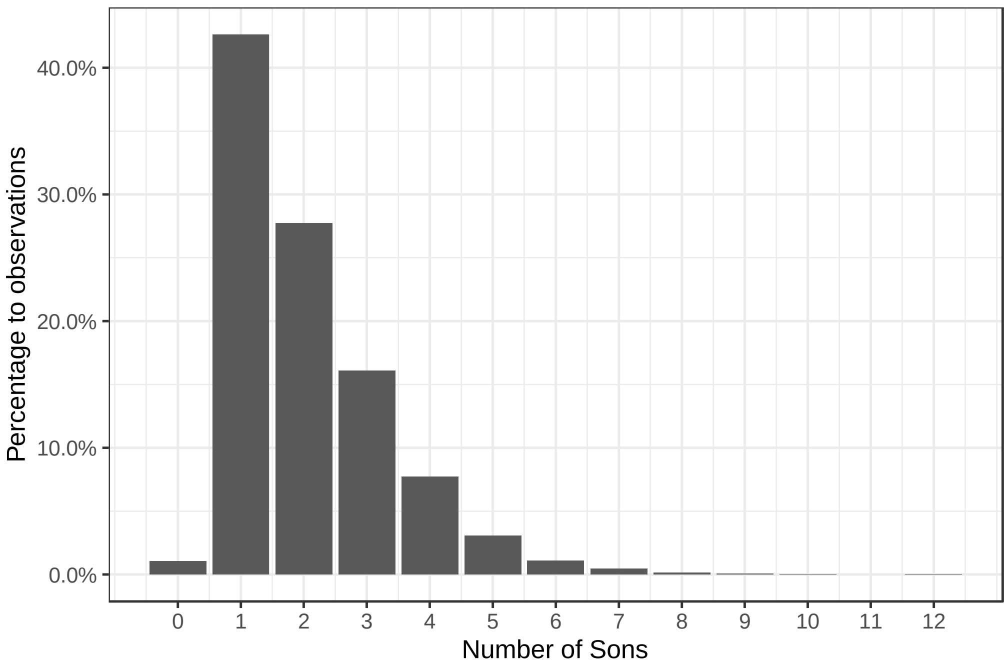

Figure 4.3 Distribution of number of sons of the "ancestors" in the sample

Source: The lineage sample.

Table 4.2 The effects of *Sons* on the number of male descendants for males born from 1350 to 1920, negative binomial regression

	Dependent Variable: Number of male descendants in								
	Gen.3	Gen.4	Gen.5	Gen.3	Gen.4	Gen.5	Gen.3	Gen.4	Gen.5
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Sons	1.791***	1.781***	1.800***	1.766***	1.754***	1.752***	1.778***	1.756***	1.714***
	(0.057)	(0.058)	(0.069)	(0.062)	(0.065)	(0.083)	(0.045)	(0.059)	(0.092)
$Sons^2$	0.968***	0.969***	0.967***	0.968***	0.970***	0.969***	0.965***	0.965***	0.966***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.004)	(0.005)	(0.007)
Literacy							1.253***	1.495***	1.587***
							(0.032)	(0.061)	(0.099)
Marriages							1.100***	1.145***	1.194***
							(0.021)	(0.034)	(0.054)
Controls									
Firstborn	N	N	N	Y	Y	Y	Y	Y	Y
Out-migration	N	N	N	Y	Y	Y	Y	Y	Y
Survival	N	N	N	Y	Y	Y	Y	Y	Y
Birth cohort FE	N	N	N	Y	Y	Y	Y	Y	Y
Lineage FE	N	N	N	Y	Y	Y	Y	Y	Y
Constant	0.938***	1.149***	1.230***	1.252***	1.607***	1.627***	1.179***	1.498***	1.581***
	(0.042)	(0.049)	(0.065)	(0.261)	(0.409)	(0.586)	(0.253)	(0.391)	(0.621)
N	9,364	9,364	9,364	7,016	7,016	7,016	7,016	7,016	7,016
Pseudo R^2	0.091	0.040	0.023	0.097	0.045	0.037	0.101	0.049	0.041

Notes: 1. Coefficients are incidence rate ratios (IRR) for the negative binomial regression, and robust standard errors are in parentheses. 2. *p<0.1; **p<0.05; ***p<0.01.

4.4.2 Mechanisms through which fertility affected long-run reproductive success

Galor and Klemp (2014) discern that moderate fecundity could enhance child quality by increasing the probability of getting married and getting educated, which would thus enable the children to leave more descendants. Therefore, in this section, I examine in the six lineages the two types of Beckerian child quantity-quality trade-off: the effects of family size on the sons' probabilities of marriage and literacy.

4.4.2.1 Logistic estimation results

Tables 4.3 and 4.4 report the Logistic regression results based on Equation (2). In Table 4.3, where quality is measured by marriage, the key variable *Brothers* always retains positive coefficients in all six specifications. If a male had more brothers, he would be more likely to get married. Column 6 establishes that the results are robust to controlling for the father's and the grandfather's literacy.

Table 4.4 suggests a rather different role that family size played. Before the inclusion of father's and grandfather's literacy, columns 1-5 suggest that for a one unit increase in *Brothers*, the odds for the male of being literate versus not being literate increase by a factor of about 1.2. However, after including the two variables in column 6, the coefficient on *Brothers* is no longer statistically significant. Controlling for the male's lifespan and his father's lifespan in column 7 does not much change the coefficient on the number of brothers. The effects of number of brothers a male had on his literacy were thus unclear, given the insignificant coefficients on *Brothers* in the two specifications.

As expected, the variables that have the most substantial effect on sons' quality are the father's and the grandfather's literacy. Figure 4.4 demonstrates the predicted probability of being literate and being married for different sized families, conditioned on father's literacy. The figure shows that the considerable difference in sons' quality arises from the difference in fathers' human capital. For a male who was brought up in a family of two sons, the predicted probability of marriage is about 75.3 per cent if he had a literate father, while that for a male who had an illiterate father is about 65.5 per cent. The difference is wider for the probability of being literate, while the two probabilities are 21.8 per cent and 3.4 per cent, respectively.

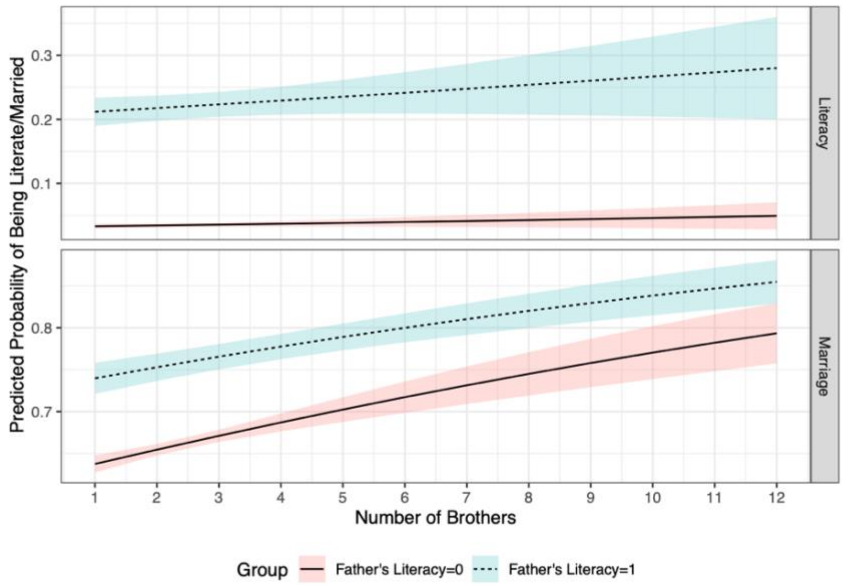

Figure 4.4 Predicted probability of being literate/married for different sized families, with a literate and an illiterate father

Notes: 1. The predicted values are calculated from the results of column 6 of Table 4.3 and column 6 of Table 4.4. 2. The shaded area represents the 95% confidence interval for the predicted curve.

Table 4.3 The relationship between family size and marriage, logistic regression

	Dependent Variable:					
	Marriage					
	(1)	(2)	(3)	(4)	(5)	(6)
Brothers	1.013	1.036***	1.120***	1.136***	1.135***	1.108***
	(0.012)	(0.014)	(0.018)	(0.019)	(0.019)	(0.020)
Uncles					1.019	1.011
					(0.013)	(0.013)
Father's literacy						1.971***
						(0.141)
Grandfather's literacy						1.091
						(0.070)
Firstborn			1.382***	1.410***	1.410***	1.426***
			(0.040)	(0.042)	(0.042)	(0.044)
Adoptee				1.346***	1.347***	1.387***
				(0.086)	(0.086)	(0.092)
Controls						
Out-migration	N	N	Y	Y	Y	Y
Survival	N	N	Y	Y	Y	Y
Birth cohort FE	N	Y	Y	Y	Y	Y
Lineage FE	N	Y	Y	Y	Y	Y
Constant	2.258***	2.938***	0.049***	0.048***	0.046***	0.064***
	(0.065)	(0.939)	(0.019)	(0.018)	(0.017)	(0.026)
N	36,360	31,106	31,106	31,106	31,080	29,449
Pseudo-R^2	0.0001	0.086	0.235	0.235	0.235	0.245

Notes: 1. If the individual is an adoptee, then "Father's literacy" and "Grandfather's literacy" denote his stepfather's and step-grandfather's literacy. 2. Coefficients are the odds ratio for the logistic regression, and robust standard errors are in parentheses, clustered on fathers. 3. *p<0.1; **p<0.05; ***p<0.01.

Table 4.4 The relationship between family size and literacy, logistic regression

	Dependent Variable:						
	Literacy						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Brothers	1.174***	1.192***	1.225***	1.243***	1.227***	1.040	1.029
	(0.025)	(0.024)	(0.026)	(0.027)	(0.028)	(0.026)	(0.034)
Uncles					1.123***	0.985	0.965
					(0.019)	(0.019)	(0.023)
Father's literacy						9.532***	8.261***
						(0.801)	(0.880)
Grandfather's literacy						3.204***	3.229***
						(0.281)	(0.357)
Firstborn			1.187***	1.209***	1.204***	1.375***	1.397***
			(0.047)	(0.048)	(0.049)	(0.071)	(0.100)
Adoptee				1.447***	1.427***	1.661***	1.719***
				(0.132)	(0.130)	(0.190)	(0.283)
Age at death							1.026***
							(0.003)
Father's age at death							1.007**
							(0.003)
Controls							
Out-migration	N	N	Y	Y	Y	Y	Y
Survival	N	N	Y	Y	Y	Y	Y
Birth cohort FE	N	Y	Y	Y	Y	Y	Y
Lineage FE	N	Y	Y	Y	Y	Y	Y
Constant	0.058***	0.004***	0.001***	0.001***	0.001***	0.001***	0.001***
	(0.003)	(0.002)	(0.0004)	(0.0004)	(0.0003)	(0.0004)	(0.0008)
N	36,360	31,106	31,106	31,106	31,080	29,449	8,343
R-squared	0.009	0.145	0.155	0.156	0.160	0.356	0.346

Notes: 1. If the individual is an adoptee, then "Father's literacy" and "Grandfather's literacy" denotes his stepfather's and step-grandfather's literacy. 2. Coefficients are the odds ratio for the logistic regression, and robust standard errors are in parentheses, clustered on fathers. 3. *p<0.1; **p<0.05; ***p<0.01.

4.4.4.2 Child quantity-quality relationship by period

I then separate the sample into three sub-samples that refer to three different periods. Table 4.5 shows the positive correlations between the brothers that a male had and the probability of his marriage in the period 1600 to 1900, but an uncertain relationship between the two in the pre-1600 period. In 1600-1900, if a male were to have one more brother, the odds of his being married could increase by a factor of 1.1.

Table 4.5 also details the results by using literacy as a measure for child quality. The positive effects of family size were only present for the period 1600-1800. In the periods 1400-1600 and 1800-1900, the coefficients on *Brothers* are not statistically significant. The odds ratio on *Brothers* is even smaller than one between 1400 and 1600, which implies a possible negative relationship between family size and literacy.

Table 4.5 The fertility-marriage and fertility-literacy relationships by period, logistic regression

	Dependent Variable:					
	Marriage	Literacy	Marriage	Literacy	Marriage	Literacy
	1400-1600		1600-1800		1800-1900	
	(1)	(2)	(3)	(4)	(5)	(6)
Brothers	1.103	0.921	1.091***	1.070**	1.114***	1.010
	(0.090)	(0.085)	(0.027)	(0.034)	(0.028)	(0.041)
Uncles	1.092	1.004	0.997	0.997	0.990	0.938*
	(0.089)	(0.088)	(0.018)	(0.024)	(0.019)	(0.037)
Father's literacy	1.267	5.974***	2.029***	7.631***	1.949***	16.629***
	(0.383)	(1.394)	(0.215)	(0.795)	(0.188)	(2.692)
Grandfather's	1.361	2.769***	0.922	3.580***	1.060	2.636
literacy	(0.408)	(0.696)	(0.085)	(0.397)	(0.093)	(0.441)
Firstborn	1.682***	1.297	1.454***	1.466***	1.378***	1.247***
	(0.249)	(0.227)	(0.067)	(0.107)	(0.065)	(0.114)
Adoptee	1.700	2.177	1.358***	1.924***	1.396***	1.320
	(0.940)	(1.257)	(0.159)	(0.306)	(0.123)	(0.233)
Controls						
Out-migration	Y	Y	Y	Y	Y	Y
Survival	Y	Y	Y	Y	Y	Y
Birth cohort FE	Y	Y	Y	Y	Y	Y
Lineage FE	Y	Y	Y	Y	Y	Y
Constant	0.033***	0.003***	0.062***	0.0001***	0.002***	0.0004***
	(0.037)	(0.004)	(0.014)	(0.0001)	(0.0005)	(0.0005)
N	1,424	1,420	14,075	14,075	12,963	12,963
Pseudo R^2	0.192	0.360	0.160	0.357	0.300	0.333

Notes: 1. The coefficients are the odds ratio for the logistic model. 2. Robust standard errors are in parentheses, clustered on fathers. 3. *p<0.1; **p<0.05; ***p<0.01.

4.4.4.3 Using the offering of sons for adoption as an instrumental variable

This section turns to the instrumented evidence on the child quantity-quality trade-off. The logistic regression results could be biased because of the unobserved parental preference and household features, despite the fact that controlling for grandfather's literacy and the number of uncles could partially capture them.

To start with, I regress only the male's quality on whether or not he had brothers who were given away. Figure 4.5 demonstrates the predicted probability of being married and being literate by family size, measured by the number of brothers that a male had. The control group includes males who had no brothers surrendered for adoption, and the treated group includes males who had brothers surrendered for adoption. For the control group, the positive relationships between family size and the two qualities are clear. However, the predicted probability of being married was not always higher for the treated group, while the predicted probability of being literate was always higher than that of the controlled group at each level of family size. Nonetheless, the raw relationship suggests that if the family size decreased because of the adoption, sons who stayed in the family would be more likely to be literate.

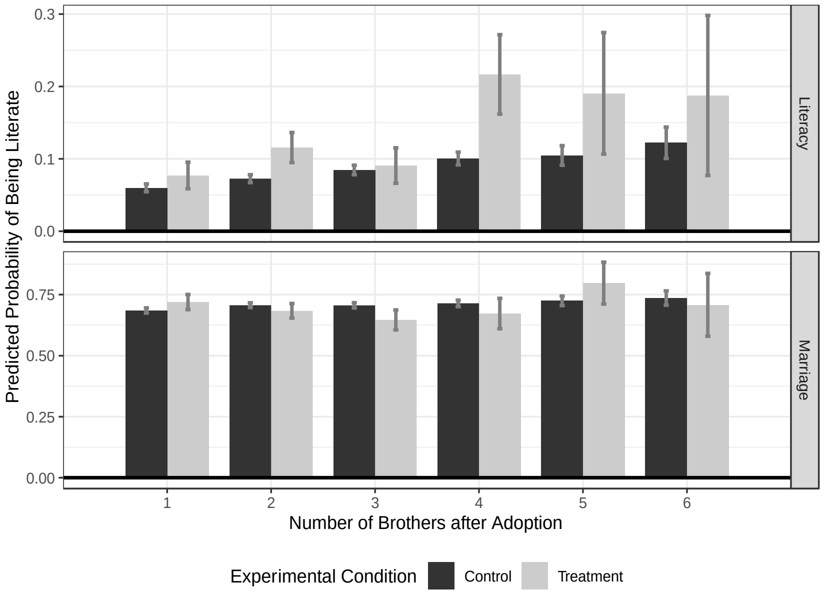

Figure 4.5 Predicted probability of being literate and married by the number of brothers, losing/not losing a brother to adoption

Notes: 1. The "control" group denotes males who had no adopted-out brother, and the "treatment" group denotes males who had adopted-out brothers. 2. Values are the expected probability of being literate and married at each level of the father's number of sons after adoption, calculated from regressing *Literacy*/*Marriage* on *Brother*. 3. Only *Brother*=1 to 6 are included, because the fathers who had more than six sons did not have adopted-out sons. 4. Error bars indicate 95 per cent confidence intervals.

The IV estimation results based on Equations (3) and (4) are in Tables 4.6 and 4.7. Table 4.6 details the results of the full sample, which includes all the males who were born from 1350 to 1920 in the six lineages. The OLS results for the first stage are reported in column 1, and the average marginal effects of the Probit regressions for the second stage are reported in columns 2 and 3, where the dependent variables are *Marriage* and *Literacy*, respectively. Table 4.7 reports the results of three sub-periods, 1400 to 1600, 1600 to 1800, and 1800 to 1900. Columns 1, 4, and 7 report the first stage results, and the remaining columns report the second stage results.

The *F*-statistic on the instrument remains higher than the Stock and Yogo (2005) critical value in Table 4.6, and also in the specifications of periods after 1600 in Table 4.7, ruling out the weak instrument concern.

As Table 4.6 demonstrates, the instrument results indicate that having brothers who were adopted out had both statistically and quantitatively significant average marginal effects on the probability that a male would be literate, but no significant effects on the probability that he would be married. The results in column 3 of Table 4.6 indicate that if a male were to have one more brother, the probability that he would be literate would decrease by 2.6 percentage points. Having a literate father would increase the probability that the male would be married and literate by 12.2 percentage points and by 14.7 percentage points, respectively. It suggests that if a male had a literate father, then he had to have at least five brothers to counterbalance the positive effects that having a literate father had on his literacy. In other words, for the majority of males who had literate fathers in the six lineages, despite being raised in larger families, they were still more likely to be literate than the ones with illiterate fathers.

Table 4.7 shows that the relationships also varied across periods. In terms of the marriage probability, the insignificant coefficients on the number of brothers suggest that family size could not affect the likelihood that a male would be married throughout the entire period. In terms of being literate, the negative effects of family size can be found only in the period 1600-1800. From 1400 to 1600 and from 1800 to 1900, the human capital of the father and the grandfather could account for the son's human capital to a great extent. For males who were born in the period 1600 to 1800, having one more brother would lead to an average decrease of 5.4 percentage points in the probability of literacy. Nevertheless, in both cases, the father's literacy still remained the factor that mattered the most. For example, in 1600-1800, having a literate father would increase the literacy probability by 16.5 percentage points.

In Table 4.8, I separate the sample again based on the two types of lineage, the common lineages and the elite ones. The relationship between the number of brothers and marriage probability in the common and the elite lineages were similar, and similar to previous results, family size did not affect the male's "quality" measured by marriage probability. In terms of literacy, the trade-off of child quantity and quality is only observed in elite lineages: having one more brother would cause an average decrease of 3.5 percentage points in the probability of literacy.

The contradictory results between the instrumental variable estimates and the logistic estimates imply that the previous results are biased because of the omitted variables. Clearly, the human capital of the father and the grandfather cannot entirely capture the parental preference and family features. The positive covariance of the unobserved household features and the two quality indicators leads the logistic estimates of the coefficient on *Brothers* to be greater than the real value of the coefficient.

Table 4.6 Two-stage regression with adopted-out sons, 1350-1920

	First Stage	Second Stage	Second Stage
	Brothers	Marriage	Literacy
	(1)	(2)	(3)
Adopted-out brothers	-0.586***		
	(0.040)		
Brothers		-0.013	-0.026**
		(0.018)	(0.012)
Father's literacy	0.467***	0.122***	0.147***
	(0.056)	(0.014)	(0.012)
Grandfather's literacy	0.182***	0.018*	0.067***
	(0.045)	(0.011)	(0.007)
Controls			
Firstborn	Y	Y	Y
Out-migration	Y	Y	Y
Survival	Y	Y	Y
Birth cohort FE	Y	Y	Y
Lineage FE	Y	Y	Y
Constant	3.217***		
	(0.234)		
Observations	27,480	27,480	27,480
Number of clusters	14,638	14,638	14,638
p-value, Wald exogenous test		0.090	0.010
F-statistic on instrument	215.94		

Notes: 1. Robust standard errors clustered by fathers in parentheses. 2. Ivprobit estimation: the first stage being OLS, the second stage probit, regressed on predicted values from the first stage. The two models have the same first stage. 3. The coefficients in columns 2 and 3 are average marginal effects. The *F*-statistic on the instrument is derived from a 2SLS estimate, which has the same first stage. 4. *p<0.1; **p<0.05; ***p<0.01.

Table 4.7 Two-stage regression with adopted-out sons by period

	First Stage	Second Stage	Second Stage	First Stage	Second Stage	Second Stage	First Stage	Second Stage	Second Stage
		1400-1600			1600-1800			1800-1900	
	Brothers	Marriage	Literacy	Brothers	Marriage	Literacy	Brothers	Marriage	Literacy
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Adopted-out brothers	-0.538**			-0.604***			-0.565***		
	(0.242)			(0.058)			(0.052)		
Brothers		-0.035	-0.102		0.005	-0.054**		-0.033	0.004
		(0.124)	(0.094)		(0.025)	(0.022)		(0.025)	(0.014)
Father's literacy	0.454***	0.034	0.219***	0.461***	0.104***	0.165***	0.424***	0.141***	0.118***
	(0.121)	(0.064)	(0.035)	(0.081)	(0.019)	(0.020)	(0.081)	(0.018)	(0.007)
Grandfather's literacy	0.020	0.036	0.112***	0.261***	-0.008	0.089***	0.070	0.006	0.035***
	(0.113)	(0.034)	(0.025)	(0.063)	(0.015)	(0.013)	(0.070)	(0.016)	(0.007)
Controls									
Firstborn	Y	Y	Y	Y	Y	Y	Y	Y	Y
Out-migration	Y	Y	Y	Y	Y	Y	Y	Y	Y
Survival	Y	Y	Y	Y	Y	Y	Y	Y	Y
Birth cohort FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lineage FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Constant	5.080***			3.732***			4.125***		
	(0.659)			(0.116)			(0.225)		
Observations	1,398	1,398	1,394	13,359	13,353	13,353	11,764	11,764	11,764
Number of clusters	743	743	741	7,050	7,047	7,047	6,811	6,811	6,811
p-value, Wald exogenous test		0.693	0.299		0.754	0.0001		0.036	0.718
F-statistic on instrument	4.95			107.37			119.01		

Notes: 1. Robust standard errors clustered by fathers in parentheses. 2. Ivprobit estimation: the first stage being OLS, the second stage probit, regressed on predicted values from the first stage. The two models have the same first stage. 3. Coefficients in columns 2, 3, 5, 6, 8, and 9 are average marginal effects. The *F*-statistic on the instrument is derived from a 2SLS estimate, which has the same first stage. 4. *p<0.1; **p<0.05; ***p<0.01.

Table 4.8 Two-stage regression with adopted-out sons by lineage type, 1350-1900

	First Stage	Second Stage	Second Stage	First Stage	Second Stage	Second Stage
	Common Lineages Brothers	Marriage	Literacy	Elite Lineages Brothers	Marriage	Literacy
	(1)	(2)	(3)	(4)	(5)	(6)
Adopted-out brothers	-0.550***			-0.569***		
	(0.150)			(0.041)		
Brothers		-0.074	-0.133		-0.015	-0.035**
		(0.053)	(0.035)		(0.017)	(0.014)
Father's literacy	0.405***	0.194***	0.121***	0.473***	0.090***	0.160***
	(0.112)	(0.025)	(0.037)	(0.062)	(0.014)	(0.013)
Grandfather's literacy	0.260**	0.026	0.036**	0.116**	0.001	0.079***
	(0.101)	(0.025)	(0.018)	(0.048)	(0.011)	(0.008)
Controls						
Firstborn	Y	Y	Y	Y	Y	Y
Out-migration	Y	Y	Y	Y	Y	Y
Survival	Y	Y	Y	Y	Y	Y
Birth cohort FE	Y	Y	Y	Y	Y	Y
Lineage FE	Y	Y	Y	Y	Y	Y
Constant	3.503***			3.492***		
	(0.296)			(0.585)		
Observations	8,488	8,488	8,464	18,130	18,106	18,130
Number of clusters	3,649	3,649	3,642	10,569	10,556	10,569
p-value, Wald exogenous test		0.131	0.746		0.101	0.002
F-statistic on instrument	13.46			195.14		

Notes: 1. Males in birth cohort 1900-1920 are dropped in the regressions because none of them were literate. 2. Robust standard errors clustered by fathers in parentheses. 3. Ivprobit estimation: the first stage being OLS, the second stage probit, regressed on predicted values from the first stage. The two models have the same first stage. 4. Coefficients in columns 2, 3, 5, and 6 are average marginal effects. The *F*-statistic on the instrument is derived from a 2SLS estimate, which has the same first stage. 5. *p<0.1; **p<0.05; ***p<0.01.

4.5 Conclusion

The chapter uses a new genealogical dataset and demonstrates the survival pattern of six Chinese lineages in the Ming and Qing dynasties. Empirical investigation indicates the presence of an optimal level of fertility for long-run reproductive success, despite the fact that the optimal level was beyond the fertility level of most of the males in the sample. A close analysis of the mechanisms through which fertility affected the survival of the family line demonstrates the dual role that a father's fertility took in affecting two types of offspring quality, measured by marriage and literacy. Instrumenting family size by the variation induced by the practice of adoption, I find that the number of brothers a male had could not affect his marriage throughout the entire period; while having one more brother would reduce the probability of a male's being literate in the seventeenth and eighteenth centuries. The results also point to the fact that child quality was more closely related to the father's human capital than to the father's fertility: the strong positive effects of father's human capital on child quality could more than offset the negative effects of increasing family size.

Appendices

Appendix 4.A Extra tables for Chapter 4

Table 4.A1 Summary statistics for Chapter 4

Statistics	N	Mean	Std.	Min	Max
All Males					
Literacy	36,456	0.08	0.28	0	1
Father literacy	35,614	0.14	0.35	0	1
Grandfather literacy	34,524	0.18	0.38	0	1
Number of brothers	36,456	2.56	1.49	1	12
Number of uncles	36,422	2.63	1.55	1	12
Number of marriages	36,456	0.80	0.63	0	10
Age at death	11,344	50.02	17.60	1	105
Father's age at death	16,085	57.05	14.30	15	105
Adoptee	36,456	0.06	0.24	0	1
Firstborn	36,456	0.50	0.50	0	1
Out-migration	36,456	0.01	0.07	0	1
Survival to adulthood	36,456	0.91	0.28	0	1
Birth cohort	34,863	5.17	0.98	1	7
Lineage	36,456	3.77	1.40	1	6
Ancestors					
Number of sons	9,364	2.05	1.27	0	12
Number of grandsons	9,364	2.94	2.98	0	50
Number of great-grandsons	9,364	3.63	5.17	0	88
Number of great-great-grandsons	9,364	3.89	7.82	0	194
Literacy	9,364	0.13	0.34	0	1
Number of marriages	9,364	1.14	0.48	0	10
Firstborn	9,364	0.51	0.50	0	1
Out-migration	9,364	0.001	0.04	0	1
Survival to adulthood	9,364	0.997	0.06	0	1
Birth cohort	8,725	4.31	0.95	1	7
Lineage	9,364	3.82	1.29	1	6
Non-adoptees					
Literacy	34,176	0.08	0.28	0	1
Father literacy	33,356	0.14	0.35	0	1
Grandfather literacy	32,326	0.18	0.38	0	1
Number of brothers	34,176	2.65	1.49	1	12
Having adopted-out brother(s)	34,176	0.08	0.26	0	1
Firstborn	34,176	0.51	0.50	0	1
Out-migration	34,176	0.01	0.07	0	1
Survival to adulthood	34,176	0.91	0.28	0	1
Birth cohort	32,646	5.15	0.997	1	7
Lineage	34,176	3.73	1.41	1	6

Notes: 1. The "number of brothers" includes the male individual himself, and the "number of uncles" includes the male individual's father. 2. "Father literacy" denotes the stepfather's literacy if the individual is an adoptee. 3. "Father's age at death" denotes the biological father's age at death for all individuals.

Table 4.A2 Effects of the number of sons on the number of grandsons, OLS regression

	Dependent Variable: ln (Number of male descendants+1)								
	Gen.3	Gen.4	Gen.5	Gen.3	Gen.4	Gen.5	Gen.3	Gen.4	Gen.5
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Sons	0.384***	0.351***	0.292***	0.391***	0.371***	0.314***	0.383***	0.358***	0.303***
	(0.018)	(0.024)	(0.027)	(0.020)	(0.027)	(0.029)	(0.018)	(0.024)	(0.027)
$Sons^2$	-0.018***	-0.015***	-0.011***	-0.019***	-0.016***	-0.012**	-0.019***	-0.017***	-0.014**
	(0.003)	(0.004)	(0.005)	(0.003)	(0.005)	(0.005)	(0.003)	(0.004)	(0.004)
Literacy							0.173***	0.295***	0.269***
							(0.021)	(0.032)	(0.037)
Marriages							0.067***	0.083***	0.114***
							(0.015)	(0.023)	(0.027)
Controls									
Firstborn	N	N	N	Y	Y	Y	Y	Y	Y
Out-migration	N	N	N	Y	Y	Y	Y	Y	Y
Survival	N	N	N	Y	Y	Y	Y	Y	Y
Birth cohort FE	N	N	N	Y	Y	Y	Y	Y	Y
Lineage FE	N	N	N	Y	Y	Y	Y	Y	Y
Constant	0.460***	0.484***	0.473***	0.634***	0.765***	0.794***	0.591***	0.713***	0.722***
	(0.020)	(0.027)	(0.003)	(0.133)	(0.168)	(0.183)	(0.136)	(0.167)	(0.184)
N	9,364	9,364	9,364	7,016	7,016	7,016	7,016	7,016	7,016
R^2	0.275	0.143	0.083	0.305	0.181	0.168	0.315	0.196	0.180

Notes: 1. Robust standard errors are in parentheses. 2. *p<0.1; **p<0.05; ***p<0.01.

Table 4.A3 Effects of losing brothers on child quality, OLS regression

	Dependent Variable:	
	Marriage	Literacy
	(1)	(2)
Adopted-out brothers	0.005	0.013
	(0.011)	(0.008)
Father's literacy	0.113***	0.369***
	(0.010)	(0.010)
Lineage FE	Y	Y
Birth cohort FE	Y	Y
Constant	0.680***	0.102***
	(0.038)	(0.041)
N	28,391	28,391
R-squared	0.109	0.279

Notes: 1. Robust standard errors are in parentheses, clustered on fathers. 2. *p<0.1; **p<0.05; ***p<0.01.

Chapter 5

Conclusion

This thesis is a new examination of fertility in Ming-Qing China which uses a novel dataset constructed from genealogical biographies of more than 70,000 family members of six Chinese lineages. The individual-level dataset allows the thesis to systematically investigate the fertility choices in Chinese families from several different perspectives. New empirical evidence has been shown of the marital fertility rates, the absence of deliberate fertility controls, social gradients in fertility, and the reproductive success in the long run.

The three substantive chapters indicate three main sets of results. Chapter 2 estimates the total marital fertility rates in Chinese families and offers a starting point for studying fertility. It exploits the fertility behaviours of the wives in the five of the six lineages and shows the trend and changes in fertility rates. The results first suggest a rather low level of marital fertility in China compared to that in Western Europe in the pre-modern era, but also an absence of secular decline in fertility over this period. At the same time, the chapter shows that two effective parity-dependent controls, early stopping and longer spacing were absent in Chinese families. The two parts of analyses together demonstrate a unique fertility pattern in imperial China, namely, a combination of moderate fertility rates and no deliberate fertility controls.

Given the common practice of remarriages and concubinage in the upper-class population, studies of female fertility alone could hardly give a full picture of historical fertility in China. Therefore, Chapter 3 turns the focus to the reproduction of males, and explores the social gradients in male net reproduction in the six lineages. The empirical investigation finds a positive relationship between social status and fertility. The degree holders and the office holders produced three times as many sons as the non-degree holders. The social gradients are also robust to a set of individual-level and family-level socio-economic factors, including fathers' and brothers'/cousins' social outcomes. However, the effect disappears once I control for the number of marriages. Increased marriages among upper-class males drove reproductive success. The study of reproduction from the perspective of males thus complements the analysis in Chapter 2 and suggests that remarriages and polygamy also served as key social institutions that sustained the relatively steady population growth in late imperial China.

Chapter 4 investigates the transmission of fertility across generation, expanding the single-generational reproductive success story in Chapter 3 into a multi-generational one. The empirical results first show the presence of a Darwinian trade-off and find in the six lineages that the optimal level of fertility for long-run reproductive success was about nine sons. The chapter then turns to the hotly debated child quantity-quality relationship and finds that family size was negatively correlated with child literacy in the period 1600-1800, while its relationship between the child's chance of marriage was uncertain throughout the entire period. Given the limited negative effect that family size had on a son's literacy, the chapter finally concludes that it was not family size so much as father's human capital that was of central importance in affecting a son's quality.

The rest of the chapter first compares the main findings with those of previous literature from three perspectives and briefly discusses the general implications of the thesis. It then points out the limitations of the research and finally suggests two underexplored avenues for future genealogical research.

5.1 Comparisons with previous works

5.1.1 The causes of moderate marital fertility in imperial China

Why was marital fertility low in imperial China? Lee et al. propose mainly four factors to explain low fertility in China: 1) the high rate of female infanticide; 2) the unbalanced marriage market resulting from the distorted sex ratio; 3) the common practice of adoption and fictive kinship; 4) three "demographic mechanisms" within marriages: late starting, early stopping and long spacing (Lee et al. 1999a; 1999b; 2002; Wang et al. 1995, p. 98). Contradictory to their opinions, the neo-Malthusian scholars argue that even if fertility was low, it was simply a result of subsistence pressure, or more specifically, was merely "some combination of poor health, inadequate nutrition, heavy labour, and poverty-induced deposal separation", which had nothing to do with deliberate control (Wolf 2001; Huang 2002). They believe that all the so-called fertility controls were helpless choices of poor Chinese families.

The main findings of the thesis support some of their views, but also show that the arguments of both schools need some qualifications. Regarding the neo-Malthusian view, poverty cannot fully explain the low rates. Of the five lineages studied in Chapter 2 of the thesis, the two elite lineages, the Zha lineage and the Gu lineage had much lower marital fertility in most of the times. The high proportion of degree holders, stemming from the substantial investment in human capital, clearly proves that they were not lineages under high subsistence pressure at all. Furthermore, low living standards and poor health conditions could affect fecundity to some extent, but they were more harmful to the survival of offspring. Because infant mortality is considered in the research, low fertility could not be simply viewed as an outcome of poverty.

The four factors maintained by Lee et al. are not sufficient enough either. The first three factors that they propose are mainly related to the overall population growth pattern and attempt to explain the low rates of net reproduction from the perspective of family formation. The findings in Chapter 3 and Chapter 4 show that these three factors are significant in constraining net reproduction of the lower-social-status males in traditional China, but these factors cannot account for the low fertility rates of married females demonstrated in Chapter 2. In terms of the last factor, the “demographic mechanisms”, as Chapter 2 of the thesis argues, the absence of parity-dependent spacing and stopping suggests that the low rates were not caused by deliberate fertility controls. As argued in Section 5 of Chapter 2, the moderate level of marital fertility was mainly a by-product of a sets of cultural-related customs, rather than a conscious choice made by the Chinese parents.

5.1.2 Social gradients in fertility in common and elite lineages

Chapter 3 of the thesis is not the first attempt to show the relationship between social status and net reproduction. Table 5.1 describes the findings on this relationship in previous literature.

Various variables have been used to measure social status and net reproduction. Although positive relationship has been found in most of the works, Chapter 3 uses a new dataset and also provides specific social gradients in fertility. Moreover, as the genealogical sample used in this present thesis contains genealogies of two different types of lineage, the common and the elite lineages, the chapter enables to examine the relationships in the two types of lineage separately. The chapter finds different scale of social status effects on marriage and net reproduction, and also different scale of close kin effects on social status, marriage, and net reproduction in the two types of lineage. These findings are new to the ones in previous works.

Table 5.1 Previous literature on the relationship between social status and fertility

Article	Source	N	Status Measure	Status-fertility Relationship	Area and Period	Comments
Chen et al. 2010	Population Registers	108,100	Landed wealth	Positive (no specific social gradients in fertility given)	Shuangcheng, Northeast China; 1866-1907	The main results of the paper suggest that a married woman in families with larger ownership of land was more likely to have a registered male birth. After controlling for the household landed status, occupation of the husband does not play a key role in affecting wife's net fertility (only the group "soldier" had a statistically significant positive effect on female net fertility in one specification).
Song et al. 2015	Imperial Genealogies/ Liaoning household registers	Imperial lineage: 3,314; Liaoning: 18,997	Occupation and titles (banner, civil service, noble titles, salaried degree titles)	Positive	Beijing and Shenyang; 1675-1725 + 150 Liaoning: 1715-1765 + 125	The paper reveals the reproductive success enjoyed by high-social-status founders in a multi-generational model. Social gradients in net reproduction within the generation and also number of marriages are not the focus of the paper.
Harrel 1985	Genealogies	4,598	Occupation and titles	Positive	Xiaoshan, Zhejiang, 1550-1850	The paper reveals family-level estimates within lineages. It does not look at individual-level relationship and it does not examine it across lineages.
Telford 1995	Genealogies	10,512 husbands; 11,804 wives	Occupation and titles	Positive	Tongcheng, Anhui, 1520-1661	The observation unit is the annual growth rate of lineage population. It does not look at individual-level relationship.
Wang, Lee, and Campbell 1995	Imperial genealogies	43,950 husbands; 34,765 wives	Nobility	Positive	Beijing, 1680-1840	The paper demonstrates that high nobility and polygyny would increase royal nobles' net reproduction. It is a story about the Manchu royal family.
Lee and Campbell 2008	Household registers	161,000	Occupation and titles	Unclear (no specific gradients given)	Liaoning, 1749-1909	The empirical results demonstrate the positive relationship between the social status of the male individual and his likelihood to have the first marriage in the next register is positive. However, the effect of the male's or his father's position on his net reproduction is not statistically significant.

5.1.3 An effective strategy for child quantity and quality in traditional China

The results in Chapter 4 of this thesis illustrate a complex relationship between human capital and fertility in a multigenerational model. On the one hand, literate males in the six lineages could leave more male descendants in at least four subsequent generations, because their sons and grandsons were also more likely to be literate. On the other hand, literate males were expected to have more sons than the illiterate males had, while a larger family size would lower the probability that any of the sons in the family would be literate, especially in the period 1600 to 1800.

Because of the strong positive effects brought by fathers' human capital on sons' quality, the negative effects of increasing family size would be easily cancelled out. It also explains the high optimal level of fertility for long-run reproductive success shown in Figure 4.2 in Chapter 4. The negative effects of family size on the long-run reproductive success could only take effect when the number of sons a father had was greater than nine.

The presence of a negative relationship between offspring literacy and family size in the seventeenth and the eighteenth centuries confirms what Shiue (2017) reveals. Shiue (2017) argues that, because of the high returns to education in the early Qing period (1644-1800), parents were more willing to invest in their children's education; while after 1800, the population explosion, together with the expansion of civil exam degree holders made the degree less valuable than before, leading to the disappearance of the trade-off. Nevertheless, Chapter 4 takes a further step to examine the relationship in common and elite lineages separately, and finds that the negative relationship was present in the three elite lineages, but not in the three common ones.

However, it is worth pointing out that the human capital that is measured by *Literacy* in the present chapter is different from the "standard" human capital measures in previous literature on pre-modern Western societies, such as whether or not the individual could sign. Mokyr (2016, p. 292) describes literacy in pre-modern China as either "a full literacy, as enjoyed by the educated elite [or] knowledge of just a few hundred characters, which would mean reading at a rudimentary level only". With this classification, the *Literacy* in the chapter represents "full literacy". The literate males in the sample were all capable of producing written works, and at least two-thirds of them were the "educated elites" (civil service exam degree holders and office holders) in Ming-Qing China.

In terms of rudimentary literacy, Rawski (1979, p.23) estimates that in nineteenth century China, the literacy rates of the male population ranged from 30 to 45 per cent. "Knowledge of just a few hundred characters" was easy to acquire, while "full literacy" was not.[74] Although the rise in social status created strong incentives for Chinese males to achieve academic degrees by taking *keju* exams, the high opportunity costs and intense competition prevented most of them from devoting persistent efforts to taking the exams repeatedly (Ebrey 1993; Shiue 2017). Elman (2000, p. 240) points out that a classical literacy "required substantial investments of time, effort, and training", and always exacting "financial and labour sacrifices".

Lee and Park (2019) find that in pre-modern Korea, in order to ensure the longest possible survival of the family line, parents would rather maximize the probability of having one son to achieve the highest social rank than distribute resources equally to raise the social status of all the sons. Hence, one strategy that fertile parents in the six lineages could adopt for long-run reproductive success would have been to allocate the most resources to one or a few of their sons to help them pass the *keju* exams, which could explain the observed child quantity-quality trade-off in 1600-1800, and also in elite lineages only.

However, besides the changes in incentives proposed by Shiue (2017), another cause for the disappearance of the trade-off after 1800 was related to the diminished family size. In my sample, the average number of sons born to a male in the period 1600-1800 had is 1.40, while that for a male born from 1800 to 1900 is only 0.75. Only the males who had a great many sons had to calculate exactly the amount of resources to spend on each of their sons; otherwise, such calculations were unnecessary.

5.2 Implications

In this section, I list three general implications that arise from the three main chapters together, which shed light on the long-run stagnation of the Ming-Qing economy. The first two implications are related to the absence of a fertility transition and the formation of human capital in the Ming and Qing dynasties, while the third is about the survival of the Confucian ideology in China. All three implications are also in need of more solid and quantitative evidence that future research might supply.

[74] In pre-modern China, lineage schools and home-schooling mainly performed the function of equipping the offspring of the family with basic literacy.

5.2.1 The absence of a fertility transition in imperial China

The fertility transition was initiated in France around 1820, and then spread to most other Western countries in the late 19th century (Lee 2003). Thanks to the fertility transition, by the late nineteenth century, most Western European countries were characterized by low fertility rates, rising educational levels, and the dominance of human capital over physical labours (Alter and Clark 2010, p.44).

In spite of its significance to the modern economic growth, the causes of the decline are still under debate. Since the formulation and development of the first comprehensive theory of demographic transition, "the demographic transition theory" (Thompson 1929; Landry 1934, cited in Kirk 1996; Notestein 1945), many models have been proposed to illuminate the puzzles of the transition by using two main approaches. One is "the innovation approach", and the other is "the adjustment approach" (Carlsson 1966; Cummins 2009). The "innovation" hypothesis means that the decline of fertility represents an innovation, a new culture or new knowledge that changes people's attitudes to fertility, while the "adjustment" one believes that the presence and prevalence of controlling fertility is a result of people's response to changing socio-economic conditions (Cummins 2009, p. 20).[75]

However, regardless of the difference between the two approaches, they agree on the point that a series of social changes have to occur first in order to alter people's fertility choices. Coale (1974, pp.352-353) summarizes that a society has to satisfy three conditions to experience a secular decline in fertility: first, "fertility must be within the calculus of conscious choice"; second, "perceived social and economic circumstances must make reduced fertility seem an advantage to individual couples"; finally, "effective techniques of fertility reduction must be available."

Most Western European societies fulfilled these conditions in the nineteenth century. A stylized fact is that during the transitional period, the national-level association between wealth and fertility in Europe changed from positive to negative (Alter and Clark 2010, p.63), and since then a smaller family size has become advantageous under Europe's socio-economic conditions. Many scholars have offered various explanations for the change, and one of the most influential explanations is Becker's (1960) child quantity-quality trade-off theory.

[75] A large amount of literature on the demographic transition centres around the socio-economic development in Europe. For example, Caldwell (1976) and Easterlin (1975; Easterlin and Crimmins 1985) both emphasize the importance of modernization and urbanization in changing the fertility pattern. Leibenstein (1957; 1975) focuses on the increase of income and takes the changing "taste" and "desire" of couples for children into account.

Children, in this theory, are treated as "consumer durables", and parents prefer to spend more on improving the human capital of their children rather than increasing the size of their family (Becker 1960; Becker et al. 1990).

However, Qing China, clearly, missed all of these conditions. In terms of the first condition, Chapter 2 indicates the absence of parity-dependent fertility controls in the Chinese families, and Chapter 3 shows the positive relationship between social status and fertility in Ming-Qing China. They both suggest that the Chinese did not consciously limit their fertility, and the Malthusian mechanism kept functioning throughout the entire period. The empirical investigation in Chapter 4 presents a response to the second condition, implying that in the two dynasties, reduced fertility was not advantageous to parents.[76]

Chapters 3 and 4 also uncover the reasons behind the parents' choices. Although the empirical evidence indicates a presence of child quantity-quality trade-off in the period 1600-1800 in the six lineages, the negative effect of child quantity on child quality was moderate. It could easily be offset by the positive effects of one's father's and grandfather's human capital. A literate man's household budget constraint in the six lineages was so high that he did not need to choose between child quantity and quality, but could have them both. For a literate man in Qing China, having more sons could largely translate into more literate sons, thus reduced fertility was not an advantage to him.

5.2.2 Human capital formation

Chapter 3 supports one key element of the Unified Growth Theory – in the Malthusian and the post-Malthusian regimes, higher income brought about higher rates of population growth (Galor and Moav 2002). As this chapter argues, these high-income males in pre-modern China were also males with high educational attainments. Therefore, another critical question may be, why, despite the growing representation of these high-quality individuals in the population, China still failed to make fast technological progress and thus the transition to modern

[76] Regarding the first condition, Lee and Wang (1999a, p. 61; 1999b) believe that female infanticide was an internal control to "regulate the number and sex of their children". However, Cao and Chen (2002) argue that if infanticide was a type of fertility control, then male and female infants should be equally treated. The sex-biased infanticide proves that couples were not controlling family size per se, but only the sex structure of the family. In terms of the third condition, Lee and Wang (1999a) argue that since the Song dynasty, many contraception and abortion techniques were widely used in imperial China. Nonetheless, a detailed analysis by Sommer (2010) clearly shows that all these techniques were extremely unsafe and ineffective. Moreover, the techniques were mainly used when a woman was having an affair or wanted to abort an illegitimate birth.

economic growth, as Galor and Weil (2000) propose? Exploring the type of human capital in imperial China can shed some light on this puzzle.

Not every type of "high quality" is conducive to the growth process. The hereditary human traits that raised social status and increased income in Ming-Qing China were unable to bring about any significant technological changes. Current literature emphasizes the crucial importance of the generation and transmission of the tacit, practical, and innovative "useful knowledge" to modern economic growth (Mokyr 2016; McCloskey 2010; Epstein 2013). However, the mode of knowledge that has been taught and tested for centuries in China, concerned with Confucian morals and philosophy, cannot be regarded as a scientific and technological type of knowledge and can hardly facilitate modern economic growth (Mokyr 2016; Lin 1995; Yuchtman 2017).[77] As Fei (1953, p.74) once commented, in traditional China, "the intelligentsia have been a class without technical knowledge…Chinese literary language is very inapt to express scientific or technical knowledge."

Education in imperial China, which was not economically useful in nature, promoted intellectual obedience and uniformity, rather than innovation. Scepticism of received wisdom was strictly suppressed. In the Ming and Qing dynasties, scholars were forbidden to have academic discussions about the Sages' teachings, not to mention discussions about what should be taught in schools and tested in exams.[78]

In such a case, as McCloskey (2010, p. 162) argues, "the accumulation of human capital can be a bad idea, negative capital." Emphasizing and expanding education during this period imposed only more severe intellectual constraints upon a larger population. The reproductive success of the Confucians intensified the diffusion of this growth-impeding education, while in the English case, the increased proportion of the middle class in society contributed to the diffusion of "growth-promoting education" (de la Croix et al. 2019). As a result, even if the trade-off between child quantity and child human capital from the seventeenth to the nineteenth centuries was effective enough, the quality that the Chinese elites inclined towards at the time was not enough to set in motion a process of sustained economic growth.

Nonetheless, when ideology begins to change, the accumulation of human capital turns out to be a good idea. *Keju* did lead to high literacy and numeracy rates and a culture that highly values education in China (Baten et al. 2010). Many studies also argue that *keju* had a persistent

[77] McCloskey (2010, pp. 163) points out, "Education can make people spiritually free…without making people rich..." Education based on Confucian morals cannot even make people "spiritually free", let alone "rich".

[78] According to Elman and Woodside (1994, p. 112), "[t]he emperor…not the philosopher, had the final say on how Confucian concepts, arguments, and beliefs were put into educational practice via examinations."

and positive effect on Chinese economic growth in the present day (Brandt, Ma, and Rawski 2014; Chen et al. 2020).

5.2.3 Survival of Confucianism

World history has witnessed many examples of cultural persistence amid changes. Since Emperor Wu of Han selected Confucianism as the dominant political ideology in China in the second century, it has also experienced its ups and downs — its dominance has several times been challenged, but it has also managed to maintain itself for centuries. Even today, Confucian culture still plays a vital role in Chinese society.

A recent study by Giuliano and Nunn (2017) shows that the persistence of culture is associated with the stability of the living environment across generations. In a stable society, where traditions are relevant and useful to the current generation, the traditional culture is more likely to be inherited and to persist than in a variable society. My results in Chapter 3 and Chapter 4 provide another demographic perspective from which to examine cultural persistence, at least in the Chinese context. The reproductive success of the Confucians ensured the reproduction of the existing cultural and political system in imperial China. The descendants of the Confucians were brought up by studying the Confucian classics, and they would derive much benefit from retaining the dominance of Confucianism, especially in the political and educational system. In the words of Fei (1953, p.74), "in the traditional scheme, the vested interests had no wish to improve production but thought only of consolidating privilege. Their main task was the perpetuating of established norms in order to set up a guide for conventional behavior." With a growing proportion of Confucians in the population over centuries, no alternative ideology could easily replace the existing one.

5.3 Limitations and future research

This thesis has striven to systematically re-examine Chinese fertility in the Ming-Qing period by using a new micro-level genealogical dataset. However, the thesis also suffers from two serious limitations, which are also worth considering when future research is designed.

The first limitation lies in the limited representativeness. Imperial China was such a large empire with so many faces, that this research, concentrating on six Chinese lineages, cannot make claims about the general population without cautiously considering the problem of selection. On the one hand, the thesis studies only six lineages and about 70,000 individuals over 500 years. In relation to the large population size in Ming-Qing China, this sample is extremely limited. However, with more and more individual-level research, we might finally build up a generalized depiction of the Chinese demographic pattern.

On the other hand, although keeping genealogies was not a privilege for the elites alone in the Ming and Qing dynasties, and was remarkably widespread in Southeast China, not every single Chinese family would in fact keep its genealogy. Wealthier and higher-social-status families were more inclined than the ordinary families to keep them. Therefore, the commoners in the present sample still could have higher social status than most of the commoners in society. This lack of representativeness is an inevitable limitation of the research. However, within each of the lineages, and also between them, there is enough differentiation in individual demographic outcomes that cannot be explained by the characteristics of the lineage, and hence, an in-depth investigation of these "successful segments" of population is necessary and should also be the first step in understanding the Chinese demographic pattern as a whole (Harrell 1985).

The second limitation is that in its analyses the thesis has necessarily had to neglect the girls and the children who died in infancy. Because lineages were traced through male family members only in the patrilineal society, the compilers of genealogies deliberately ignored information of daughters and children who died in infancy. Hence, several important questions cannot be addressed in the thesis. This is a great pity and it is to be hoped that it can be addressed in future studies by discovering and exploiting new data.

The first unsolved question concerns the rate of female infanticide. Due to the incomplete records of daughters who survived infancy, I am unable to estimate the rate of female infanticide in the six lineages. In fact, the precise frequency of the practice in pre-modern Chinese families is still uncertain, despite the fact that cases of "drowning girls" (*ni nv, 溺女*) are commonly recorded in county annals, local gazetteers, officials' pleas to the Court, and folklore in Ming-Qing China.[79] Lee and Wang (1999a) believe that about one-tenth of the new-born female children were murdered in the Qing imperial lineage between 1700 and 1830; in the farming population in Northeast China, the proportion was about twenty to twenty-five per

[79] Feng (1986) lists records on female infanticide from the local gazetteers of twenty-seven counties in the Qing dynasty. Based on his estimates, the practice was common in Southeast China. See further in Feng and Chang (2001), and Guo (2000) for detailed records on bride price, dowry, and infanticide.

cent in the period 1774-1873.[80] Although in Chapter 2 of this thesis, what I intend to show is the "true" number of children that was ever born for each married female, the missing analysis on the "true" number of daughters who survived infancy still prevents the research from revealing the complete pattern of fertility.

Moreover, Lee and Wang (1999a) argue that a large proportion of males failed to get married, which thus effectively controlled the Chinese population growth, was caused by the shortage of women in the marriage market. Without knowing the exact proportion of the girls who were victims of infanticide, I could not plausibly estimate how great an effect this shortage had on the marriage chances of the males in my sample. This question, in fact, is also an interesting question to consider in relation to the marriage pattern in traditional China.

The second related question is about the rate of infant mortality. Understanding the level and the trend of infant mortality was of great importance for us to understand the traditional fertility pattern. One of the central elements in the demographic transition theory is that the decline of mortality leads to the decline of fertility. The proposition seems to be self-evident, but empirical findings indicate that the mortality decline did not always precede the fertility decline (see for example Knodel 1974; Lesthaeghe 1977). Cummins' (2009, p. 22) calculation shows that the correlation coefficient between infant mortality and fertility in Europe between 1840 and 1913 is only about 0.054.

In the traditional Chinese society, this relationship is even hard to establish in the first place because of the lack of accurate data. Fei (1947) points out that some rural Chinese women would give birth to a dozen children throughout their lifetimes. The reason for the high fertility, in his opinion, was mainly the high infant mortality. The high risk of death forced people to procreate more. Without knowing the infant mortality rates in the six lineages, I could not build a quantitative association in this thesis between the gross fertility and the net fertility, nor could I firmly argue that parents' expectation of a high infant mortality rate is also one of the reasons behind the absence of a fertility transition in Qing China. This unresolved question should be addressed in the future. A plausible starting point could be a detailed demographic study of the era of Republican China (1912-1949), a period for which more records and data are accessible than the imperial era can offer.

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[80] Their estimates, however, are constructed simply on the basis of the recorded number of boys and girls in the imperial genealogies and population registers, but do not take into account the high possibility of under-registration for girls. In other words, they compare the number of surviving boys and the number of surviving girls in the records and assume the gap between the two numbers to be the number of girls who died because of infanticide. Using their method, the rate of female infanticide in my sample would be over 70 per cent, which is untenable.

Nevertheless, except for the two major limitations, the genealogical dataset itself still shows potentials that this research has not fully fulfilled. Genealogies are also useful in studies on mortality and marriage, the two central but under-researched topics in the historical Chinese context. The leading cause for the lack of attention to them lies in the difficulty of data acquisition and cleaning. Investigating these two topics needs complete vital statistics at an individual level. In order to examine the marriage pattern, moreover, linked genealogical records of the involved families are essential, which requires more work on data collection. However, as shown in Table 1.4, only about twenty-two per cent of the individuals recorded in the present lineage sample had complete records. Therefore, collecting and transcribing more high-quality genealogies to construct representative samples is necessary and should be the priority in future studies.

Besides combining the genealogies of different lineages, genealogies should also be linked with other historical sources to construct comprehensive datasets. In recent years, with the rapid development in machine learning, constructing and exploiting linked individual-level datasets has become a growing trend in economic history research (Abramitzky et al. 2019). For instance, Abramitzky, Boustan, and Eriksson (2012, 2014) examine the European immigrants in the US by linking up censuses data; Aizer et al. (2016) match records of welfare programmes in the United States to census and death records to study the impacts of these programmes on the received families and their children's life outcomes.

This kind of attempts is also not rare for Chinese studies. Jiang and Kung (2020) match the candidates' names on the *keju* exam papers (*zhujuan*, 硃卷) by *juren* to the list of *jinshi* degree holders to study the social mobility in the Qing era. Li and Zhen (2015) merge the genealogies of the Que lineage and the records on the division of household properties to investigate the impacts of partible inheritance in traditional Chinese families. In this thesis, in order to test the reliability of social status information in genealogies, I also match the records of official positions in the Zha genealogies to the Qing Government Employee Records. However, most of the previous linkages have ended up with datasets of limited size. Further attempts to link between the genealogical records and other types of individual-level records at the individual level on a large scale could unlock more potentials from these historical sources and elucidate the many unresolved puzzles about Chinese economic history.

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