High-Value Work and the Rise of Women: The Cotton Revolution and Gender Equality in China*

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Abstract

The cotton revolution in early modern China (1300-1840 AD) led to a prolonged phase of female breadwinning through an exogenous increase in women's labor productivity. I explore the link between this productivity shock and gender-equitable beliefs and test this relationship both during and after the cotton revolution. First, I document a positive relationship between the cotton revolution and the belief that women are just as capable as men. Next, I show that the cotton revolution is associated with less prenatal sex selection, more years of schooling for women, more women staying unmarried, and a higher share of female CEOs. This result is robust to using variation within ethnolinguistic groups, matched samples and a measure of pre-1300 attitudes towards women. I then instrument cotton weaving with the interaction between a relative humidity index and distance to the center of technological diffusion. In pre-1840 China, the cotton revolution reduced widow suicide and the use of dowry. After 1840, pre-1840 exposure to the cotton revolution is associated with more female labor force participation under factory systems, and predicts a higher probability for married women to head the household under the strictest form of state socialism.

Keywords: Relative female income, female breadwinning, gender-equitable beliefs
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I Introduction

Gender equality is usually viewed as a modern phenomenon. Economists have proposed several explanations for the expansion of economic and political rights for women in the past 200 years (Doepke and Tertilt, 2009; Doepke, Tertilt, and Voena, 2012; Fernández, 2014). In this paper, I provide an alternative account of the rise of women by examining a unique historical experiment: the cotton revolution in the phase of proto-industrialization of China—a phase during which the productivity of women increased substantially and remained high relative to that of men. By examining the impact of this gender-asymmetric productivity revolution, this paper highlights the role of female labor productivity in the emergence of gender-equitable beliefs and its subsequent effect on gender equality.

A key component of the cotton revolution was a one-time technological breakthrough in cotton textile production that took place after 1300 AD, the introduction of the multiple treadle-operated spindle-wheels. This device roughly doubled or tripled the productivity of female spinning operatives. By solving a crucial bottleneck in the production, in the area of spinning, the use of multiple treadle-operated spindle-wheels made weavers more productive. This breakthrough occurred in the context of a market economy and trading network and in the presence of political institutions that ensured that relative female income remained high for more than 500 years. In areas suitable for the spinning and weaving of cotton, women's labor productivity far exceeded that in traditional agrarian societies.

In reference to this cotton revolution, the historian of Chinese science, Joseph Needham noted that: "For more than 450 years Chinese cotton-spinning technology was therefore superior to the spinning methods used in any other country (Needham and Kuhn, 1988, p. 224). The cotton revolution was a substantial shock to the economic value of women's work. The adoption of new spinning and weaving technologies led to production surpluses, which served as a basis for market exchange on a large scale. During this period, China accounted for one-third of the world's population and between one-third and one-half of global GDP, and had a relatively well-integrated national and regional market economy (Shiue and Keller, 2007). By 1840, cotton textiles accounted for 24.4% of the domestic trade.[1]

Before 1300, women spun and wove, but they worked with fabrics sourced from plants with lower average yields per unit of land and used less productive technologies. They also spent time in agricultural fields, but their productivity in the field was lower than that of men. Between 1300 and 1840, after which date mechanized cotton textiles flooded into China, women produced cotton textiles at home, and sold them to local, regional and national

[1] Table I shows a breakdown of trading goods just before 1840. As much as 94,553,000 *tael* worth of cotton textiles were traded, second only to that of grain.

markets. This resulted in a "Golden Age" for female incomes. Women worked together with extended family groups and as in many traditional societies, weaving skills, along with the loom, were passed down across generations (Buckley and Boudot, 2017).

Compared with other episodes of expansion of labor market opportunities for women, and in other parts of the world, the significance of the cotton revolution is that it boosted women's incomes to a level comparable to or greater than those of their husbands.[2] The ability to produce cotton textiles enabled women to become the major household income earners (B. Li, 1997).

Anthropologist Marvin Harris postulates that male dominance was initially determined by male strength and their comparative advantage in warfare. Thus as warfare was taken over by professionals, inequalities between men and women became a matter of their relative contributions to economic production (Harris, 1993). In imperial China, when the cotton revolution took place around 1300 AD, it dramatically increased women's contribution to economic production, providing an ideal context for an empirical examination of this claim. I formulate the hypothesis that the tradition of holding men more highly than women is deeply rooted in women's relatively low contribution to economic production in the past. Society is used to assigning different values to different genders, and in many civilizations, there has been the perception that women are less capable than men and a culturally-determined belief that females are less valuable. I hypothesize that when women's contribution to economic production becomes close to or above that of men, gender-equitable beliefs will emerge.

To estimate the effects of the cotton revolution on gender inequality, I collect information about cotton textile production from county and prefecture gazetteers. Information available in those gazetteers allow me to construct a binary variable of cotton textiles at a county level for the period of 1300 to 1840. My main sample comprises a total of 1,489 counties. I link this data to my main outcome variable: sex ratio at birth, a revealed preference measure of cultural beliefs about women's worth. Examining variation across counties, I find a strong negative relationship between the cotton revolution and the skewdness of the sex ratio at birth. The baseline estimates suggest that the cotton revolution is associated with a reduction of 3.7 boys per 100 girls in sex ratio at birth, or a quarter of its standard deviation.

To ensure that my results are not driven by systematic differences between counties with and without cotton textiles (1300-1840), I use matched samples, cluster standard errors on different geographic units, address biases in gazetteer data, employ different subsamples and account for historical and modern confounders. I then check three different hypotheses raised in previous work: plough agriculture, the Neolithic Revolution and loamy soil as determinants

[2]An optimistic estimate in Pomeranz's 2002 work suggests that a woman who weaved could earn four times as much as does an unskilled male laborer.

of gender inequality. Finally, I include one of the most stringent controls—language fixed effects—to only use variation within populations speaking the same language.[3] Members of the same ethnic group, if exposed to the cotton revolution, would more likely develop gender-equitable beliefs.

China experienced a series of political and economic shocks in the past two centuries. Many of those shocks had a profound impact on the economy and on society. I account for these intermediating events and their interactions with cotton textile production in my analysis. Reassuringly, neither early industrialization, missionary activities, nor recent economic liberalization can explain away the effects of the cotton revolution.

To establish causality, I instrument cotton textile production with a relative humidity index pertaining to weaving suitability. Relative humidity (%) played a key role in the production of cotton textiles. For the successful manufacture of cotton textiles, the fibers must contain a suitable amount of moisture. Based on several sources, the range of relative humidity suitable for cotton weaving is between 60% and 85%.[4] Within this range, tensile strength increases in relative humidity (Lewis, 1913; Iqbal et al., 2012). The spinning and weaving of cotton, silk, hemp, wool and synthetics vary in their humidity requirements. Scientists and engineers have studied optimal humidity for each fabric (Stamper and Koral, 1979; Ananthanarayanan, 2013; Kut, 2014). I take the distance between actual and optimal humidity at a monthly level, and aggregate those values over months to build a Humidity-for-Weaving Index. Because relative humidity might affect conditions faced by women through other channels, I use the interaction between the Humidity-for-Weaving Index and distance to the center of national market as a second instrument to create a more exogenous source of variation. In both cases, IV estimates are comparable to the OLS estimates, with the second instrument providing an estimate closer to my OLS estimates, offering further assurance that the effects I find are causal.

In tracing the mechanisms, I first establish that there was an initial impact of the cotton revolution on women. Using data collected from historical gazetteers, I find evidence that cotton textile production prevented widow suicide in the Ming Dynasty (1368-1644). One interpretation of the results is that women who were able to survive on their own incomes coped better with widowhood than did those who relied on their husband for their livelihood. Widows who were weavers maintained a decent standard of living and were highly respectable in their communities. Compared to widows elsewhere in the world, who were often isolated and subject to assault and persecution, widows in parts of China were self-sufficient and

[3]Language fixed effects can also be included in other specifications. All the results carry through.

[4]A humid climate makes cotton fibers more pliable, lowers the chance of breakages in the yarn and reduces dust in the air (Lewis, 1913; Lander, 1914; Farnie, 1979; Ananthanarayanan, 2013).

economically independent.

I subsequently examine gender inequality after 1840 to provide further evidence on the cultural transformation brought about by the cotton revolution. I find that in early 20th century China, a higher share of industrial workers were female in places where there used to be cotton textile production, and that under state socialism, which leveled the playing ground for men and women both politically and economically, the probability of a wife heading the household was higher in places positively impacted by the cotton revolution.

This paper aims to understand the emergence of gender-equitable beliefs. There has been a shift in attitudes towards working mothers (Fernández, Fogli, and Olivetti, 2004) and attitudes towards premarital sex (Fernández, 2014). However, certain aspects of gender norms and gender roles, such as the gender identity norm (Bertrand, Kamenica, and Pan, 2015), and in particular, a belief that women are less capable than men (Sarsons, 2015) have remained resilient.

This study shows that when the relevant shock is large enough, the more resilient aspects of gender norms and gender roles can change. It suggests that the economic value of female labor seems to be a major ingredient in how society assigns different values to different genders. However, the relationship between the economic value of female labor, and the perception of women being inferior, appears to be non-linear. For instance, low-value work women performed in the past, such as cotton cultivation, has no impact on sex ratio at birth today, whereas high-value work does. One interpretation is that the perception of women being inferior only changes when the economic value of female labor reaches a sufficiently high level. There exists a discontinuity in the correspondence between the value of women's work and the perception of them being inferior. This provides a possible explanation for why certain aspects of gender norms and gender roles have yet to adapt in spite of changing economic forces.

Qian's (2008) study finds a negative relationship between women's incomes and sex ratios. In Qian's framework, the economic effects of increasing female incomes improves survival rates for girls contemporaneously. In this paper I show that an exogenous, sizable increase in female incomes resulting from the cotton revolution led to the emergence of gender-equitable beliefs. The lag between the end of the treatment period and my main outcome—up to 160 years—is sufficiently long to enable me to disentangle the transitory effects of a change in relative female income—through an *economic* channel—from its lasting effects—through a *cultural* channel. Furthermore, since the relationship between past economic value of female labor and sex ratio at birth in 2000 is not linear. This further rules out a pure economic channel being the explanation of the correlation between the cotton revolution and sex ratio

at birth in 2000. More specifically, when there is a small increase in historical relative female income, it does not reduce sex selection. I also show that gender-equitable beliefs emerged over the course of the cotton revolution, and that such beliefs can independently shape gender inequality after the economic effects of the cotton revolution are long gone.

One strength of this setting is that the cotton revolution was a highly specific treatment. It allowed women to earn a substantial income, and increased their share of the total household income. But it was not accompanied by the type of macroeconomic dynamics that say, the British Industrial Revolution, was associated with. Cotton was spun and woven in the homes of women; it was organized around their extended families and similar technologies were employed throughout the period. Wealth accumulation due to the cotton revolution was limited, and economic gains were eroded by population growth. State-merchant relations and capital formation in imperial China took a very different path than in the West—there was no movement towards factory organization. In the absence of widespread economic and political changes, the identification of the effects of the cotton revolution on women and related channel becomes more feasible.

Another strength of this setting is that there was a unified, centralized state in both historical and modern China, a feature highly useful for distinguishing the cultural channel from other possible channels. Constrained by centralized rule, formal institutions remained unchanged despite the cotton revolution. Also, the state eliminated local monopolies of violence as far as possible. This is a precondition for relative contributions to economic production, rather than physical strength, to take a central stage as the basis for gender inequality (Harris, 1993).

China's experience with state socialism in the 20th century can be exploited as a historical "laboratory" for isolating the role of culture. First, state socialism mandated labor force participation for both genders. This eliminated the explanatory power of economic differences in men and women. Next, given the high degree of centralization characteristic of state socialism, local economic and political institutions are not a function of voter preference. Hence, attitude towards women can only affect outcomes that are determined solely by private decisions. This allows me to measure the direct effects of more gender-equitable beliefs brought about by the cotton revolution.[5]

In comparison with modern field experiments, an advantage of this historical natural experiment is that the cotton revolution took place on a larger scale (Figure I). Also, due to universal in-kind taxation, a high percentage of the households engaged in textile work,

[5]In a usual setting, attitudes towards women can directly shape gender inequality by affecting private decisions, as well as indirectly shape those outcomes by first shaping women's political and legal rights, educational and labor market outcomes.

which eliminates concerns for sorting in the marriage market and other general equilibrium concerns.

This paper is organized as follows. Section III sets forth the relations between my argument and the related literature. Section III explains the historical context. Section IV discusses data sources and variable constructions. Section V provides modern survey evidence. Section VI summarizes my baseline estimates, robustness checks and an instrumental variable analysis. Section VII traces the mechanisms. In Section VIII, I discuss the interpretations of the results and a few caveats. Section IX concludes the paper.

II Related Literature

The recent literature on gender equality has paid increasing attention to the role of culture and identity in determining gender inequality (Fortin, 2005; Fernández, 2007; Fernández and Fogli, 2009; Gneezy, Leonard, and List, 2009; Alesina, Giuliano, and Nunn, 2013; Bertrand, Kamenica, and Pan, 2015). Fernández (2007) and Fernández and Fogli (2009) find that cultural proxies have significant explanatory power for the work and fertility behavior of second-generation American women. Other studies find that differences in psychological traits between men and women are in fact rooted in culture. Gneezy, Leonard, and List (2009) find that women compete less, but only in patriarchal societies.

Researchers have long been interested in how policy interventions can change gender norms. Few interventions have been shown to have a robust effect on gender norms. Both Beath, Christia, and Enikolopov (2012) and Windt, Humphreys, and Sierra (2018) find little or no evidence that placing women in leadership positions affects attitudes or behavior. This study focuses on an important aspect of gender-equitable beliefs, i.e. the perception of women being less capable, and shows that in the long run, high-value work opportunities can change such beliefs.

This study also contributes to the broader literature on the historical determinants of cultural norms and beliefs. Many of these document the persistent impact of a negative shock on cultural values such as Nunn and Wantchekon's (2011) work on the effects of the trans-Atlantic slave trade on corruption and trust today and Voigtländer and Voth's (2012) study on the persistence of antisemitic beliefs in Germany. My study is closely related to those papers that study how past economic factors have shaped contemporary gender norms such as that of Alesina, Giuliano, and Nunn (2013) who attribute conservative gender norms to the use of the plough which required upper body strength and Grosjean and Khattar (Forthcoming) who examine conservative gender norms and its origins in historical marriage market conditions in Australia.[6] This study provides evidence that cultural norms persist

[6]Other relevant studies include that of Jha (2013), who shows that cities in India that were medieval

under small and transitory shocks, but can indeed change in face of large and long-standing shocks.

Although the main focus of this paper is not sex ratio imbalances, my analysis contributes to the literature on sex ratio imbalances by identifying an cultural factor in the skewdness of sex ratios. Sex ratio imbalances, especially in India and China, have become an important topic of policy debate and have attracted scholarly attention. Sex selection on a large scale is held to be responsible for a great share of the "missing women".[7] Almond, H. Li, and S. Zhang (Forthcoming) shows that rural land reform in China led to an increase in sex ratios. Sex selection is also present in developed countries. Daul and Moretti (2008) and Almond and Edlund (2008) find evidence for sex selection in the United States. Edlund (1999) explicitly models sex ratios in relation to son preference. Scholars have identified relative adult female earnings (Rosenzweig and Schultz, 1982; Gupta, 1987; Duflo, 2003; Qian, 2008; Carranza, 2014) and biological factors (Oster, 2005) as causes of sex ratio imbalances. This study takes one step further by investigating the origins of a culture of son preference. In addition, by reviewing the history of widow survival in China, this paper adds to the literature on "missing unmarried women" (Anderson and Ray, 2015; Miguel, 2005).

III The Cotton Revolution

Before 1300, silk and hemp were the two main fabrics used for clothing. High-quality silk was the most valued fabric. It was produced in a small number of urban shops, and demanded only by a small elite.[8] Hemp was the predominant fiber for ordinary clothes. Wool was not available in China.

Following a one-time technology breakthrough in cotton textile production, cotton gradually replaced hemp and low-to-medium grade silk to become the dominant fiber for day-to-day clothes. Pre-existing political and economic institutions—such as the tax system—and existing cultural norms, all of which were uniformly present across China proper, meant that women, rather than men, were spinners and weavers. Moreover, this technological breakthrough took place in a society that had well-functioning markets and a developed trade

trading ports experienced significantly fewer religious riots between Muslims and Hindus in the period after 1850. Grosjean (2014) examines the persistence of a culture of honor among Americans of Scots-Irish descent. She finds that this culture of honor results in higher homicide rates among Scots-Irish in the US South and Mountain West but not elsewhere and argues that this culture has persisted only where formal institutions are comparatively weak.

[7] See Das Gupta and Mari Bhat (1997), Arnold, Kishor, and Roy (2002), Ebenstein (2010), and Lin, Liu, and Qian (2014)

[8] The production and consumption of high-quality silk involved a small and selected segment of the population. Silk accounted for 3% of the domestic trade, based on I. Only 7% of the Chinese population in Ming China was urban.

network. As a consequence, women, working in their own homes and with family members, were able to produce cotton textiles on a large scale for the market thereby earning incomes that far exceeded those available in past agrarian societies. The incomes their earned from cotton textile production enabled them to became major income earners within the household (B. Li, 1997).

The production of cotton textiles, like that of other goods, was highly decentralized. Individual households owned the machinery, purchased raw cotton from the market, and sold finished cloth back to the market, which differed greatly from the British putting-out system (see Appendix I). Those households reaped most of the gains from their production.

Despite the rapid expansion of cotton textile production, the growth was Smithian. There was little further technological innovation (Elvin, 1972). The level of output per capita stagnated due to the offsetting Malthusian forces of rapid population growth.[9] China did not industrialize, or became a capitalistic economy, which is one of the most important stylized facts in economic history. China did not industrialize until at least 150 years after the British Industrial Revolution ("The Great Divergence"), and there has been a sizable literature in economic history investigating the causes of the Great Divergence.

After 1840 China opened up its market to the West after its defeat in the first Opium War. Mechanized cotton textiles from the British Empire began to replace cotton textile handicraft produced by Chinese households. Household cotton textile production only began to collapse in the period between 1870–1910 due to competition from imported manufactured textiles (Myers, 1965, p. 621). Appendix I details the market structure and features of decentralized production during that period.

A Technological Improvements in 1300

Around 1300, Huang Dao Po, a Shanghai native (1245-1330 AD), acquired new spinning and weaving technologies from an ethnic group, known as the Li, residing on Hainan Island and brought them back to mainland China.[10] The production of cotton textiles involves two processes: spinning and weaving. Raw cotton is spun into thread and yarn before cotton thread is woven into cloth. Due to the use of new spinning and weaving technologies, the production of cotton textiles on a large scale became feasible for the first time (Bray, 1997; G. Zhao, 1977).

Huang Dao Po introduced a new spinning wheel that had three spindles. Spinning wheels, for a long time, had just one spindle. The new spinning wheel increased productivity by

[9]For a discussion of macroeconomic conditions and Malthusian stagnation during that period, see Appendix I.

[10]Contemporary Li people still use those technologies for textile production. Finished cloth can purchased by tourists who visit Hainan Island.

allowing women to use both their hands and their feet to keep the wheel spinning. Its technical design was comparable to that of the Spinning Jenny, which was invented in 18th century England and a predecessor to subsequent technologies used in textile manufacturing. The adoption of the new spinning wheel in 14th century China dramatically increased spinning productivity.

This device roughly doubled or tripled the productivity of female spinning operatives. Workers using multiple treadle-operated spindle-wheels could produce between 500 and 1500 grams of yarn by operating up to five spindles at the time. Joseph Needham notes that until the British Industrial Revolution, "the technological standard of Chinese cotton manufacture had no parallel anywhere else in the world" (Needham and Kuhn, 1988, p. 223). Needham concludes that: "For more than 450 years Chinese cotton-spinning technology was therefore superior to the spinning methods used in any other country (Needham and Kuhn, 1988, p. 224).

This resolved a bottleneck that previously prevented the the cotton textile industry from further increasing productivity–before the new spinning wheel was used, every weaver had to be matched with three to four spinners given the rate at which spinning took place. In addition, Huang also introduced new techniques for cotton fluffing and crushing and methods of weaving mixed cotton fabrics, colored fabrics and fabrics with mixed warp and weft fibers.

Following this one-time technological breakthrough, cotton textile production expanded rapidly in the following centuries. Due to its durability, cotton replaced hemp and began to dominate the everyday clothing market. Other attractive features of cotton cloth include being effective in the cold weather, and offering higher yields per unit of land. [11] Demand for cotton was kept high by government demand, especially military demand for uniforms, and by expanding urban markets (Myers, 1965). According to Pomeranz (2000, p. 338), cotton textile production in 1750 was only slightly before that of Britain's in 1800.

B Gains from the Long-Distance Trade of Cotton Cloth

Cotton weaving faced different climatic constraints from those of the cultivation of cotton. A relatively dry climate is preferred for cotton cultivation, with low precipitation during the growing season. Cotton spinning and weaving is more suitable in a humid climate. As a result, places with different climates quickly began to specialize in the spinning, weaving or cultivation of cotton. The long-distance trade of both raw cotton and cotton cloth emerged in response to differential endowments and regional specialization. A portion of cotton cloth

[11] See Appendix I for a discussion of the impact of the cotton revolution on non-cotton textile producing regions.

was transported by the state as part of the in-kind tax system.[12]

In the late Ming period, the market exchange of cotton cloth became more prevalent as a market economy developed further with the "single whip" reform. A booming money economy promoted domestic trade and expanded the market for cotton cloth.[13] The production of cotton cloth became increasingly commercialized and specialized. In describing patterns of regional specialization, van [298]Glahn16 notes:

> "Since Jiangnan could not produce sufficient cotton to meet the rising demand for cloth, merchants imported raw cotton from the Central Plain and Guangdong. Merchant capital regularly intervened at each step in the manufacturing process. Many rural spinners and weavers, the vast majority of whom were women, became full-time cottage handicraft workers earning piece-rate wages. Brokers based in market towns delivered ginned cotton to spinners and yarn to weavers on credit, purchasing the finished product at a discounted price."

By the time of the Opium War (1840–1842), the size of the cotton textile trade was second only to that of the grain trade. To illustrate the relative size of the cotton textile trade, I show the breakdown of trading goods just before 1840 in Table I.

The type of data that contain gazetteers imposes a few limitations: (a.) The scarcity of local gazetteers prior to the Ming Dynasty (1368-1644) contributes to the choice of 1368 AD as the starting point for my data collection. (b.) Some places likely began to publish gazetteers much later than other places do. The frequencies with which gazetteers were published can vary from place to place too. (c.) For all sorts of reasons, some places might have been less able to preserve gazetteers.

My key source, Wang (2006), is based on a comprehensive survey of nearly all gazetteers first composed during the Ming period that can be found today. The near-universal coverage of historical gazetteers makes Wang (2006) a highly desirable source for this study. However, b.) and c.) likely remain given his approach. Both may result in an uneven distribution of gazetteers by time and space.

To mitigate b.), I refrain from exploiting the timing or intensity of cotton textile production as recorded in gazetteers. Instead, I use a binary variable to indicate whether or not

[12]R. Huang (1964) estimates that in the early 17th century, at least one million bolts of cotton cloth were transported through the Grand Canal as tax payments to the Ming Government. One bolt of cotton cloth is 33.33 meters long. One million bolts of cotton cloth were worth half a million *taels* at the time. For much of the Ming Dynasty, cotton textiles accounted for a large portion of taxes in kind, second only to grain.

[13]The Single Whip Law was initiated in the early 16th century, and was applied to the entire empire in 1580 by Zhang Juzheng (Flynn and Giráldez, 1995). The reform replaced per capita taxes and in-kind taxes in most regions, which led to the further growth of a money economy and a great expansion of commerce.

Table I: Domestic Long-Distance Trade in 1840

Categories	Quantity	Value	
		Silver (10,000 taels)	Percent (%)
Grain	24,500,000,000 *jin*	16,333.30	42.14
Cotton	2,555,000 *dan*	1,277.50	3.3
Cotton textiles	31,451,770,000 bolts	9,455.30	24.39
Raw silk	71,000 *dan*	1,202.30	3.1
Silk textiles	49,000 *dan*	1,455.00	3.75
Tea	26,050,000 *dan*	3,186.10	8.22
Salt	3,220,000,000 *jin*	5,820.90	15.1
Total		38,762.40	100

Notes: The table is taken from B. Li (2010). The original estimates are made by Wu (1983). The figures exclude goods exchanged on local markets.

a location ever had any cotton textile production prior to 1840. By coding cotton textiles (1300-1840) as an indicator variable, my estimates are less affected by the timing of the first gazetteer, or by the frequencies of gazetteers being published. Provided that no gazetteer was published in a prefecture until 1800, but cotton textile production appeared far before 1800, using a binary variable for cotton textiles (1300-1840) will minimize the bias that may be generated by trying to use the timing of the first record or the total number of records on cotton textiles. If production was not reversed, a gazetteer in later years would adequately reflect the historical presence of cotton textile production. A likely exception is Fujian Province. Fujian is a coastal province that is rugged and mountainous. It relied heavily on ocean trade. While the cotton textile industry thrived in earlier times, cotton textiles became less common in Fujian after the Ming Dynasty, after the suspension of sea-based trade.

Gazetteers published in later years were more likely to have survived. Some places might have been subject to more negative shocks, or less able to cope with shocks, and hence, have preserved fewer gazetteers. By discarding the timing dimension, I can reduce "survivorship bias". Although my current coding methods already minimize possible biases due to the use of gazetteer sources, it does not remove the bias. If frequencies of gazetteers are both correlated with the cotton revolution and cultural beliefs about women, my estimates can be biased. In Appendix F.4, I show results based on different samples of counties with varying frequencies of gazetteers.

IV Data

I combine several gazetteer-based sources to construct my main variable, cotton textile production (1300-1840). For other historical variables, I use China Historical GIS (CHGIS), the digital map collection of Harvard University, the database of Chinese Gazetteers (*Zhongguo fangzhi ku*), the 1916 economic census and surveys conducted by Christian missionaries in the early twentieth century. For modern outcomes and controls, I use modern censuses and surveys, including the 2000 population census (county-level), the 1990 census (individual-level) from the IPUMS International, the 2004 Industrial Census from the China Geo Explorer, the Chinese City Statistical Yearbooks and Chinese General Social Surveys (2005, 2010). For climatic and geographic variables, I rely on data from the Climate Research Unit of University of East Anglia, FAO (GAEZ v3.0), NASA and NOAA. Appendix D provides details on sample construction, data sources, and variable constructions.

A Cotton Textile Production (1300-1840)

To obtain an estimate of the distribution of counties and prefectures where cotton textiles were produced between 1300 and 1840 across China today, I map historical locations of cotton textile production into modern counties.[14]

Historical gazetteers provide qualitative information on cotton textile production. My main interest lies in the spinning and weaving of cotton textiles, rather than the cultivation of raw cotton. Information on cotton spinning and weaving, as well as cotton cultivation, can be inferred from a section describing goods that were produced locally (*shihuo zhi*). I code cotton textiles (1300-1840) as one, if finished cotton cloth is mentioned in the gazetteer of a specific county or prefecture (*jibei bu* or *mian bu*). Both *mian* and *jibei* mean "cotton". *jibei* is just an alternative name to *mian*. *bu* means "cloth". I draw on several historical studies to construct my dataset. A key source I use is Wang (2006). More information on those historical studies are available in Appendix D.2.

I rely on county and prefecture gazetteers (Figure A.VI). For prefectures, their historical boundaries are known; but for counties, their exact boundaries before the year of 1911 are unknown. Based on my default method, a historical county is the "ancestor" county of a modern county, if the county seat falls into the boundary of a modern county. A value of one is assigned to a modern county if cotton textiles were produced in its "ancestor" county between 1300 and 1840; zero is assigned otherwise.[15] In addition, a value of one is assigned

[14]The year 1840 marks the end of the household production of cotton textiles. Section III provides detailed background information for the cotton revolution.

[15]All gazetteers I use were published in the Ming and Qing Dynasty (1368-1840), because very few gazetteers were published before 1368. Here I assume that gazetteers published in the early Ming Dynasty

to a county with more than half of its area overlapping with a historical prefecture with cotton textile production, and zero to other counties. This yields a dummy variable of cotton textiles (1300-1840) for each county.

To account for boundary changes over time, I use time-series maps of prefectures and counties to identify precise historical locations of cotton textile production between 1300 and 1840. This allows me to use historical locations closely matched to sources. For example, when a record is taken from a prefecture-level gazetteer published in 1503, it is geocoded as in that particular prefecture with its boundaries in 1503.

I also code cotton textile production using alternative methods. I locate historical counties in a map from a later period (the earliest will be year 1911) when their boundaries became known. This method results in a continuous variable of cotton textile production, which yields highly similar estimates to the estimates based on the binary variable. Alternatively, I create a continuous variable based on the percentage of land area of each county that overlaps with a historical prefecture with cotton textile production. This also yields estimates highly comparable to those obtained with the binary explanatory variable. In Appendix D.2, I lay out the detailed procedure for constructing the main explanatory variable. In Appendix D.3, I describe how cotton textile production (1300-1840) is linked with modern outcomes. As a summary, Figure I shows the distribution of counties and prefectures that previously produced cotton textiles across China in 2000.

Historical gazetteers provide valuable information on cotton textile production between 1300 and 1840. However, two types of biases are present in gazetteer data: publication bias and survivorship bias (Appendix D.2). Wealthier counties published more gazetteers and at an earlier date. My solutions to this are as follows: first, I use a binary treatment variable constructed to avoid introducing spurious correlations between cotton textiles (1300-1840), stage of development and cultural beliefs about women's worth; second, in Table A.VIII, I run several regressions based on the number of gazetteers available in a county. I show that my coefficient estimates are not sensitive to the frequency at which historical gazetteers were published, which suggests that "publication bias" and "survivorship bias" are unlikely to drive my results.

B Control Variables

In this section, I outline the set of control variables used for the county-level analysis in modern-day China. Additional controls are used in my analyses of other historical episodes of China and will be discussed in those sections.

My baseline controls include contemporary controls such as a county's per capita GDP

would contain information on cotton textile production that began before 1368.

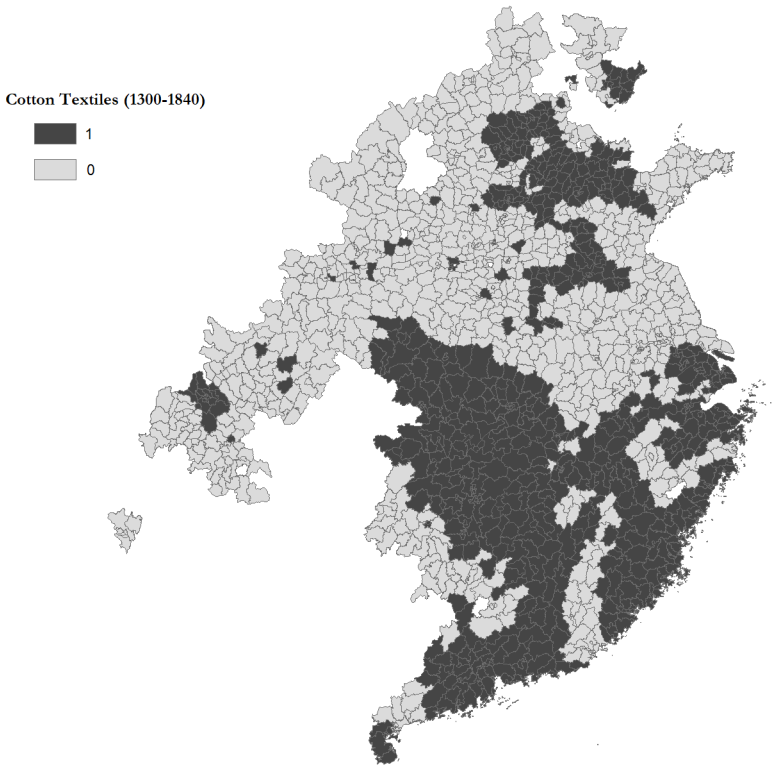


Figure I: Cotton Textile Production (1300-1840)

measured in 2000, share of urban population, share of agriculture workforce, share of service workforce, share of urban *hukou* (household registration), years of schooling (male), share of ethnic population, governance status and provincial capital status, historical controls such as agricultural suitability, population density in 1300, proximity to the Grand Canal or the Yangtze River and treaty port, as well as a set of geographic controls, such as ruggedness, distance to coast, latitude and longitude. To account for deep-rooted socio-cultural differences across regions, I include Skinner socioeconomic macroregion fixed effects, in addition to province fixed effects.

I obtain most of contemporary controls from the 2000 Census. Maps are from National Bureau of Statistics (2005). Skinner socioeconomic macroregion data are available at the G.W. Skinner Data Archive (Skinner, M. Henderson, and Berman, 2013). Historical controls include agricultural suitability, proximity to the Grand Canal or the Yangtze River and treaty port status. *Agricultural suitability* is downloaded from the FAO website. When more than one suitability measure is available for a particular type of crop, I use the suitability measure based on intermediate-level input under rain-fed conditions in the most recent version of the FAO database (GAEZ 3.0). *Proximity to the Grand Canal or Yangtze* is obtained from the China Historical GIS (CHGIS). *Distance to the nearest coast* and *ruggedness* are downloaded from the National Aeronautics and Space Administration (NASA) website.

For other types of work women engaged in, I include *cotton suitability*, *tea suitability* and *rice suitability* data from FAO, and historical production data on other types of textiles from historical gazetteers. Suitability maps are available in Appendix A. To assess the impact of large economic and political shocks, I control for treaty ports (Jia, 2014), density of communicants (Stauffer et al., 1922) and coastal China (National Bureau of Statistics, 2005). In addition, I check to see how three hypotheses examined in previous work hold up in this study. I obtain data on ancestral plough use from the Ethnographic Atlas (Murdock, 1967), information on Neolithic settlements (Chang, 1963) and soil texture from the Harmonized World Soil Database (Nachtergaele et al., 2008). Finally, I add language group as a control using data from the G.W. Skinner Data Archive.

Summary statistics are shown in Table A.I. Appendix D.4 provides the historical context for variables including proximity to the Grand Canal, treaty ports, density of communicants in early 20th century, pre-1300 commercial tax quota and historical courier routes.

V The Capable Woman: Historical Narrative and Modern Evidence

Anecdotal evidence suggests that women producing cotton textiles enjoyed greater autonomy and higher social status (c. Zhao, 2015). As depicted in the oral tradition, men were

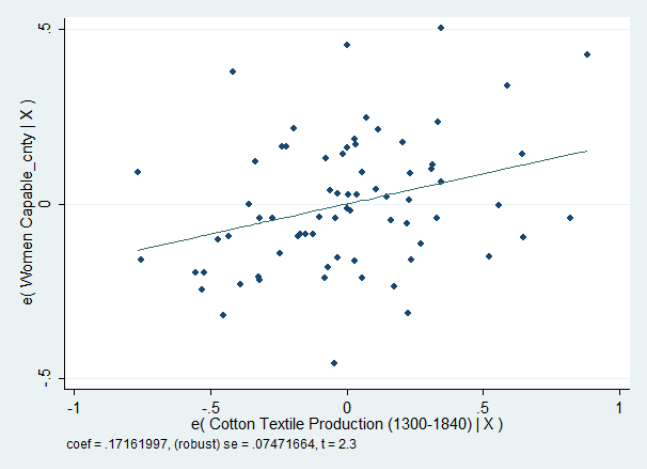


Figure II: "Women are just as capable as men. "

getting pocket money rationed by their wife (*niang niang shou li tao zhen xian*). In a survey article (Man, 2011), Zheng paints a vivid image of female breadwinners being unwavering.[16] In Xu (1987), a woman proudly proclaimed that she single-handedly supported the family and was a "strong woman," a "she-husband." She declared that her husband was passionate about literary writing and painting. She stressed that he could not make much money and did not help to make ends meet.

Married women supporting husband's career with their incomes. Many Chinese young men were heavily invested in taking civil exams, which typically took 15-20 years of their life. Women's incomes were crucial to supporting their husband's career. Upon divorce, marriage laws in imperial times were unfavorable to women. It allowed men to freely exit marriage ("seven codes for divorcing wives") which often left women with little resource. Women with incomes from cotton weaving were far less vulnerable.

Historical evidence on the perception of women is lacking. From modern surveys, we observe a positive correlation between the cotton revolution and the view that women are just as capable. Because such attitudes are measured in 2010, they are less likely driven by the economic effect of the cotton revolution on women's incomes. Details can be found in Appendix E.

[16] Zheng complies a list of historical sources: Chen et al. (1991), Gu (1995), and Xu (1987).

VI The Cotton Revolution and Women's Position in Society: Evidence from the 2000 Census

A Sex Selection as a Key Proxy

Having demonstrated the relationship between the cotton revolution and gender equitable beliefs in CGSS, I turn to the 2000 census to obtain a large sample and higher quality data. My main proxy of gender equitable beliefs is sex selection. There are a number of determinants of birth sex ratio (see Appendix C.1). Under conditions specified in Appendix C.2, I argue that birth sex ratio is a strong indicator of the perception of women being inferior. The one-child policy exacerbated pre-natal sex selection by enhancing fertility constraints (Appendix C.4), as well as widespread access to ultrasound screening (Appendix C.3).

I test my hypothesis by estimating the following equation:

$$\text{Sex ratio at birth}_c = \alpha + \beta \text{cotton textiles (1300-1840)}_c + \mathbf{X}_c^H \mathbf{\Omega} + \mathbf{X}_c^G \mathbf{\Lambda} + \mathbf{X}_c^C \mathbf{\Pi} + \epsilon_c \ , \quad (1)$$

where c denotes a county. cotton textiles (1300-1840)$_c$ is cotton textile production for 1300-1840 at County c. Sex ratio at birth$_c$ is the number of the boys per hundred girls born.[17] $\mathbf{X}_c^H$ is a vector of historical controls, and $\mathbf{X}_c^G$ and $\mathbf{X}_c^C$ are vectors of geographical and contemporary controls respectively, each measured at the county level.

$\mathbf{X}_c^G$ and $\mathbf{X}_c^H$ are intended to capture geographic and historical characteristics that may have been correlated with cotton textiles (1300-1840) and may still affect present-day outcomes. I include in $\mathbf{X}_c^H$ agricultural suitability and estimated population density in 1300. For an agrarian economy, agricultural productivity reflect economic fundamentals and shape social structures. Extreme poverty can cause individuals to pursue infanticide as a survival strategy (L. M. Li, 1991), which might affect modern outcomes through attitudes towards pre- or post-natal sex selection. It is also a rough proxy of historical male incomes given that men were primary agricultural workers at the time. Historical population density is a proxy for economic development and can shape the ancestral traits of modern populations (Putterman and Weil, 2010). Historical population data are scarce. I use estimated population density in 1300 from Goldewijk, Beusen, and Janssen (2010) and Klein Goldewijk et al. (2011). The distribution of cotton textiles (1300-1840) depended on the trade networks. I include a control for whether the county was on the Grand Canal or on the Yangtze River—the major trade networks at the time. To account for the impact of treaty ports established in the 19th century, I include treaty port status as a control. To control for geographic dif-

[17] I can derive an alternative measure of sex ratio imbalances by taking the natural log of the deviation of sex ratio at birth from the normal range. Results are very similar when this alternative measure is used.

ferences across counties, I include in $\mathbf{X}_c^G$ the natural log of distance to coast and the natural log of one plus ruggedness, latitude, longitude and their interaction.[18] To address norms such as patrilocality and concern for women's purity and other differences across those historically relatively autonomous regions, I include fixed effects corresponding to socioeconomic macroregions defined by Skinner, M. Henderson, and Berman (2013).[19]

The contemporary control variables include socioeconomic characteristics such as the natural log of a county's per capita GDP measured in 2000, share of urban population, share of agriculture workforce, share of service workforce, share of urban *hukou* (household registration), years of schooling (male), share of ethnic population, political characteristics including governance status and provincial capital status, and province fixed effects.

The OLS estimates show that in counties with cotton textile production between 1300 and 1840, fewer girls are missing today. The coefficient estimates are both statistically significant and economically meaningful. I begin my analysis with socioeconomic region fixed effects only (column 1), and then include both socioeconomic region fixed effects and province fixed effects (column 2). When I include the full set of controls in column 3, the size of the coefficient increases from -3.008 to -3.753. The cotton revolution is associated with a decrease of sex ratio at birth by 3.753 boys per 100 girls, which is 27% of the standard deviation of sex ratio at birth.[20] Column 3 contains the baseline specification for the rest of this study. Figure A.I in Appendix A shows a partial regression plot corresponding with column 3. It indicates that the coefficient estimate of cotton textiles (1300-1840) is not influenced by a small number of counties.

In column 4, the coefficient estimate remains similar when I omit logged per capita GDP, logged share of urban *hukou*, logged share of agricultural workforce and logged share of service workforce and years of schooling (male).[21] In column 5, in addition to controls omitted from column 4, I exclude the share of ethnic population.[22] In the last column, I exclude provincial

[18]Deng (1999) makes the point that in premodern China, people living in rugged terrain tended to net consumers of cotton textiles.

[19]Please refer to Appendix D.4 for a more detailed description of socioeconomic macroregions.

[20]The specification is also robust to the inclusion of the squared term of log per capita GDP. Chung and Gupta (2007) suggests that sex ratios can change in nonlinearity through different stages of development. Results are robust to controlling for fertility; however, fertility is a "bad" control, as decisions are made simultaneously on fertility and sex selection [pp.64-68](Angrist and Pischke, 2008).

[21]Though large sex ratio imbalances are a relatively new phenomenon in China, the underlying cultural beliefs about women are not, and per capita GDP could have been negatively affected by past gender discrimination. Sex ratio imbalances *per se* can also affect GDP through increasing saving rates (Wei and X. Zhang, 2011). In either case, controlling for log per capita GDP will constitute the case of "overcontrolling".

[22]The share of ethnic population might have become endogenous to the dependent variable in the past few decades due to responses to the one-child policy. Under the one-child policy, ethnic minorities were allowed to have more children than were the Han Chinese. W. Huang and Zhou (2016) has documented that inter-ethnic marriages have become more common under one-child policy.

Table II: Cotton Revolution and Sex Ratio Imbalances: OLS Results

	Dependent variable: sex ratio at birth in 2000					
	(1)	(2)	(3)	(4)	(5)	(6)
Mean of Dep. Var.	118.3	118.3	118.6	118.6	118.6	118.6
Cotton textiles (1300-1840)	-3.008***	-3.225***	-3.753***	-4.049***	-3.887***	-4.066***
	(0.668)	(0.713)	(0.731)	(0.775)	(0.777)	(0.773)
Log per capita GDP			-2.941***			
			(0.479)			
% in agriculture			0.245			
			(0.379)			
% in service			-0.538			
			(1.302)			
Years of schooling (male)			-2.485***			
			(0.724)			
% ethnic population			-0.718***	-1.118***		
			(0.249)	(0.253)		
Provincial capital			3.091***	0.0496	-0.221	
			(1.006)	(0.958)	(0.954)	
Self-governed			-2.882**	4.586***	5.484***	
			(1.364)	(0.890)	(0.861)	
Governed by province			-2.363*	3.436***	4.110***	
			(1.249)	(1.065)	(1.063)	
Historical controls	No	No	Yes	Yes	Yes	Yes
Geographic controls	No	No	Yes	Yes	Yes	Yes
Province FE	No	Yes	Yes	Yes	Yes	Yes
Socioeconomic Macroregion FE	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.150	0.231	0.368	0.314	0.306	0.288
Observations	1622	1622	1489	1489	1489	1489

Notes: The table reports the impact of cotton textiles (1300-1840) on sex ratio imbalances. The unit of observation is a county in 2000 Census. The dependent variable is sex ratio at birth. Column 1 reports estimates with only socioeconomic macroregion effects. Column 2 reports estimates with both socioeconomic macroregion and province effects. Column 3 includes all controls. "Historical controls" are treaty port status, agriculture suitability, and whether a county was on the Grand Canal or the Yangtze River (major trade networks). "Geographic controls" ar the natural log of one plus ruggedness, the natural log of distance to coast, latitude, longitude and their interaction. Column 4-6 sequentially drops potentially endogenous modern controls. The omitted category for governance status is being governed by the prefecture-level city government. Robust standard errors are used in all specifications. Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

capital status and governance status, and the coefficient estimate remains close to those in previous columns.

These results can be replicated using the individual-level 2000 census (1% sample). Using the same data, I can back out the birth sex ratio of older cohorts. Figure A.II summarizes the results. It is apparent that the negative relationship between the cotton revolution and sex ratio imbalances only emerged in the late 1990s. This coincides with the timing of having widespread ultrasound access.

To further ensure the robustness of the results, I conduct the following tests: (i.) clustering at different geographic units; (ii.) addressing biases in gazetteer data; (iii.) using different subsamples (omitting the Yangtze Delta and omitting high net in-migration counties); (iv.) accounting for historical and modern confounders (pre-1300 commercial networks, historical state presence and modern industrial composition); (v.) other activities performed by women in historical times, such as the continued production of other textiles after 1300, tea picking, and rice cultivation. (vi.) ancestral plough use (Alesina, Giuliano, and Nunn, 2013); Neolithic settlements (Hansen, Jensen, and Skovsgaard, 2015), soil texture (Carranza, 2014). Appendix F summarizes the results of the above tests.

In addition, I compare cotton textile production with lower-value economic activities performed by women, such as the production of other textiles after 1300, tea picking, and rice cultivation. I show that the value of lower-value economic activities performed by women do not have a relationship with birth sex ratios. This suggests high-value work such as cotton weaving has a distinctive role in influencing sex selection decisions.

A.1 Related Outcomes

As predicted, there is no significant difference in female labor force participation or female unemployment, regardless of the measure chosen (Table IV). This is because state socialism mandated employment for both genders. As state socialism weakens, it is possible that more women will stay out of the workforce in counties with historical exposure to the cotton revolution.

Table III examines a series of outcomes that likely reflect gender equitable beliefs. These outcomes are educational attainment, marital status and representation in leadership positions. The cotton revolution predicts more educational attainment for women, more women staying unmarried and more women being represented in leadership positions. Compared to the birth sex ratio, these outcomes are more likely affected by factors beyond individual preferences such as the stage of development, and hence less credible measures of gender equitable beliefs.

Table III: Education, Marriage, Leadership

	Years of Schooling (1)	Unmarried (2)	Company CEOs (3)
Mean of Dep. Var.	0.865	0.0119	0.139
Cotton textiles (1300-1840)	0.0104***	0.000635***	0.0105**
	(0.00244)	(0.000177)	(0.00424)
Baseline controls	Yes	Yes	Yes
Province FE	Yes	Yes	Yes
Socioeconomic Macroregion FE	Yes	Yes	Yes
Adjusted R^2	0.583	0.640	0.278
Observations	1489	1489	1489

Notes: Column 1 examines the female-to-male ratio of years of schooling. Column 2 examines the percentage of unmarried women. Column 3 examines the female-to-male ratio of company CEOs. Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table IV: Labor Force Participation and Unemployment

	Female Labor Force Participation			Female Unemployment	
	(1)	(2)	(3)	(4)	(5)
Mean of Dep. Var.	0.523	0.818	0.918	3.596	1.189
Cotton textiles (1300-1840)	-0.000198	-0.000347	0.00241	-0.0738	0.0170
	(0.00270)	(0.00520)	(0.00626)	(0.131)	(0.0392)
Baseline controls	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes
Socioeconomic Macroregion FE	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.818	0.586	0.778	0.727	0.186
Observations	1489	1489	1489	1489	1303

Notes: Column 1 examines the ratio of women in the labor force to the size of female population. Column 2 examines the female-to-male ratio of labor force participation. Column 3 examines the ratio of women in the labor force to the population of women aged 15-50. Column 4 examines the percentage of women who are unemployed. Column 5 examines the female-to-male ratio of unemployment. Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

B Accounting for Selection

A potential concern with the baseline estimates is selectivity into the adoption of new cotton spinning and weaving technologies. If counties with cotton weaving began with more gender equitable beliefs, or are more likely to have accomplished gender equitable beliefs even in the absence of the cotton revolution, estimates will be biased away from zero.

In Appendix G, I check the degree of selection on unobservables based on selection on observables (Table A.XII), employ matched samples based on different matching criteria (Table A.XIV), and add ethnolinguistic groups fixed effects (Table A.XIII). Below I describe an instrumental variable strategy.

B.1 Instrumental Variable Strategy

I use the interaction between the Humidity-for-Weaving Index and distance to the center of technological diffusion as my instrumental variable. Details of the humidity-for-weaving index can be found in Appendix H. Distance to the center of technological diffusion on its own is not a valid instrument. According to Pearl (2000), the interaction term between non-instrumental variables can still be an effective instrument.

I begin my IV estimation by testing the relationship between my instruments and cotton textiles (1300-1840). Because my treatment variable is binary, I use Probit-2SLS as my main estimation strategy. Probit-2SLS is a three-stage procedure recommended in Wooldridge (2002, pp.623-626). It uses a Probit model for the first stage.[23] The purpose of using this estimation strategy is to properly model the relationship between the Humidity-for-Weaving Index and cotton textiles (1300-1840) in order to best mitigate the problem of weak instruments due to omitted nonlinearity (D. J. Henderson and Parmeter, 2015).[24]

Panel A of Table V shows the estimates from the first stage: the instrument is positively correlated with cotton textiles (1300-1840). The second stage is to calculate the predicted probability of cotton textiles. The third stage is to regress sex ratio at birth on the predicted probability of cotton textiles. Third-stage results are reported in Panel B. Column 1 contains the OLS estimates. Column 2 reports the Probit-2SLS estimate. My IV estimate is that a one-standard-deviation increase in cotton textiles (1300-1840) leads to a reduction of sex ratio

[23]The full procedure is as follows: first, use Probit to regress the treatment on the instrument and exogenous variables; second, use the predicted values from the first step in the first stage of a regular 2SLS procedure, together with the exogenous variables; third, run the second stage as in a regular 2SLS procedure.

[24]D. J. Henderson and Parmeter (2015) shows that instruments that may be strong in a nonlinear relationship with the treatment could be weak when a linear relationship is imposed upon. An alternative method to address nonlinearities is to use a nonparametric instrument. However, Newey (2013) shows that nonparametric IV estimation only behaves when the instrument is very strong. When the reduced form R^2 is low, and a linear IV slope can be estimated, the variance of the coefficients of nonlinear terms will be very high.

Table V: Cotton Revolution and Sex Ratio at Birth: Instrumental Variable Analysis

	(1) OLS	(2) Probit-2SLS	(3) Probit-2SLS	(4) 2SLS
	Humidity-for-Weaving Index × Dist. to Songjiang (inverse)			
	Panel A: 2SLS Dependent variable: sex ratio at birth in 2000			
Mean of Dep. Var.	118.7	118.7	118.7	118.7
Cotton textiles (1300-1840)	-2.86***	-9.762**	-5.648 ***	-7.78*
	(0.730)	(3.170)	(2.860)	(4.729)
	Panel B: First Stage Dependent variable: cotton textiles (1300-1840)			
Humidity-for-Weaving Index × Dist. to Songjiang (inverse)		0.044	0.043	0.012
		(0.010)	(0.010)	(0.002)
Humidity-for-Weaving Index	Yes	Yes	Yes	Yes
Dist. to Songjiang (inverse)	Yes	Yes	Yes	Yes
Baseline controls	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes
Socioeconomic Macroregion FE	Yes	Yes	Yes	Yes
Observations	1454	1450	1430	1430

Notes: The table reports OLS, Probit-2SLS and 2SLS estimates. The unit of observation is a county in the 2000 Census. The dependent variable is sex ratio at birth. For Probit-2SLS, the full procedure has three stages. First-stage (Probit) and third-stage (2SLS) results are summarized in the table. The second stage is to calculate the predicted probability of cotton textile production. In columns 3 and 4, counties whose birth sex ratio is in the top 99 percentile are excluded. Baseline controls are the same as in column 3 of Table II. Robust standard errors are included in all specifications. Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

at birth by 4.783 boys per 100 girls (4.783=9.762*0.49). In columns 3-4, I exclude county outliers. In excluded counties, birth sex ratios are greater than 165.7, which is greater than those of 99% of the counties. In column 4, I use regular 2SLS instead of Probit-2SLS. My estimates are less significant.

C Post-1840 Political and Economic Shocks

C.1 Early Industrialization

Early industrialization began in China after 1840. The effects of early industrialization could bias my results in the following ways: (a.) If counties positively impacted by the cotton revolution were more likely to experience early industrialization after 1840, my results would confound the effects of industrialization with those of the cotton revolution. One fact counting against this is that industrialization in China was on a limited scale (Fairbank,

1978). During the late Qing and Republican era, much of the rural and hinterland China continued to engage in household production and individuals maintained traditional lifestyles. In 1933, almost a hundred years after the first treaty port was established in Shanghai, the handicraft industry still made up for 61% of the total industry output. (b.) If women were more likely to be part of the industrial workforce when they already worked at home, I would not be able to disentangle the effects of the cotton revolution and the effects of female labor force participation after 1840.[25] Given that much of industrialization in 19th century China took place in treaty ports (Jia, 2014), I include treaty port status as a proxy for early industrialization, which is already in the baseline specification. Columns 1-3 of Table VI show coefficients of interest after controlling for or omitting treaty ports. Being a treaty port in the 19th c. indeed has an impact on sex ratio at birth. The interaction term between treaty port status and cotton textiles (1300-1840) is close to zero and insignificant, suggesting that the cotton revolution has no differential impact on sex ratio at birth by treaty port status. I also drop all treaty ports in column 3 and this slightly increases the size of the main coefficient estimate.

C.2 Expansion of Christianity

As Christianity emphasizes the value of human life, expansion of Christianity in China might have influenced constituted a source of variation in willingness to conduct sex selection. In the 19th and early 20th century, missionaries went to China to spread Christianity. Christianity might have shaped both attitudes towards infanticide and gender-role attitudes. Although the share of Chinese populations that were ever converted was small, they had a disproportional influence on the rest of society (Bai and Kung, 2014).

To check the impact of Christianity, I first include the density of communicants in column 4. As expected, a greater share of communicants in the population is negatively associated with sex ratio at birth. The size of the coefficient of interest increases by one-fifth, suggesting that some of the effects of the cotton revolution might have been masked by missionary activities. Counties without cotton textiles (1300-1840) had a higher density of communicants. I interact the density of communicants with cotton textiles (1300-1840) in column 5. The coefficient is positive for the interaction term, but not statistically significant. This implies the effect of the cotton revolution is smaller for counties with a greater share of communicants, and likewise, the effect of Christianity is smaller for counties positively impacted by the cotton revolution. In column 6, I drop all counties with more than 10 communicants per

[25]Section VII.C provides evidence that women in provinces more exposed to the cotton revolution were more likely to work outside of the home at the onset of the industrialization. Goldin and Sokoloff (1982) documents a substantial involvement of women in the industrialization of the American Northeast and a wage increase for women relative to men.

10,000 residents; the estimated coefficient slightly increases in size.

C.3 Post-1979 Economic Policies

A set of liberalization policies were implemented after 1979 to vitalize the economy. I estimate the impact of economic liberalization on sex ratio at birth by exploiting the fact that coastal regions had greater propensity for economic liberalization. Shortly after 1979, five special economic zones were approved and they were all located on the coast. The Yangtze Delta and the Pearl River Delta witnessed rapid export-led economic growth upon economic liberalization. Are those regions are the same regions that had cotton textile (1300-1840).[26] I already have per capita income in the baseline specification to control for the impact of economic development; to account for other effects of post-1979 economic liberalization, I add a control for the coastal region (column 7), interact the coastal region with cotton textiles (1300-1840) (column 8) and drop the coastal region from the sample (column 9). The estimated coefficient decreases, but only slightly, after the inclusion of the coastal region dummy. In column 9 the coefficient size of interest increases by about a third.

[26]Figure I suggests that both the Yangtze Delta and the Pearl River Delta are indeed associated with cotton textile production.

Table VI: Post-1840 Political and Economic Shocks

	Dependent variable: sex ratio at birth										
	(1)	(2) Early Industrialization	(3)	(4)	(5) Christianity	(6)	(7)	(8) Economic Liberalization	(9)	(10) All	(11) None
Mean of Dep. Var.	118.6	118.6	119.1	118.8	118.8	119.4	118.6	118.6	118.8	118.8	118.8
Cotton textiles (1300-1840)	-3.753***	-3.739***	-4.108***	-4.164***	-5.983***	-5.949***	-3.669***	-4.363***	-4.941***	-6.251***	-4.207***
	(0.731)	(0.764)	(0.766)	(0.883)	(1.415)	(1.021)	(0.730)	(0.783)	(0.798)	(1.413)	(0.881)
Treaty port	-3.943***	-3.863***		-3.248**	-3.364**	-7.366***	-3.673***	-4.010***	-7.008***	-2.732	-3.333**
	(1.043)	(1.292)		(1.468)	(1.459)	(1.997)	(1.061)	(1.060)	(1.414)	(2.045)	(1.463)
Cotton textiles (1300-1840) × Treaty port		-0.138								-0.817	
		(1.929)								(2.858)	
Christianity				-0.348	-0.852*					-0.802*	
				(0.382)	(0.487)					(0.480)	
Cotton textiles (1300-1840) × *Christianity*					1.121*					0.858	
					(0.666)					(0.675)	
Coastal							-2.288	-4.843***		-6.164**	
							(1.515)	(1.822)		(2.539)	
Cotton textiles (1300-1840) × coastal								4.620**		6.197**	
								(2.077)		(3.085)	
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Socioeconomic	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Macroregion FE											
Adjusted R^2	0.368	0.368	0.392	0.359	0.360	0.379	0.369	0.370	0.366	0.362	0.360
Observations	1489	1489	1289	993	993	766	1489	1489	1260	993	993

Notes: The table reports the impact of Cotton textiles (1300-1840) on sex ratio at birth accounting for political and economic shocks. The unit of observation is a county in 2000 Census. The dependent variable is sex ratio at birth. Baseline controls are those used in column 3 of II. Christianity is measured by log (communicants per 10,000+1). "on the coast" refers to a county within 50 kilometers of the coast. Column 3 drops all treaty ports. Column 6 drops all counties with more than 10 out of 10,000 individuals being communicants. Column 9 drops all coastal counties. Column 10 include all interaction terms. Column 11 includes only baseline controls and uses the same sample as Column 10. As part of the baseline controls, treaty port status and provincial capital are controlled for in all specifications. Robust standard errors are included in all specifications. Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Lastly, I include controls for all three large political and economic shocks and interacted them with cotton textiles (1300-1840) in column 10. This results in a sample of 993 counties. I find that if those shocks can be taken as exogenous, the cotton revolution is associated with a reduction of sex ratio imbalances by 6.2 boys per 100 girls in places without exposure to any of the shocks. Using the same sample but without controlling for those shocks, the main coefficient estimate is 4.2 boys per 100 girls (column 11).

VII Understanding the Mechanisms

A Nature of the Treatment: A Transition to the Female Bread-Winning Household

The nature of the positive impact of the cotton revolution on women is related to, but not limited to the contemporaneous effect of increasing incomes.

From 1820 to 1850, in the industrialization of the American Northeast, female labor force participation was substantial, and the wages of women increased relative to that of men (Goldin and Sokoloff, 1982). In a letter, a New England farm girl was full of excitement when she began to work on well-paying jobs in textile mills (Dublin, 1993).[27] Ferree (1976) finds that working-class women are happier if are employed; they work for the money but they also gain a sense of competence, connectedness, and self-determination from their job. Similarly, at a community level, in India, work earns women money and respect.[28]

The cotton revolution led to women particpating in cotton weaving in some parts of China, but in cotton cultivation in other parts. Did gender equitable beliefs also emerge in places specializing in cotton cultivation? Below I compare the effect of cotton weaving with that of cotton cultivation.

A.1 Comparison with Cotton Cultivation

Women participated in the cultivation of cotton ("raw cotton"). Raw cotton is first spun into yarn, yarn woven into cotton fabrics. The locations of cotton cultivation did not overlap with the locations of cotton spinning or weaving.[29] I do not find a significant relationship between cotton cultivation and birth sex ratio (column 1). In column 2, I include both cotton textiles (1300-1840) and cotton cultivation, and use a dummy variable of raw cotton

[27]Dublin (1993) is a collection of letters from five women working in textile mills. Mary Paul said in a letter "I can earn more to begin with [at lowell] than anywhere about here." When she got paid, she expressed her excitement over buying new shoes "Last Tuesday we were paid. In all I had six dollars and sixty cents paid $4.68 for board. With the rest I got me a pair of rubbers and a pair of 50 cts shoes."

[28]http://www.nytimes.com/2016/01/31/world/asia/indian-women-labor-work-force.html?$_r = 0$.

[29]See Appendix A for a map of cotton suitability. Regions specialized in cotton cultivation or in spinning and weaving. The US South specialized in cotton cultivation, when the UK specialized in the manufacture of cotton. FAO provides cotton suitability data at the level of 5 arc-minute grid cells (10km*10km). Consistent with other suitability measures used in this study, I use "agro-climatically attainable yield for intermediate-input-level, rain-fed cotton for baseline period 1961-1990" as my measure of cotton suitability.

Table VII: Cotton Cultivation

	Dependent variable: sex ratio at birth in 2000		
	(1) Continuous	(2) Continuous	(3) Dummy
Mean of Dep. Var.	118.6	118.6	118.6
Cotton textiles (1300-1840)		-3.719***	-3.635***
		(0.740)	(0.741)
Raw cotton	-0.00177	-0.000492	-2.028
	(0.00322)	(0.00322)	(1.654)
Baseline controls	Yes	Yes	Yes
Province FE	Yes	Yes	Yes
Socioeconomic Macroregion FE	Yes	Yes	Yes
Adjusted R^2	0.358	0.368	0.368
Observations	1484	1484	1484

The table reports the results of the relationship between cotton cultivation and birth sex ratios. The unit of observation is a county in 2000 Census. Baseline controls are those used in Column 3 of baseresults. Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

in column 3. In both cases, the coefficient estimate of cotton textiles (1300-1840) does not vary much from the baseline estimate.

Cotton weaving generated more incomes than did most other occupations of that period. This is a crucial condition for women to be breadwinners in average households, not just in a selected sample of households or among unmarried women. Women in areas with cotton cultivation did not earn enough to become breadwinners. This helps to explain that long lasting impact of the cotton revolution which distinguishes it from other episodes during which demand for female labor increased, such as Black Death.

B Initial Impact: The case of widow survival, 1368-1644

The cotton revolution began around 1300. To shed light on the timing of this transition and the formative years of gender-equitable beliefs, I look into the historical case of widow survival using data collected from gazetteers published in the Ming Dynasty.

The cotton revolution greatly improved the economic prospects of widows. Stable incomes derived from cotton textile production played a beneficial role in the survival of widows. With those incomes, widows were able to not only support themselves, to support their children and in-laws, but also to contribute to communities by charitable giving (Elvin, 1984; Zurndorfer, 1998; Sommer, 2000).

Historical data on the number of widows and their mortality in the universe do not exist. Records kept by counties and prefectures on "virtuous women", however, provide information on widow suicide. The "virtuous women" system is a state-sponsored institution that rewards widows for adhering to a strict moral code. In the spirit of Song-Ming Neo-Confucianism,

women were praised for maintaining female chastity after their husband's death. Those women were called "virtuous women". Before 1300, among all "virtuous women", half of the women were "chaste widows" who provided for their in-laws and children for a number of decades, the other half were "heroic widows" who committed suicide upon their husband's death to demonstrate their exemplary character (Dong, 1979).[30]

Widow records are from local gazetteers. Only records on imperial testimonials of merit (*jingbiao*) proffered by the central government are used in this exercise so that estimates are unaffected by local standards for awarding "virtuous women" status. Using prefecture-level gazetteers published in the Ming Dynasty (1368–1644) and available on *zhongguo fangzhi ku, Series I (Chinese Gazetteer Database)*, I create a measure of widow suicide during the Ming Dynasty.[31]

Table VIII summarizes the results. Column 1 shows an unconditional relationship between cotton textiles and widow suicide with only province fixed effects. Column 2 includes the natural log of one plus distance to Qufu, population density in 1300. In the spirit of Kung and Ma (2014), I use distance from Qufu—the birthplace of Confucius—as a proxy for the cultural demand for "virtuous" behavior on the part of women. The coefficient estimates of cotton textiles are close to conventional cutoffs of statistical significance after controlling for distance to Qufu. In columns 3-7, I sequentially add population density in 1600, agricultural suitability, ruggedness, latitude, longitude and their interaction term. Across the columns, I find cotton textile production consistently predicts a lower number of "heroic widows".

The above exercise provides some suggestive evidence that cotton textile production reduced widow suicide. Ideally, I would like to compare widow suicide rates before and after the cotton revolution (1300-1840). However, a very small number of gazetteers were published before the Ming period (1368-1644) and even fewer have been preserved to this day. Information on widow suicide before Ming is too scarce for the purpose of this exercise.

In Ming and Qing China, an unprecedented number of widows participated in a wide range of economic and social activities. A strong financial position elevated the status of a widow in the family of her deceased husband's, as well as in her own family of origin. Also, because cotton textiles enabled women to maintain a livelihood in the absence of their husband, from the perspective of parents, a daughter's ability to support herself under adverse circumstances reduced their mental and financial exposure to the fate of their daughter. This was especially relevant because premodern China was characterized by high levels of economic

[30] For more details on Song-Ming Neo-Confucianism and "virtuous women", please refer to Appendix I.6.

[31] The sample is restricted to prefectures with at least one prefecture-level gazetteer composed in the Ming period. As prefectures can have different rules as to what materials to include in the gazetteer, a prefecture needed to have at least one *jingbiao* record to be included in the sample.

Table VIII: *jingbiao*: Widow Suicide

	Dependent variable: widow suicide					
	(1)	(2)	(3)	(4)	(5)	(6)
Mean of Dep. Var.	0.500	0.500	0.500	0.500	0.500	0.500
Cotton textiles	-0.338	-0.461^{+}	-0.594^{+}	-0.621^{+}	-0.665^{+}	-0.581^{+}
	(0.369)	(0.293)	(0.381)	(0.377)	(0.389)	(0.352)
Log (dist. to Qufu)		-0.722***	-0.712***	-0.814***	-0.756***	-0.242
		(0.172)	(0.172)	(0.196)	(0.183)	(0.420)
Pop. density in 1600			0.181	0.316	0.224	0.345
			(0.274)	(0.322)	(0.338)	(0.390)
Agriculture suitability				-0.106	-0.178	-0.177
				(0.0892)	(0.139)	(0.137)
Ruggedness	No	No	No	No	Yes	Yes
Latitude	No	No	No	No	No	Yes
Longitude	No	No	No	No	No	Yes
Latitude × Longitude	No	No	No	No	No	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.326	0.482	0.465	0.465	0.461	0.526
Observations	32	32	32	32	32	32

Notes: The table reports the impact of cotton textiles (1300-1840) on widow suicide. The unit of observation is a prefecture on the 1911 prefecture map. The dependent variable is the number of search records related to women's receiving the title of "virtuous woman"(*jingbiao* for committing suicide following their husband's death. Qufu is the birthplace of Confucius. A prefecture needed to have at least one *jingbiao* record to be included in the sample. Outliers in either widow suicide or chaste widowhood are not included in the sample. The explanatory variable is cotton textile production recorded in prefecture-level gazetteers published in the Ming period. Robust standard errors are used in all specifications. Standard errors in parentheses $^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

uncertainty.[32] Improvement in the conditions faced by widows contributed to women coming to occupy a more substantial space in society (Bray, 1997; Pomeranz, 2004; c. Zhao, 2015).

C Female Labor Force Participation in a Market Economy

To provide further evidence that the cotton revolution transformed the culture, I examine its effects after 1840. Data are quite scarce for this period. As a first approximation, I examine the share of female workers in the industrial workforce in the early 20th century.

There is no systematic data on the composition of the workforce for periods prior to the Republican Era (1911-1949). The 1916 Economic Census documented the number of male and female workers working in a factory by province and industry, with household

[32]Bossler (2000) finds evidence for a continued relationship between a married woman and her natal family. Although a woman became a member of her husband's extended family upon marriage, her natal family could still be implicated in times of crisis. This included cases in which a widowed woman in poverty imposed a financial burden on her natal family.

production workers excluded. There was a lot of regional variation in female labor force participation. Table A.IV provides summary statistics. At the province-industry level, on average, roughly 19% of the workers were female. Women made up a sizable portion of the industrial workforce in Jiangsu, Zhejiang and Shanghai, where women even outnumbered men; in comparison, women rarely worked outside of home in Zhili, Shanxi and Shaanxi. This suggests that women had very different responses to industrial job opportunities at the onset of China's industrialization. Such different responses cannot be explained by a prior history of women working outside of home, since the vast majority of women in China did not work outside of home prior to this period. This is more likely due to the persistence in the role of bread-winning females: families that were used to women generating incomes would be more likely to let women take on industrial jobs, when these new jobs became the high-paying jobs at the time.

For this period, no information is available for outcome variables commonly examined in the modern literature, such as sex ratio at birth, female education attainment, or indicators of spousal relations. Disaggregated data did not exist.

I regress cotton textiles (1300-1840) on the share of female workers in the industrial workforce. Table IX suggests that in provinces with a higher share of population exposed to the cotton revolution, a higher share of women worked in factories. The results are not affected by whether I add industry dummies or control for provincial populations. It is conceivable that women were employed more often because there was persistence in specific skills, i.e. women who could produce textiles at home had an advantage in industrial production of textiles. However, I find that the share of female workers was not only higher in textile manufacturing but also higher in other industries. Cotton textiles (1300-1840) are positively correlated with the share of female workers in most industries, with the exception of fur making. These results are consistent with the hypothesis that there was a permanent change in gender-equitable beliefs, and that the change remained in place after the economic effects of the cotton revolution gradually faded.

D Under the Microscope of State Socialism: 1949-1990

Next I examine the effects of the cotton revolution under state socialism. One main shortcoming of relying on the share of female workers to investigate the effects of the cotton revolution is that many economic, political and social factors are at play in the decision to participate in the labor force. Exploiting the setting of state socialism, where many political, economic and social forces were heavily regulated by the state, I am able to isolate the channel through which the cotton revolution influence modern outcomes. In addition, due to centralized rule, cultural norms could not easily influence local economic, political and

Table IX: Share of Female Workers: Evidence from the 1916 Economic Census

	Dependent variable: % female workers			
	(1)	(2)	(3)	(4)
Mean of Dep. Var.	0.197	0.197	0.197	0.197
Cotton textiles (1300-1840)	0.137**	0.110*	0.110*	0.110*
Log Total Population	No	No	No	Yes
Industry dummies	No	No	Yes	Yes
#clusters	14	14	14	14
Adjusted R^2	0.0244	0.267	0.262	0.340
Observations	170	170	170	170

Notes: The table reports the impact of cotton textiles (1300-1840) on the share of female workers before state socialism. The unit of observation is an province-industry pair. The dependent variable is the share of female workers. Column 4 accounts for the number of clusters and report p-value (0.068) based on the empirical distribution of t-statistics using a wild cluster bootstrap-t procedure. Standard errors are clustered at the province level and in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

legal institutions at a local level. This allows me to distinguish the effects of the cotton revolution through gender-equitable beliefs from other channels such as human capital and local development.

From 1949 to the early 1990s, the state tightly controlled and centralized most political, economic and social domains, such as property ownership and labor force participation. Chinese women gained the same legal status as men. Marriage laws were passed in 1950 to grant women the right to free marriage and the right to divorce, inherit property and have custody over their children. China also mandated equal entry to the labor market and instituted equal pay for equal work for men and women (Hannum and Xie, 1994; Yang, 1999; Entwisle and G. Henderson, 2000).

Despite the tight control of the state, the state was not able to intervene in every decision made by individuals. Even at the peak of state socialism (1949-1990), families were allowed to decide whether the husband or the wife would become the head of the household. Using the 1990 Population Census, I turn to a micro-level analysis that examines variation in the identity of the head of the household. Parallel to US Census before 1980, population censuses in China have a variable "Head of household" and a second variable "Relationship to head of household".[33] The first categories of the"Relationship to head of household" are "self" and "spouse". I code "Head of household" as one when"Relationship to head of household"

[33]In the United States, the census switched to "Person 1" and "Relationship to first person listed on the questionnaire" just before 1980. https://www.census.gov/history/www/through_the_decades/index_of_questions/1980_population.html

is listed as "self", zero when"Relationship to head of household" is listed as "spouse". In most cases, the husband assumes the role of the head of the household, but there is plenty of regional variation: depending on the prefecture, anywhere from 1 to 20% of the heads of the households were wives. During this period, men and women had equal rights, and private property did not officially exist. For those reasons, being the head of the household status did not reflect underlying property relations, nor did it entitle one to a different set of legal rights. The head of the household status became a cultural symbol that had the connotation that whoever in that position led and ran a family. For most people, the idea of having a wife as the head of the household is unthinkable—only 5% of married couples decided to have the wife be the head.

Table A.II describes the main sample based on the 1990 Census. Only married individuals are included. Each observation is an individual who is the head of the household. The sample is restricted to Han Chinese. I use the same geographic coverage as in the main sample in Section VI.[34] Approximately 47% of the total population lived in a prefecture positively impacted by the cotton revolution. By the time of the census, migration rates were still low; many individuals lived in the same town as their ancestors.

My estimation equation is

$$\text{Wife}_{i,p} = \alpha + \beta \text{cotton textiles (1300-1840)}_p + \mathbf{X}_p^H \mathbf{\Omega} + \mathbf{X}_p^G \mathbf{\Lambda} + \mathbf{X}_p^C \mathbf{\Pi} + \mathbf{X}_i^I \mathbf{\Gamma} + \epsilon_{i,p} \,, \qquad (2)$$

where p denotes a prefecture.[35] My outcome variable is whether the head of the household is the wife. Cotton textiles $(1300\text{-}1840)_p$ is cotton textile production between 1300 and 1840 in Prefecture p.[36] If the cotton revolution was effective in transforming cultural beliefs about women, β should be positive and significant. $\mathbf{X}_p^H$, $\mathbf{X}_p^G$ and $\mathbf{X}_p^C$ are the same controls as in the county-level analysis.[37] $\mathrm{X}_i^I \mathbf{\Gamma}$ denotes individual-level controls: age group and family size. Robust standard errors are clustered at the prefecture level for all specifications.

Estimates based on Logit regressions are reported in Table X.[38] Column 1 includes all

[34]To be included, the territory of a prefecture has to be entirely contained in the geographic coverage of the main sample.

[35]In the IPUMS 1990 census data, individual residence is only recorded at the prefecture level.

[36]See Appendix D.3 for more details as to how this variable is constructed. Small boundary changes occurred over time. To reduce measurement error, I construct a binary variable such that prefectures with more than 90% of the territory with cotton textile production are coded as one; prefectures with less than 10% of the territory with cotton textile production are coded as zero. The difference between the dummy and the continuous variables is, however, small (See Table A.II).

[37]$\mathbf{X}_p^C$ are county-level census data aggregated to the prefecture level weighted by county population. For $\mathbf{X}_p^C$ most controls from the census year 2000 are replaced with controls from the census year 1990. GDP per capita 2000 is replaced by GDP per capita 1989.

[38]For cotton textiles (1300-1840), a binary variable is used in all regressions. The continuous variable, however, yields similar results.

Table X: Wife Heading the Household : 1990 Census

	Dependent variable: wife			
	(1)	(2)	(3)	(4)
Mean of Dep. Var.	0.0589	0.0647	0.0589	0.0589
Cotton textiles (1300-1840)	0.332*	0.316*	0.355*	0.339*
	(0.179)	(0.176)	(0.183)	(0.179)
Marginal effects	0.017*	0.018*	0.017**	0.018+
	(0.010)	(.0104)	(0.009)	(0.011)
Age >30	No	Yes	No	No
Education	No	No	Yes	No
Occupation	No	No	Yes	No
Pop. density in 1820	No	No	No	Yes
Age group	Yes	Yes	Yes	Yes
Family size	Yes	Yes	Yes	Yes
Baseline controls	Yes	Yes	Yes	Yes
Socioeconomic macroregion FE	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes
# cluster	88	88	88	88
Pseudo R^2	0.067	0.062	0.195	0.067
Observations	701263	555282	701263	701263

Notes: The table reports the impact of cotton textiles (1300-1840) on the probability of wife heading the household. The unit of observation is a individual in the 1990 Census. The dependent variable is a binary variable that equals one when an individual is a wife. The sample is restricted to individuals who are the head of the household, married and Han Chinese. All estimates are based on Logit regressions. Baseline controls are the same as in column 3 of Table II, except that contemporary controls here are replaced by variables from the 1990 census. Robust standard errors are clustered at the prefecture level. Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

baseline controls together with controls for age group and family size. In column 2, I restrict the sample to women over 30. In column 3, I include additional individual-level controls, such as educational attainment, occupation and migration status, which are possibly endogenous to gender-equitable beliefs. In column 4, I include the natural log of population density in 1820. My coefficient estimates are highly stable across the columns. In prefectures positively impacted by the cotton revolution, the probability of a wife's being the head of the household increases by 1.7%, which is 29% of the average probability for women to head the household (5.89%). Estimates in column 4 suggest that the past population density is not a main channel through which the cotton revolution affects present-day gender inequality.[39] This

[39]In Appendix I I discuss macroeconomic consequences of the cotton revolution. From 1300 to 1840, the total population increased eightfold. Historians attribute part of the population increase to a greater ability to produce textiles.

lends more confidence to the main hypothesis that the cotton revolution led to the emergence of gender-equitable beliefs.

The above analysis shows the impact of the cotton revolution remains under state socialism. The coefficient estimates of cotton textiles (1300-1840) should be interpreted as the direct effect, rather than the total effect, of the cotton revolution through the channel of cultural beliefs about women's worth. In other words, if the cotton revolution was able to freely shape local political and legal institutions through aggregated preferences, the magnitude of those estimates would be greater.

It is possible that state socialism promoted gender-equitable beliefs. To demonstrate the impact of state socialism on gender-equitable beliefs, I show results of a cohort analysis in Appendix F.8.

VIII Interpretations and Caveats

This section discusses the external validity and policy implications of this study. The study shows that it is possible to change the perception of women being less capable than men. However, several conditions were necessary for such a change to occur. One important condition was that the production of cotton textiles did not require the overhauling of the entire social structure and therefore, did not meet much social resistance. Due to the nature of at-home work, women generated market income without having to reduce their investment in their families. Women continued to produce textiles after they became married, and there has never been a Chinese equivalent of "marriage bars" restricting employment of married women.

Another favorable condition was that the underlying productivity of cotton textile production was easy to ascertain. In contrast to modern firms, which often have a multi-layer managerial structure, the monitoring of output in home production of cotton textiles was straightforward. Cotton textiles were produced at home and the value of women's work was revealed when these textiles were sold in the market. The fact that the production was easily measured and not subject to ambiguous standards of interpretation reduced opportunities to exercise discrimination, which tends to arise when evaluation is more difficult, as described in critiques of the comparable-worth hypothesis (Deaux, 1985; McArther, 1985).

There is no denying that several historical contingencies enabled women to reap the benefits of the cotton revolution and to earn such high incomes. (a.) Imperial China had a "quasi-socialist" state. The traditional division of labor in which men worked in the fields and women produced textiles, was partly caused by the state in-kind taxation system. (b.) Men's labor productivity stagnated as with high rates of land ownership and high demand for male labor in plough-based agricultures, the labor of most men could not be freed up

easily. (c.) Female involvement in textile work, often as early as in their pre-teen and teen years, did not crowd out their educational attainment.[40]

Historical contingencies were critical in enabling women to earn high incomes for such a long period. For women to earn high incomes in today's world, however, it is not necessary to have identical conditions to those in Imperial China. With advances in technology and changes in institutions, economic opportunities favoring women provide a richer variety of ways for women to earn high incomes today. Likewise, in this historical experiment, it took hundreds of years of high relative female income for the perception of women to change. This could explain why modern experiments have not been overly successful in changing gender norms, but this does not mean that it will take equally long to see such changes in a modern context.

There are a few other caveats regarding the external validity of this study: (a.) Population mobility was low in premodern China due to the combined forces of state policies and cultural traditions. Because the communist state continued to restrict population mobility, migration rates remained low after 1949; (b.) An important feature of Chinese culture is that parents have substantial power over children, which may have facilitated the vertical transmission of cultural values. For that reason, and consistent with the theoretical reasoning of Bisin and Verdier (2001), the persistence of beliefs seen in China could be stronger than in other places; (c.) The lack of development of local legal systems and political institutions means that individuals can neither coordinate on reforms, nor can they coordinate to block progress. (d.) Past decades of state socialism might have weakened cultural values through both progressive laws and propaganda. In the absence of state socialism, the impact of the cotton revolution on modern outcomes might have been greater.

It is worth noting that despite a tradition of Confucianism and patrilocality, there have been many outstanding Chinese women. Chinese women who go to top business schools demonstrate more competitive inclinations than their US counterparts.[41] This paper reconciles the phenomenon of ambitious and successful professional women in China, with the

[40]This is because in premodern China, women were almost universally illiterate, regardless of when and where they first engaged in work. In contrast, interventions in increasing economic opportunities for women would not necessarily result in higher life-time incomes for women in the contemporary world, due to competing claims on time by workforce participation and human capital investments (Shah and Steinberg, 2015).

[41]Among MBAs or undergraduates at top programs, 65 percent of the women consider themselves "very ambitious", compared with 36 percent of their U.S. counterparts; 76 percent aspire to a top job versus 52 percent of Americans. Female candidates are found to be as competitive, if not more so, than their male counterparts.http://iveybusinessjournal.com/publication/ambitious-educated-women-and-their-key-role-in-solving-chinas-talent-crunch/. Two-thirds of the richest self-made women in the world are active in China. http://qz.com/529508/china-is-home-to-two-thirds-of-the-worlds-self-made-female-billionaires/.

conservative past of the country, by highlighting the unique role of high-value work opportunities in changing the perception of women being inferior.

IX Concluding Remarks

Using a historical experiment, the cotton revolution (1300-1840 AD), this paper examines the hypothesis that high-value work opportunities for women can lead to the emergence of gender-equitable beliefs. When women began to earn an income close to or higher than that of men, a shift in culture occurred. It switched from an equilibrium in which women were seen as less capable than men in part because they contributed less to household production to one in which they could achieve value and esteem as a result of engaging in high-value work.

I show that a sizable portion of the variation in sex ratio at birth in present-day China can be linked to the cotton revolution. The cotton revolution is also associated with more investment in girls' education. These results are robust to clustering at different geographical levels, matched samples, addressing biases in gazetteer data, different subsamples, accounting for historical and modern confounders, the inclusion of deep determinants of gender norms as raised in previous literature, and an instrumental variable strategy. I find that high-value work has a distinctive role in transforming cultural beliefs about women's worth. Accounting for large political and economic shocks after 1840, the effects of the cotton revolution remain.

This finding is complemented by survey evidence: the production of cotton textiles between 1300 and 1840 predicts gender-equitable beliefs. I show an initial impact of the cotton revolution on women that occurred as early as 1600: places positively impacted by the cotton revolution had lower rates of widow suicide. The effects of the cotton revolution have been manifested under various political and economic conditions. When China began to industrialize, more women worked in the industrial sector in places positively impacted by the cotton revolution. Under post-1949 state socialism, gender-equitable beliefs operated in the private domain when the public domain became highly centralized and tightly controlled by the government.

Societies lacking high-value work opportunities for women in the past, through the perception of women being less capable than men, can continue to discourage women today. Those beliefs can be reflected in both discrimination against women and negative self-evaluation or self-stereotyping by women, and potentially, in gender differences in terms of both preferences and psychological traits. Risk attitudes, attitudes toward competition, attitudes toward negotiation and other psychological traits have been shown to be different for men and women, and scholars have shown that this difference can be at least partly explained by nurture and

cultural attitudes.[42] To change the perception of women, technologies and institutions that facilitate the creation of high-value work opportunities for women might be highly beneficial. In addition, this study also suggests that it is possible for women to become more equal to men even in traditional societies. Given that a large number of developing countries have remained agricultural and traditional, this study is highly relevant for our understanding of how to improve gender equality in traditional societies.

[42]Gneezy, Leonard, and List (2009) find that the social environment, namely, whether a society is patriarchal or matrilineal, is key to women's competitive inclinations. Y. J. Zhang (2015) similarly finds a cultural component in competitive inclinations.

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For Online Appendix

A Additional Figures and Tables

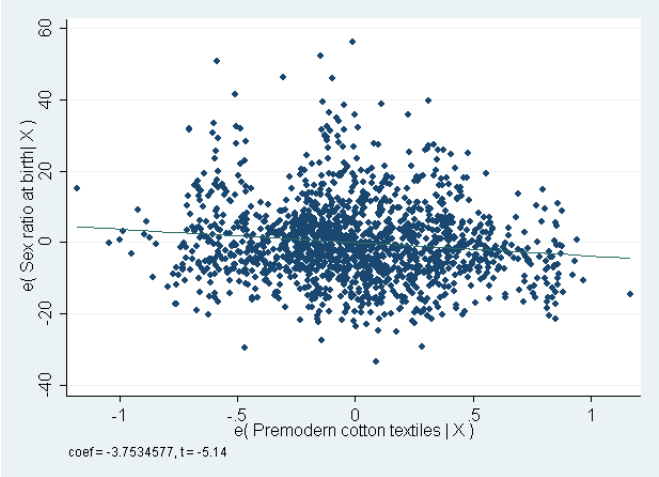


Figure A.I: Partial Regression Plot

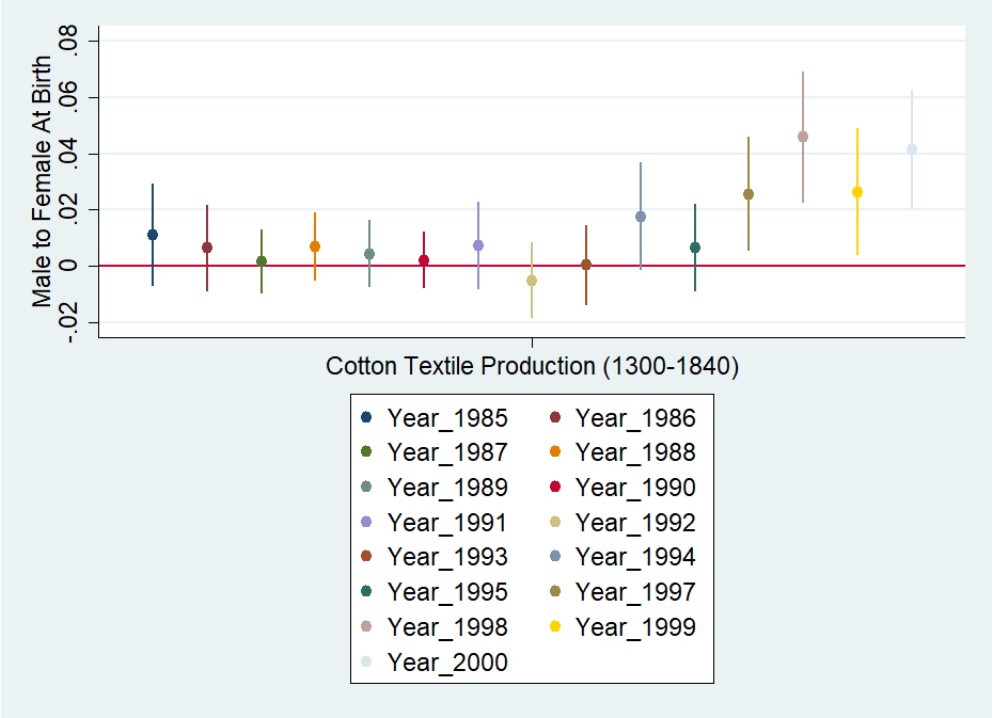


Figure A.II: The Impact of the Cotton Revolution on Birth Sex Ratios, Year-to-Year

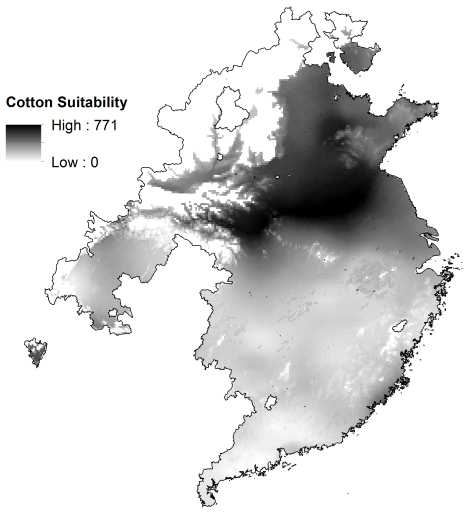


Figure A.III: Agro-Climatically Attainable Yield (kg DW/ha) for Immediate-Input-Level, Rain-Fed Cotton

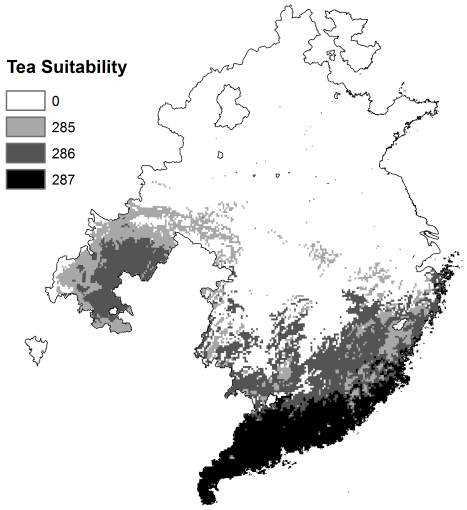
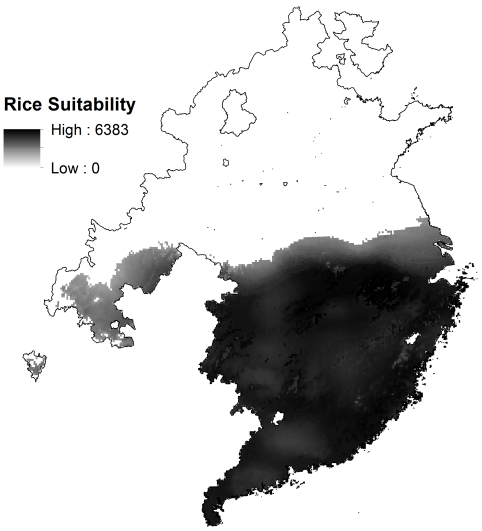
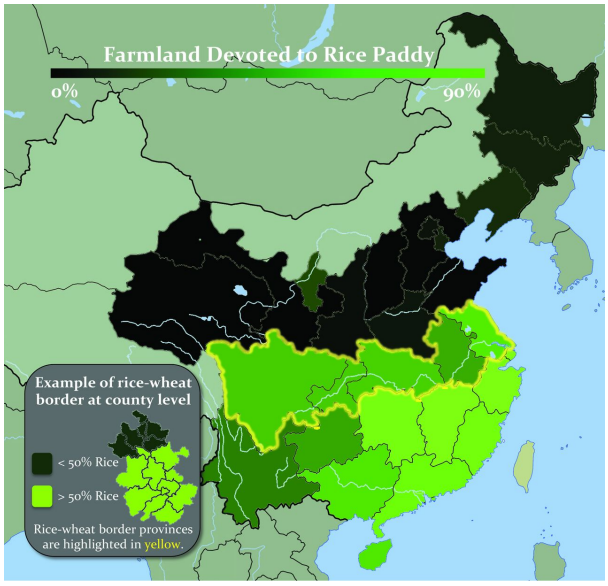


Figure A.IV: Agro-Climatically Attainable Yield (kg DW/ha) for Immediate-Input-Level, Rain-Fed Tea



a: Agro-Climatically Attainable Yield (kg DW/ha) for Immediate-Input-Level, Rain-Fed Wetland Rice



b: Farm Land Devoted to Rice Paddy. Source: **talhelm14**

Figure A.V: Rice Cultivation

Table A.I: Summary Statistics: County-Level Analysis

Variable	Mean	Std. Dev.	Min.	Max.	N
Sex ratio at birth	118.306	13.956	91.622	193.16	1622
Cotton textiles (1300-1840)	0.467	0.499	0	1	1622
Log share of ethnic minorities	-0.925	1.49	-4.605	4.544	1620
Log per capita GDP	9.102	0.74	6.251	12.073	1528
Log share of agriculture workforce	-0.925	1.49	-4.605	4.544	1620
Log share of service workforce	2.838	0.637	0.940	4.572	1622
Log share of urban household registration	2.939	0.766	1.105	4.554	1622
Log share of urban population	-1.243	0.816	-4.443	0	1622
Men's years of schooling	8.279	0.979	6.09	12.49	1622
Provincial capital	0.119	0.324	0	1	1621
Governance status:					
Governed by the prefecture-city government	0.309	0.462	0	1	1622
Self-governed	0.539	0.499	0	1	1622
Governed by the provincial government	0.152	0.359	0	1	1622
Treaty port	0.136	0.343	0	1	1622
Agricultural suitability	4.789	2.071	1	8	1585
On the Grand Canal or Yangtze	0.091	0.287	0	1	1622
Log population density in 1300	3.476	1.194	-0.432	6.645	1603
Log (ruggedness+1)	1.144	0.797	0.078	3.083	1622
Log distance to coast	5.329	1.398	0.083	7.07	1615
Latitude	31.962	4.632	20.42	43.728	1622
Longitude	114.494	4.338	101.584	125.414	1622
Humidity-for-weaving index, daytime	6.743	2.889	3.379	15.124	1612
Humidity-for-weaving index, full-day	8.079	3.864	3.548	23.428	1618
Humidity-for-weaving index, full-day, 80%	19.743	17.784	4.508	270.27	1618
Log distance to Suzhou	6.272	0.616	2.82	7.433	1622
Yangtze Delta	0.054	0.225	0	1	1622
Net in_migration	0.021	0.314	-0.293	4.733	1621
Sex ratio, aged 5-9	114.577	9.797	95.035	165.582	1622
Sex ratio, aged 1-4	121.076	16.147	91.655	204.068	1622
Women's years of schooling	7.189	1.13	4.48	11.28	1622
Men's years of schooling	8.279	0.979	6.09	12.49	1622
Years of schooling	7.748	1.038	5.520	11.85	1622
Cotton suitability	408.127	198.45	0	768	1600
Rice suitability	2555.093	2695.73	0	6326	1600
Rice suitability, binary	0.489	0.5	0	1	1600
Tea suitability	83.5	130.101	0	287	1600
Tea suitability, binary	0.292	0.455	0	1	1600
All textiles	0.773	0.419	0	1	1622
Log (commercial tax quota+1)	2.51	3.715	0	10.837	1622
#courier routes	0.434	0.836	0	6	1622
Log (#textile companies+1)	2.829	1.659	0	7.87	1622
Plough	0.848	0.359	0	1	1622
Late Neolithic settlements	0.651	0.477	0	1	1622
Early Neolithic settlements	0.517	0.5	0	1	1622
Fraction in slit (%)	33.289	10.175	0	50	1589

Fraction in clay (%)	23.055	8.779	0	49.316	1589
Soil texture:					
Clayey soil	0.195	0.397	0	1	1566
Loamy soil	0.680	0.467	0	1	1566
Sandy soil	0.125	0.33	0	1	1566
Language group:					
Mandarin supergroup	0.562	0.496	0	1	1622
Jin group	0.099	0.298	0	1	1622
Wu group	0.092	0.29	0	1	1622
Gan group	0.065	0.247	0	1	1622
Xiang group	0.037	0.189	0	1	1622
Min supergroup	0.061	0.239	0	1	1622
Yue group	0.041	0.199	0	1	1622
Hakka group	0.033	0.178	0	1	1622
Hui group	0.008	0.089	0	1	1622
Residual	0.002	0.043	0	1	1622
#county-level gazeteers	0.834	1.058	0	7	1622
Log (communicants per 10,000+1)	1.558	1.099	0	5.254	1054
Coastal	0.168	0.374	0	1	1615

Table A.II: Summary Statistics: 1982 Census

Variable	Mean	Std. Dev.	Min.	Max.
Cotton textiles (1300-1840)	0.47	0.486	0	1
Cotton textiles (1300-1840), binary	0.476	0.499	0	1
Wife	0.059	0.236	0	1
Family size	4.216	1.491	1	20
Age group:				
0 to 4	0	0	0	0
5 to 9	0	0	0	0
10 to 14	0	0	0	0
15 to 19	0.001	0.031	0	1
20 to 24	0.05	0.217	0	1
25 to 29	0.135	0.342	0	1
30 to 34	0.144	0.351	0	1
35 to 39	0.164	0.37	0	1
40 to 44	0.124	0.329	0	1
45 to 49	0.094	0.292	0	1
50 to 54	0.087	0.282	0	1
55 to 59	0.076	0.266	0	1
60 to 64	0.057	0.231	0	1
65 to 69	0.037	0.19	0	1
70 to 74	0.019	0.138	0	1
75 to 79	0.008	0.091	0	1
80+	0.003	0.055	0	1
Education attainment:				
Less than primary completed	0.275	0.447	0	1
Primary completed	0.59	0.492	0	1
Secondary completed	0.128	0.334	0	1
University completed	0.007	0.086	0	1
Occupation:				
Legislators, senior officials and managers	0.033	0.18	0	1
Professionals	0.015	0.121	0	1
Technicians and associate professionals	0.039	0.193	0	1
Clerks	0.027	0.163	0	1
Service workers and shop and market sales	0.027	0.161	0	1
Skilled agricultural and fishery workers	0.624	0.484	0	1
Crafts and related trades workers	0.1	0.3	0	1
Plant and machine operators and assemblers	0.033	0.179	0	1
Elementary occupations	0.02	0.139	0	1
Other occupations, unspecified or n.e.c.	0	0.015	0	1
NIU (not in Universe)	0.081	0.273	0	1
Migration status (5 years):				
Same major, same minor administrative unit	0.985	0.121	0	1
Same major, different minor administrative unit	0.01	0.099	0	1
Different major administrative unit	0.005	0.069	0	1
Abroad	0	0.004	0	1
Prefecture-level characteristics:				
Log share of ethnic population	0.404	0.511	0	2.368
Log per capita GDP	7.385	0.441	6.472	9.622
Log share of agricultural work force	4.225	0.284	2.317	4.519

Log share of urban population	2.808	0.475	1.912	4.104
Provincial capital	0.124	0.33	0	1
Prefecture-level city	0.71	0.454	0	1
Prefecture or league	0.29	0.454	0	1
Treaty port	0.188	0.391	0	1
Agricultural suitability	-3.829	1.696	-7	-1
On the Grand Canal or Yangtze	0.343	0.475	0	1
Log(1+ruggedness)	1.242	0.758	0.091	2.854
Log distance to coast	5.212	1.282	0.822	7.056
Log population density in 1600	4.07	0.772	2.167	5.669
Latitude	115.457	4.279	101.732	121.426
Longitude	31.734	3.928	21.845	40.712

Notes: Ths table provides summary statistics on 701,263 individuals in 88 prefectures.

Table A.III: Summary Statistics: Widow Suicide

Variable	Mean	Std. Dev.	Min.	Max.	N
Cotton textiles (1300-1840)	0.587	0.476	0	1	32
Widow suicide	0.5	0.718	0	2	32
Chaste widow	4.172	4.559	0	17	32
Log(dist. to Qufu)	6.327	0.645	4.305	7.436	32
Agricultural suitability	4.563	2.154	2	8	32
Log (ruggedness)	3.378	2.623	0.103	8.569	32
Longitude	117.094	3.054	110.092	121.409	32
Latitude	29.667	3.004	20.862	36.588	32

Table A.IV: Summary Statistics: Female Employment in 1916

Variable	Mean	Std. Dev.	Min.	Max.	N
Province-level characteristics:					
Cotton textiles (1300-1840)	0.528	0.327	0.032	0.993	14
Log (population size)	17.832	0.369	17.173	18.321	14
Province-industry-pair characteristics:					
%female workers	0.197	0.258	0	1	170
Industry:					
Textiles—cotton	0.076	0.267	0	1	170
Textiles—linen	0.029	0.169	0	1	170
Textiles—wool	0.041	0.199	0	1	170
Textiles—knitting	0.041	0.199	0	1	170
Textiles—attire	0.065	0.247	0	1	170
Dyeing	0.076	0.267	0	1	170
Copper	0.076	0.267	0	1	170
Ceramics	0.076	0.267	0	1	170
Glass	0.076	0.267	0	1	170
Porcelain	0.076	0.267	0	1	170
Chemistry— Match	0.059	0.236	0	1	170
Chemistry—Gunpowder	0.047	0.212	0	1	170
Chemistry—Pharmaceuticals	0.041	0.199	0	1	170
Chemistry—misc	0.076	0.267	0	1	170
Food	0.071	0.257	0	1	170
Food—misc	0.071	0.257	0	1	170

B The Impact of the Cotton Revolution

B.1 (The Lack of) Labor Market Responses

In a frictionless economy, labor is allocated to where it is in demand. Given the uneven demand for labor from the cotton textile industry, labor should flow to regions well suited for cotton weaving. Likewise, given the high incomes women were receiving from cloth production, men should join them. Below I illustrate some of the characteristics of the Chinese economy that were responsible for a lack of standard labor market response. In Appendix I, I shed further light on those characteristics through a comparison with the British putting-out system.

First, spinning and weaving skills were typically transmitted intergenerationally, from mother to daughter. Through apprenticeship, older women passed on techniques to younger women. Because the technologies favored household production, the traditional division of labor between men and women, i.e. men plow and women weave, survived.

Second, labor mobility was low. To sustain political control, the imperial government restricted labor mobility. During much of the Ming Dynasty (1366-1644), occupational status was by inheritance and individuals stayed where they were officially registered. Another factor that affected labor mobility was that individuals stayed with their extended families under the clan system. Individuals gained protection and obtained a range of basic services from the clan, which made migration costly. Besides, the majority of Chinese families owned land. Land ownership is commonly associated with low labor mobility.[43]

As cotton weaving demanded a set of climatic conditions, there were geographical constraints on where cotton could be woven (Figure I). Finished cloth, on the other hand, was sold to everywhere in the country. Relative to the rest of China, areas where cotton weaving was feasible saw a varying degree of cotton textile boom and persistently higher productivity in the textile sector.

Women in the rest of China did not directly benefit from the cotton revolution. They benefited as consumers as they were able to purchase higher quality, light-weight textiles, from the market; but their incomes did not increase. Moreover, as producers of local textiles women in non-cotton textile producing regions may have lost incomes and may have seen their status within the household diminish.

[43]Land ownership also raised the opportunity cost of men entering into cotton textile production. The need to cultivate the land to pay in-kind taxes in grain prevented men from being full-time textile workers. Women combined childcare duties with textile work, both of which took place at home. Due to the fixed cost of owning a spinning wheel and a loom, it made more economic sense to let the full-time worker have exclusive access to them.

B.2 The Decentralized Production and Ownership of Cotton Textiles

The production of cotton textiles in premodern China was highly decentralized. The basic units of production were textile-producing households. Compared with silk, benefits of centralized production were far less substantial for cotton textiles, as the economy of scale was quite limited given the level of technology, and the quality and consistency of cotton textiles were not highly valued by the majority of consumers at the time. Even after the mid-19th century, when domestic yarn was driven out of market by foreign yarn, weaving conducted by individual weavers remained competitive.[44] The practice of weaving at home was not uncommon for the pre-industrial period and remained fairly common decades into the more industrialized period. During the years from 1790 to 1830, when yarn was produced by water-powered machinery, tens of thousands of New Englanders labored in their homes to weave yarn into cloth. In 1820, an estimated two-thirds of cloth used in America was still made in families (Rivard, 2002).

Textile-producing households were essentially small businesses in rural China. They earned average product rather than marginal product of their labor. This distinguish them from home weavers in 18th century England, or in early 19th century New England. Home weavers in China were also different from urban craftsmen in medieval and early modern Europe, who were often guilded.[45]

B.3 Macroeconomic Conditions

As noted, the Ming period saw substantial Smithian growth—as the population recover, domestic trade expanded, and market exchange grew. The growth of the textile industry was an important part of this development (Bin Wong, 1997; Pomeranz, 2000). Urbanization ensured that demand for cotton textiles from city dwellers increased. Interregional specialization increased. According to Richard van Glahn (2016, p. 298): "in many respects the major development in the late Ming period was the rise of rural handicraft industries, above all cotton manufacture". These developments were further cemented in the Qing period which saw "the maturation of the market economy" (Glahn, 2016, p. 295).

China remained Malthusian during the period. This in the long-run, increased productivity was translated into faster population growth rather than a sustained increase in per capita income. Theories of economic growth suggest that per capita income growth in a Malthusian setting dependent on the elasticity of the income-mortality schedule and the income-fertility

[44]Fairbank (1978, pp.15–28) documents that in the 19th century, people in rural China continued to use hand-crafted cloth due to its lower price and reduced susceptibility to wear and tear. Foreign merchants and consular officials in late 19th century China complained about the difficulty of penetrating the Chinese market, especially in the interior provinces.

[45]See Epstein et al. (1998), Wallis (2008), Ogilvie (2011), and Ogilvie (2014) for European guilds.

schedule (Ashraf and Galor, 2011; Voigtländer and Voth, 2013b). Fertility was high in Ming and Qing China but not unconstrained; though marriage was early and close to universal, spacing and infanticide meant that martial fertility was well below maximum (J. Lee, C. Campbell, and Feng, 2002). In this setting improved production technology for cotton textiles in conjunction with a thriving market economy could led to increased incomes in short to medium rum but in the long-run incomes will return to their Malthusian equilibrium levels due to population growth (Galor, 2011).

This macroeconomic conditions helped to ensure that the productivity shock associated with the introduction on spinning and weaving technologies had a lasting impact on society. During the period under study, the Chinese economy expanded in terms of both population and total income, but it did not experience sustained increases in per capita income. Its failure to do so is a central theme of the Great Divergence debate. Conditions favored the growth of a commercial economy, particularly in the Yangtze Delta but not industrialization. In the context, of such an economy the increase in productivity associated with the cotton textile revolution would not be expected to permanently raise incomes in the long-run. Rather we would expect the improvement in cotton textiles technology and the rise of a commercial market for cotton textile products to increase incomes in the short-to-medium run and then to have a lasting impact on the ratio between male and female wages.

B.4 A Comparison to the Cotton Textile Proto-Industry in England

Cotton textiles (1300-1840) in China bore many similarities with the proto-industry in other advanced premodern economies such as 18h century England. The following key differences, however, deserve emphasis. (a.) Chinese households typically owned the machines rather than renting them. Households occasionally owned more than one machine and hired help, but they did so on a very limited scale(Fairbank, 1978). (b.) Few concurrent technology shocks occurred during the relevant time frame (1300-1840). The cotton revolution took place in an agrarian economy, and the economy remained largely agrarian for the next six~~th~~ centuries. (c.) A relatively small number of regions had the geo-climatic conditions suitable for spinning and weaving, and especially, for weaving. (d.) Though the goods market was dense and highly sophisticated in both countries, the labor market was far from being a free labor market. Emperors in the Ming and Qing periods instituted strict laws on labor mobility. The clan system continued to keep individuals tied to their extended families (as discussed in Greif and Tabellini, 2010; Greif and Tabellini, 2015). This constrained the reallocation of labor to areas suitable for cotton textile production. (e.) A higher percentage of Chinese families owned land than British families working under the putting-out system in the 18th century. Despite periodic increases in land concentration ratio as part of the dynastic cycle, China

had no equivalent of the movement of enclosure that took place in England between 1600 and 1850. The majority of Chinese families were small landowners. Male labor was absorbed by grain production, for which women did not have the comparable physical strength. With land ownership, men often had to do field work to pay in-kind taxes or else the revenue of land would be forgone. Together (b.), (c.) and (d.) ensured that prices of cotton textiles stayed reasonably high—cotton textile prices hovered at a level that generated enough income for a skilled textile worker to support a family of four, whereas (a.) and (e.) led women to reaping most of the benefits from this revolution.

B.5 A Comparison to the Black Death

Historians have argued that the Black Death led to greater female participation in the labor force in late medieval Europe. Specifically, the Black Death induced a shift from arable to pastoral agriculture in northwestern Europe. Whereas men had a distinct comparative advantage in arable farming; this was not the case in pastoral agriculture (Voigtländer and Voth, 2013b). As a consequence of this shift and overall labor scarcity, new labor market opportunities opened up for unmarried women (De Moor and Van Zanden, 2010). The difference between this episode and the cotton revolution in China is that these were generally comparatively low-paying jobs. Women worked as milkmaids and domestic servants; they did not have the opportunity to earn higher incomes than men. The labor market opportunities that opened up in northwestern Europe after the Black Death were for young women. Women worked for a couple of years before marriage—this likely gave them greater bargaining power when it came to the choice of mate, but such advantages would not last into marriage. A simple bargaining model would suggest that women's bargaining position within marriage is unaffected by the amount of incomes they earn before marriage.

In contrast, the cotton revolution raised female earning power for women across their entire life-cycle.

C Sex Ratio at Birth in 2000

C.1 Determinants of Sex Ratio at Birth

A wide range of factors shape sex ratios in the population, but sex ratios at birth are relatively clustered, typically from 103 to 107 boys per hundred girls. The perception of women being inferior can lead to female infanticide, child neglect and underinvestment in girls. When sex-selection technology is available, the manifestation of biases against women can shift towards an earlier stage of reproductive process: pre-natal sex selection.

It has been shown that pre-natal sex selection is an important source in the skewness of sex ratio at birth (Ebenstein, 2010).[46] In the 2000 Chinese Population Census, sex ratios at

[46]Confucian values shaped traditional Chinese society in important ways. It strongly disfavored women,

birth ranged from 92 to 193 boys per hundred girls.[47]

In a usual context, individuals simultaneously make decisions on fertility and sex selection. With the same attitude towards women, a population with a lower desired fertility can have a more skewed sex ratio at birth. Under the one-child policy, however, fertility became exogenously determined. This policy created a favorable condition for identifying the effect of the perception of women on the skewness of sex ratio at birth.

In the context of China in 2000, the main variation in sex ratio at birth comes from (a.) Economic payoffs to having a boy; (b.) Difficulty to having at least one boy, i.e. variation in the one-child policy and its enforcement; (c.) Culturally-determined preference for boys.

For (a.), the economic payoffs to having a boy are impacted by the stage of development and sectoral composition (Rosenzweig and Schultz, 1982). I include per capita GDP, share of agriculture workforce and share of service workforce as controls. Due to the setting of state socialism, differential economic payoffs to having a boy is unlikely driven by gender differences in labor force participation. China's female-to-male ratio in labor force participation rate was at 85% in 2000, one of the highest in the world.[48] In terms of (b.), the one-child policy further increased the difficulty to having at least one boy.[49] The policy varied by household registration (*hukou*). Those with urban *hukou* were subject to a stricter version of the one-child policy than their rural counterparts. Ethnic minorities were either not subject to or subject to a less strict version of the one-child policy. Besides, political characteristics such as how a county is governed and whether it is a provincial capital can affect the enforcement of the policy.[50] When it comes to (c.), the share of ethnic population is also an important determinant. The pace of modernization may also affect the taste. Average years of schooling is shown to be a good proxy for modernization.[51] (c.) is where I expect the effects of the

partly because it laid a particular emphasis on continuing the family line and held that only male offspring could fulfill this purpose. A further development in Confucianism, Song-Ming Neo-Confucianism, further disadvantaged women. Song-Ming Neo-Confucianism was first developed in the Song Dynasty (960–1279), which led to a series of negative changes for women, ranging from unfriendly inheritance laws and to remarriage being stigmatized. Appendix I has more details on Confucianism, Song-Ming Neo-Confucianism and status of women.

[47] This is after the exclusion of five autonomous regions where (a.) A large share of the population comprise ethnic minorities who were not exposed to Confucian norms and institutions; (b.) The one-child policy was not enforced or not to the same degree.

[48] http://hdr.undp.org/en/content/labour-force-participation-rate-female-male-ratio. Female-to-male labor force partipcation was 74.8% in the United States and 62.4% in Germany.

[49] Fertility decline predated the one child policy (Babiarz et al., 2018).

[50] Chinese prefectures and counties underwent institutional reforms after 1982. Governance status started to vary across counties. Governance status of the county takes one when it is governed by the prefecture-level government, two when it is self-governed, and three when it is governed by the province-level government.

[51] It is common to use years of schooling as a proxy for modernization. I use years of schooling (male) instead of years of schooling in the population, because female education is influenced by differential parental investments.

cotton revolution enter.

The choice of sex ratio at birth in 2000 as the main outcome variable is motivated by the following facts: (a.) Sex selection technologies became widely available in the 1990s. By the mid-1990s, virtually all county-level hospitals, township-level clinics and local family planning agencies were equipped with ultrasound scanners (Anukriti, Bhalotra, and Tam, 2015). (b.) Before 2000, variation in the one-child policy was limited to urban versus rural *hukou*, Han Chinese versus ethnic minorities. After 2000, some counties began to experiment with a two-child policy for parents that were both the only child of their parents. (c.) Marriage remained near universal, and voluntary childlessness was relatively rare. This shuts down a possible channel flowing from the cultural beliefs about women's worth to sex ratio at birth that is not pre-natal sex selection. Selectivity into motherhood, if correlated with the cotton revolution and son preference, could be a confounder. (d.) Data quality of the 2000 census is one of the highest. After 2000, a floating population composed of 200-million temporary migrants affected the data quality of the population censuses.[52]

C.2 Connections to Cultural Beliefs About Women's Worth

The President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavior Research of the United States in 1983 came to the conclusion that "in some cases, the prospective parents' desire to undertake the procedure (of sex selection) is an expression of sex prejudice. Such attitudes are an affront to the notion of human equality and are especially in an appropriate in a society struggling to rid itself of a heritage of such prejudices ... Surveys of parents and prospective parents indicate, however, a preference for sons (especially as the first-born child). If it became an accepted practice, the selection of sons in preference to daughters would be yet another means of assigning greater social value to one sex over the other and perpetuating the historical discrimination against women." Likewise, American philosopher Mary Ann Warren (1985) considers sex selection to be 'invariably motivated by sexist beliefs".

In the United States, as ultrasound technology became widely available, fears emerged that sex selection might take place on a large scale—the 1970 National Fertility Study shows that the sex preference ratio is as high as 124 boys for every 100 girls for all women who intend to have more children (Westoff and Rindfuss, 1974).[53]

Legal and moral forces are important constraints on the use of sex selection to choose

[52] To deal with the challenge arising from tracking temporary migrants, the 2010 Census had to the recording method of "recording every individual encountered". It was not unusual to double count an individual in the place he worked (by current residence) and in his hometown (by household registration).

[53] Sex ratio imbalances on that scale, however, never actually occurred, though nearly a 20 percent "excess" of male births was initially projected to follow a technological breakthrough in sex selection technology.

the gender of a newborn in a way consistent with underlying cultural beliefs about women's worth; such constraints are not equally present in China.[54] In the 1990s, as ultrasound screening became widespread, another crucial constraint on sex selection was lifted (Cloonan, Crumley, and Kiymaz, 2005; Chen, H. Li, and Meng, 2013). During the window of a few years near 2000, China was close to being at the hypothetical setting where no meaningful constraints were placed on how sex selection was achieved and culture beliefs about women were uninhibitedly translated into sex ratio at birth through sex selection.[55] This motivates the use of sex ratio at birth in 2000 as a main proxy for culture beliefs about women.

C.3 Two Forms of Sex Selection

Two forms of sex selection exist: prenatal and postnatal sex selection. A predecessor to present-day prenatal sex selection is female infanticide—a form of postnatal sex selection. Both forms of sex selection are linked to gender bias. According to the Encyclopedia of Death and Dying, "Female infanticide is a problem rooted in a culture of sexism throughout antiquity" (Howarth and Leaman, 2003).

Historically, in some parts of the world, infanticide was prohibited. In the Roman Empire, infanticide was punishable by the death penalty by the end of the 4th century, and it was illegal for parents to fail to provide for their offspring. In other parts of the world, attitudes towards infanticide are more fluid. Infanticide was sometimes justified under the belief that newborns were not full humans (Howarth and Leaman, 2003). In the latter case, as was true in much of Asia, female infanticide was often common. When sex-selection technology became readily available, prenatal sex selection superseded infanticide. Son preference began to manifest itself in prenatal sex selection.

Lin, J.-T. Liu, and Qian (2014) and Hu and Schlosser (2015) find evidence that prenatal and postnatal selection are substitutes. Postnatal sex selection includes the neglect of girls and the sex-biased allocation of household resources. Instead of discriminating against females in different stages of their life, prenatal sex selection discriminates against females in a way that makes no future discrimination possible. In the case of prenatal sex selection, the manifestation of cultural beliefs about women's worth is highly concentrated in this one-time action. This study takes advantage the one-time feature of pre-natal selection, and argues that it is a likely better measure of underlying cultural beliefs about women's worth.

[54] J. Lee, C. Campbell, and Feng (2002) and R. Lee and M. Anderson (2002) document widespread infanticide in premodern China; they consider the practice as part of the "preventative check" on the population. See Appendix C. A for more details on attitudinal differences in infanticide across societies. Also, like other communist countries, China destigmatized abortion.

[55] After 2000, there was some relaxation in the enforcement of the one-child policy in some regions.

C.4 The One-Child Policy

The one-child policy in China was introduced in 1979 and abolished in 2015.[56] As the state imposed a limit on family size, China shifted towards a low-fertility regime from the 1980s onwards. The effects of lowering fertility on sex ratio are well-documented. (Das Gupta and Mari Bhat, 1997) illustrates the relationship between fertility decline and increased manifestation of sex bias in India. If a couple wishes to have six children, there is a 99% chance they will get at least one son, but if they want only two children, this chance is merely 76%. The lower chance to have a son naturally increases the likelihood of sex selection. This relationship produces a confounder in estimating sex bias from sex ratio at birth. Progressive norms, which would otherwise be correlated with lower sex bias, can appear to be positively correlated with sex selection by lowering fertility. The one-child policy lowered fertility to the same level for every Chinese, conditional on their urban/rural status and ethnicity. The usual channel from differential fertility to varying manifestation of sex bias is therefore blocked.

The one-child policy applied to the entire Han Chinese population, but with some variation. The main policy variation was based on *hukou* (household registration status). Urban *hukou* corresponded with a strict form of the one-child policy, whereby each couple was only allowed to have one child. Rural *hukou* corresponded with a weak form of the one-child policy, whereby a second child was permitted under certain circumstances, such as when the first child was a girl. I control for share of urban *hukou* in my baseline specification to account for this policy variation.

This is not to say there was no further heterogeneity in the one-child policy. During the entire period the one-child policy was in place, the enforcement in rural China was highly variable in 1980, and became more uniformly restrictive in 1990s. In urban China, the policy was strictly enforced from 1980 onwards, but began to adapt and evolve after 2000. Couples who were both only-child themselves, for example, were allowed to have two children instead of one. The policy was at its most stable and uniform from the 1990s to early 2000s. By focusing on the census year 2000, I can minimize exposure to the heterogeneous enforcement of the one-child policy.

C.5 Ultrasound Screening

The widespread use of fetal ultrasound began in the 1970s. Ultrasound imaging can be used to identify the gender of the fetus. Countries like China and India saw worsening sex ratios at birth with the diffusion of ultrasound technology. By identifying variation in access to ultrasound technology, Chen, H. Li, and Meng (2013) estimates that prenatal sex selection

[56]The one-child policy was discontinued on October 29, 2015. http://www.bbc.com/news/world-asia-34665539

is responsible for 40% to 50% of the increase in sex imbalances at birth in China during the 1980s. (Anukriti, Bhalotra, and Tam, 2015) similarly documents the role of ultrasound technology in the substitution of postnatal discrimination with prenatal sex selection.

In China, ultrasound scanners came into use at hospitals and clinics from the early 1980s. The number of scanners available at each county, however, remained small. By 1987, an average county only had six scanners, for over half a million people. The tipping point occurred in early 1990s, from which point scanners came to be produced domestically at a much lower cost—the equivalent of four additional machines per year for each county. This dramatically improved the coverage of ultrasound technology and lowered the cost for prenatal sex selection.

As the ability to conduct prenatal sex selection depends on access to prenatal sex determination technologies, differential access to ultrasound screening can bias my estimates if there is a correlation between cotton textiles (1300-1840) and local access to ultrasound scanners. Almond, H. Li, and Zhang (Forthcoming), for instance, shows that in the 1980s, proximity to provincial hospitals predicted access to ultrasound scanners. However, this is not a major concern for my study, since I only look at sex ratio at birth after the period of rapid expansion in ultrasound technology. According to Chu (2001) and Chen, H. Li, and Meng (2013), by the mid-1990s, "all county hospitals and clinics, and most township clinics and family planning services, were equipped with ultrasound devices that could be used for prenatal sex identification".

D Data

D.1 Sample Construction

Contemporary China has 23 provinces and 5 autonomous regions. The autonomous regions are Guangxi, Neimenggu (Inner Mongolia), Ningxia, Xizang (Tibet) and Xinjiang. In this study, I restrict my sample to China proper. China proper includes territories within the Great Wall, under the governance of both Ming and Qing China (1368-1911). It typically refers to the "Eighteen Provinces" system of the Qing dynasty. I also do not include ethnic regions (provinces, prefectures and counties) in my sample, as many ethnic minority groups were outside of the Chinese territory or at least maintained a great degree of autonomy. There are substantial differences in laws and customs between ethnic minorities and Han Chinese. Systematic information about the history of many of those regions is unavailable.

To construct my sample I went through the following steps: (a.) locate 18 provinces within China Proper. (b.) exclude frontier provinces (Gansu, Guizhou, Shaanxi and Yunnan), (c.) exclude ethnic autonomous provinces, prefectures and counties, and (d.) exclude Beijing, the capital city of Ming, Qing and contemporary China. I do this because the population

in Beijing during the Qing Dynasty was mainly composed of ethnic minorities, including the Manchu royal family and Manchu and Mongolian troops. This leaves me with a sample of 13 provinces plus Shanghai, 193 prefectures and 1,622 counties. The baseline regression uses a sample of 1,489 counties due to missing values in control variables.

D.2 Cotton Textile (1300-1840)

In collecting information on cotton textiles (1300-1840), I draw on several historical studies. A key source I use is Wang (2006). The author surveys the production of various textiles during the Ming Dynasty (1368-1644) across gazetteers composed during that period. He surveys a wide range of gazetteers to record information on all types of textiles (cotton, silk, hemp . . .), by prefecture or by county. A second source I rely on is Deng (1999), which is a compilation of all sources concerning the cotton textile market in early Qing.[57] dengyibing99 similarly relies on gazetteers for information on cotton textile production. One advantage of this particular source is that it encompasses additional areas that only began to produce cotton textiles after 1644. In contrast, late adopters are likely not represented in Wang's study given the period he focuses on. To further enhance the completeness of information on cotton textile production, I do a search among all gazetteers available on *zhongguo fangzhiku* from 1368 to 1840 for additional information on cotton textile production.

The type of data that contain gazetteers imposes a few limitations: (a.) The scarcity of local gazetteers prior to the Ming Dynasty (1368-1644) contributes to the choice of 1368 AD as the starting point for my data collection. (b.) Some places likely began to publish gazetteers much later than other places do. The frequencies with which gazetteers were published can vary from place to place too. (c.) For all sorts of reasons, some places might have been less able to preserve gazetteers.

My key source, Wang (2006), is based on a comprehensive survey of nearly all gazetteers first composed during the Ming period that can be found today. The near-universal coverage of historical gazetteers makes Wang (2006) a highly desirable source for this study. However, b.) and c.) likely remain given his approach. Both may result in an uneven distribution of gazetteers by time and space.

To mitigate b.), I refrain from exploiting the timing or intensity of cotton textile production as recorded in gazetteers. Instead, I use a binary variable to indicate whether or not a location ever had any cotton textile production prior to 1840. By coding cotton textiles (1300-1840) as an indicator variable, my estimates are less affected by the timing of the first gazetteer, or by the frequencies of gazetteers being published. Provided that no gazetteer was

[57] In the historical literature on regional and national markets in the Qing Dynasty, early Qing often refers to period before the Opium War (1644-1840). This is consistent with the scope of this study.

published in a prefecture until 1800, but cotton textile production appeared far before 1800, using a binary variable for cotton textiles (1300-1840) will minimize the bias that may be generated by trying to use the timing of the first record or the total number of records on cotton textiles. If production was not reversed, a gazetteer in later years would adequately reflect the historical presence of cotton textile production. A likely exception is Fujian Province. Fujian is a coastal province that is rugged and mountainous. It relied heavily on ocean trade. While the cotton textile industry thrived in earlier times, cotton textiles became less common in Fujian after the Ming Dynasty, after the suspension of sea-based trade.

Gazetteers published in later years were more likely to have survived. Some places might have been subject to more negative shocks, or less able to cope with shocks, and hence, have preserved fewer gazetteers. By discarding the timing dimension, I can reduce "survivorship bias". Although my current coding methods already minimize possible biases due to the use of gazetteer sources, it does not remove the bias. If frequencies of gazetteers are both correlated with the cotton revolution and cultural beliefs about women, my estimates can be biased. In Appendix F.4, I show results based on different samples of counties with varying frequencies of gazetteers.

D.3 Linking the Past to the Present

I first identify locations of historical prefectures and counties. A general rule I employ is to use the historical location of a prefecture most closely aligned with the period mentioned in the source. Time-series maps showing the evolution of prefectural boundaries are available for parts of China, but not for the entirety of it. Year 1820 is the first year in CHGIS where information on boundaries are known for all prefectures. For my main source—a source based on gazetteers composed during the Ming Dynasty—I use the portion of time-series maps corresponding with the Ming period wherever possible. For prefectures for which there are not adequate time-series maps, I use the map for historical boundaries in 1820 instead. By doing so, I can account for historical boundary changes to the greatest extent without losing observations. For information extracted from Deng (1999), I match them to the portion of time-series maps corresponding with the early Qing period; when a match is not found, I use the map for year 1820 instead.[58] For information found in other sources, I use their historical boundaries for the most relevant time period. In the event a match is not found, boundaries in 1820 will be used by default. Figure A.VI shows historical locations of cotton textile production derived from prefecture- and county-level sources.

Counties in China enjoyed a great degree of political autonomy (Qu, 2003, pp.11-15,

[58]The Early Qing, as a time period, has no precise cutoffs for timing. In this study, I use 1644-1700 as the time period.

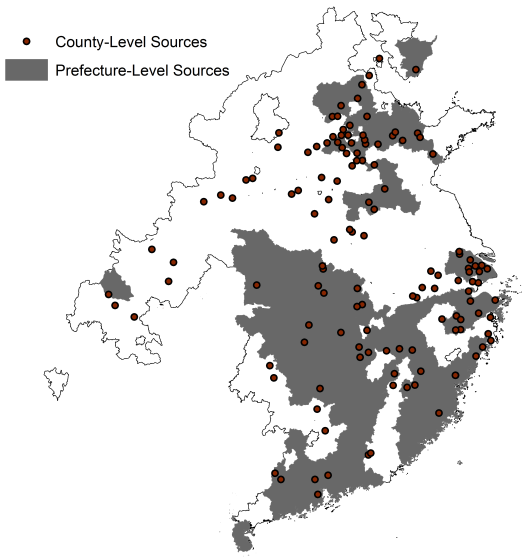


Figure A.VI: Cotton Textiles (1300-1840):
County- and Prefecture-Level Sources

179–201, 248–255). This was conducive to the formation of an independent tradition. Such autonomous counties also had relatively stable boundaries. Given those features of county and county boundaries, with regard to county-level sources, I match a historical county to its modern descendant.

In comparison, prefecture boundaries evolved over time. An important source of time-varying changes in prefecture boundaries is that specific counties governed by a prefecture-level government tend to change. It was and is still common for a prefecture to be assigned new counties or to be disassociated with existing counties every now and then. Given the transient nature of the governing territory of a prefecture, an "area size" rule is applied to linking past prefectures to modern counties. If a historical prefecture takes the value of one, one is assigned to the entire geographic area. The value of cotton textiles (1300-1840) for a modern administrative unit depends on the percentage of area associated with cotton textile production. One is assigned to counties with more than half of their area overlapping with a historical prefecture that had cotton textile production, and zero to counties with less than half or none of their area ever exposed to cotton textile production. This method could produce non-independent observations within a historical prefecture. I address the problem by clustering at the historical prefecture level in Table A.VII.

In the baseline analysis, I link historical counties to modern counties in 2000 and map historical prefectures into modern counties by area size. From the 1980s onwards, central and provincial governments began to create prefecture-level cities. Each of those cities contain

several districts. Due to their lack of historical significance, and the geographic size of each district being small, I assign the same value to all districts within the prefecture-level city for my main explanatory variable. This could produce a cluster of non-independent observations within a central district. I address the problem by clustering at the central district level in Table A.VII.

In Section VII.B, I map historical counties and prefectures into prefectures in 1990 by area size. My preferred variable form is a binary variable where a prefecture with more than half of the land exposed to cotton textile production takes the value of one, and zero otherwise. But for robustness, I also construct a continuous variable based on the percentage of land being exposed to cotton textile production. In Section VII.C, I also link historical counties and prefectures to the province level by area size. Results are robust to using population-weighted measures of cotton textiles (1300-1840).

D.4 Control Variables

Socioeconomic Macroregions Socioeconomic macroregions as defined by G. Skinner, Henderson, and Berman (2013) comprise historically relatively autonomous regions. Those macroregions are not a simple addition of provinces. This is evident in Figure A.VII, where macroregions bisect provincial boundaries in several instances. Skinner argues that China was neither a single national economic system, nor a set of separate provincial economies, but rather, consisted of a number of macroregions of trade, commerce, and population activity. He also emphasizes the social and cultural consequences of these regional patterns of trade and commerce.

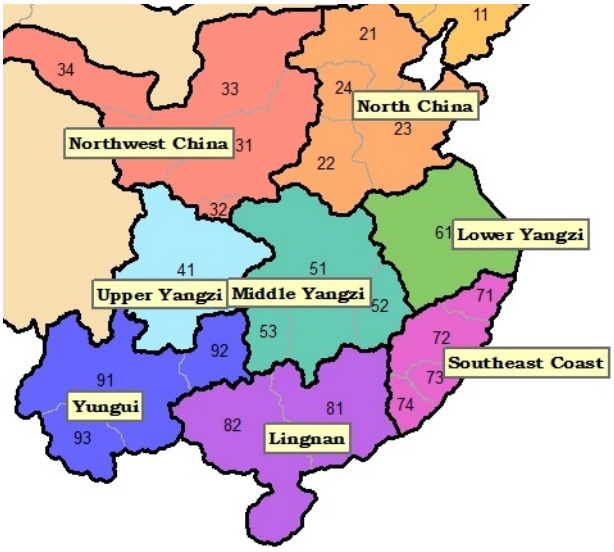


Figure A.VII: Socioeconomic Macroregions
Source: G. Skinner, Henderson, and Berman (2013, p.215)

The Grand Canal Water transport played an important role in the premodern world. The Grand Canal and the Yangtze River formed the major trade network in premodern China. Women were able to derive a high income from cotton textile production because they were able to sell cotton textiles to non-local markets (Please see Section III). But this is a desirable for all tradable goods. To account for the economic benefit of being close to the major trade network, I control for whether a county is by the Grand Canal or the Yangtze River.

The Grand Canal was first established in the Sui Dynasty (581-618 AD). Due to congestion in the river bed and the impact of natural disaster, the course of the canal changed in small ways over the centuries. In comparison to under previous dynasties, the Grand Canal was very well-maintained during the Ming Dynasty. This may be due to the need to transport tribute cloth to Beijing. To avoid potential endogeneity, I use the course of the Grand Canal in the previous Yuan Dynasty (pre-1368).

Treaty Ports Treaty ports are highly correlated with early industrialization, modernization and Western influence. Treaty ports were established after 1840 in four waves. Jia (2014) finds a long-lasting impact of treaty ports established in the 19th century on economic growth in contemporary China. To account for the possible effects of treaty ports on China's economic growth, local institutions and cultural values, I add a dummy to account for the the impact of treaty ports. Following Jia (2014)'s approach, I assign one to the modern descendant of the historical prefecture where a treaty port was created.

Communicants in Early 20th Century Christianity and traditional Chinese religions differ in their emphasis on the value of human life. As described in Appendix C, infanticide became illegal in the Christianized Roman Empire as early as the fourth century. From the 19th century to the first half of the 20th century, China saw an expansion of Christianity. To capture the effects of Christianity on the intensity of sex selection, I include the number of communicants per 10,000 as a control. Data are taken from Stauffer et al. (1922), the same source as used in Bai and Kung (2014).

Pre-1300 Commercial Networks Song China (960-1279) is known to have had a vibrant commercial economy. According to Bao's (2001) estimates, commercial taxes in 1077 made up 13.9% of the state revenues. Data on commercial taxes for the year of 1077, at a county level, are recorded in *Song huiyao jigao* (Song, 1957), and have been digitized by Peter Bol (CHGIS, 2007). Despite continuing debates on those data, scholars have used the data to study Song trade patterns and regional variance in trade, as well as measure the size of the market in preindustrial China (Balazs, 1960; Perkins et al., 1969). For a survey on the literature on trade in the Eleventh Century, please see W. G. Liu (2015, Chapter 4).

Historical Courier Routes Imperial China had a system of courier routes and courier stops. Conveyors and messengers, who were typically state employees, used those routes to deliver urgent news (Yang, Huang, and Cheng, 2006). G.W. Skinner and Zumou Yue complied spatial information for imperial courier routes and courier stops in the Late Qing (1800-1893). Those data are available at the G.W. Skinner Data Archive. http://www.gis.harvard.edu/services/products/gis-data-portals/g-w-skinner-data-archive.

E The Capable Woman: Modern Evidence

CGSS 2010 (Chinese General Social Surveys) is the first survey to contain questions directly related to gender-equitable beliefs. The first measure of gender-equitable beliefs is constructed from each respondent's view of the following question: "Do you agree with the following statement: men are naturally more capable than women?" The second measure comes from the question: "Do you agree with the following statement: men should focus on career; women should focus on family?" The respondent can choose from a scale of 1 to 5 ranging from "completely disagree" to "completely agree". I create a measure from two questions on the subjective assessment of how many sons and daughters one wants to have. For those who answer they want more daughters than sons, *daughter preference* takes on the value of one. For those who are indifferent between sons and daughters, i.e. they want the same number of sons and daughters, and those who want more sons than daughters, *daughter preference* takes on the value of zero. In addition, the CGSS includes information on age group, gender, urban/rural site, marital status, education attainment, communist party member status and urban *hukou*. I restrict the sample to the same geographic coverage as in the main sample (Section VI).

Table A.V: Gender-Equitable Beliefs: Evidence from CGSS

	Men naturally more capable			Women focus on family			Daughter preference		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		OLS			OLS			Logit	
Mean of Dep. Var.	2.989	3.006	3.006	3.638	3.659	3.658	0.0983	0.0975	0.0975
Cotton textiles (1300-1840)	-0.165**	-0.244***	-0.239***	-0.175**	-0.195***	-0.183***	0.196***	0.182+	0.200*
	(0.066)	(0.061)	(0.057)	(0.073)	(0.068)	(0.061)	(0.064)	(0.116)	(0.120)
Individual controls	No	No	Yes	No	No	Yes	No	No	Yes
Contemporary controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Historical & Geographical controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Socioeconomic Macroregion FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2 /Pseudo R^2	0.0259	0.0287	0.102	0.0503	0.0535	0.127 0.012	0.014	0.030	
Observations	6455	6161	6146	6462	6168	6152	6399	6105	6084

Notes: The table reports the impact of cotton textiles production (1300-1840) on gender-equitable beliefs. The unit of observation is a survey respondent in CGSS 2010 (Chinese General Social Surveys). Contemporary, historical and geographical controls are the same as in column 3 of Table II. Standard errors are clustered at the county level. Standard errors in parentheses $^{+}p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.VI: Evidence from CGSS: Other Values

	(1) Premarital sex	(2) Same sex	(3) Science is good	(4) Generalized trust	(5) Abortion_1	(6) Abortion_2
Mean of Dep. Var.	1.884	1.319	2.091	3.483	2.612	2.489
Cotton textiles (1300-1840)	-0.0782	0.0246	0.116	-0.00776	0.0632	-0.0362
	(0.0740)	(0.0429)	(0.101)	(0.0617)	(0.107)	(0.0977)
Contemporary controls	Yes	Yes	Yes	Yes	Yes	Yes
Socioeconomic Macroregion FE	Yes	Yes	Yes	Yes	Yes	Yes
# Clusters 71	71	71	71	71	71	71
Adjusted R^2	0.0552	0.0218	0.0248	0.0193	0.0280	0.0316
Observations	6436	6412	1938	6465	1996	2030

Standard errors in parentheses
$^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table reports the correlations between the cotton revolution and other values in CGSS 2010. The unit of observation is a survey respondent in CGSS 2010 (Chinese General Social Surveys). Surveys questions are: "Is it right to have premarital sex?"; "Is it homosexual sex right?"; "Overall, science has benefited us"; "Most people can be trusted". Abortion_1 and Abortion_2 are two different questions about attitudes towards abortion: "Do you think abortio is right or wrong? What if the family is poor?" "Do you think abortion is right or wrong? What if the fetus has birth defects?". Responses range from 1 to 5 (always right - absolutely right). Contemporary controls are the same as in column 3 of Table II. Standard errors are clustered at the county level. Standard errors in parentheses $+p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

I regress cotton textiles (1300-1840) on answers to those questions with the same controls in column 3 of Table II. Table A.V summarizes the results. I find that individuals in counties positively impacted by the cotton revolution are less likely to agree with the first two statements, and are more likely to have daughter preference. Results suggest that the cotton revolution is associated with more gender-equitable beliefs.

In Appendix Table A.VI, I show that the cotton revolution is not correlated with modern values such as attitudes towards same-sex couples, premarital sex or science. Nor is it correlated with attitudes towards abortion. There is no clear relationship between the cotton revolution and generalized trust. This seems to suggest that rather than producing modern values, the cotton revolution specifically shapes gender-equitable beliefs (Table A.VI).

F The 2000 Census: Robustness checks

F.1 Clustering at the Socioeconomic Macroregion, Province, Prefecture and Prefecture-Level City Level

As described in Appendix D.2, I assign the same value for cotton textiles (1300-1840) to all districts inside of a prefecture-level city. To deal with correlations between those observations, in column 6, I cluster standard errors at the county- and prefecture-city level. In case there are other types of correlations between observations at a higher geographic level,

Table A.VII: Clustering at the Socioeconomic Macroregion, province, prefecture and prefecture-level city level.

	Dependent variable: sex ratio at birth in 2000					
	(1)	(2)	(3)	(4)	(5)	(6)
Mean of Dep. Var.	118.6	118.6	118.6	118.6	118.6	118.6
Cotton textiles (1300-1840)	-3.762*	-3.762***	-3.753**	-3.753*	-3.753***	-3.753***
Historical controls	Yes	Yes	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Socioeconomic macroregion FE	Yes	Yes	Yes	Yes	Yes	Yes
#clusters	8	8	15	15	187	1304
Observations	1489	1489	1489	1489	1489	1489
Adjusted R^2	0.369	0.369	0.368	0.368	0.368	0.368

Notes: The table reports the impact of cotton textiles (1300-1840) on sex ratio imbalances with standard errors being clustered at different geographic levels. The unit of observation is a county in 2000 Census. The dependent variable is sex ratio at birth. In columns 1 and 2, standard errors are clustered at the socioeconomic macroregion level. Columns 3 and 4 cluster standard errors at the province level. Column 5 clusters at the prefecture level. Column 6 clusters at the prefectual-level city level or county level. Columns 1, 3, 5 & 6 report robust standard errors not adjusted by the number of clusters. Columns 2 and 4 account for the number of clusters and report p-values based on the empirical distribution of t-statistics using a wild cluster bootstrap-t procedure. P-avlues are 0.004 and 0.084 for column 2 and column 4 respectively. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

I also cluster the standard errors at prefecture level (column 5), province level (columns 3 and 4) and socioeconomic macroregion level (columns 1 and 2).

A wild cluster bootstrap-t procedure can be used to improve inferences with clustered errors in cases where only a small number of clusters are present, i.e. clustering at the level of socioeconomic macroregion (eight clusters) or province (fifteen clusters). Cameron, Gelbach, and Miller (2008) show that this procedure performs quite well even when the number of clusters is as few as six. Across the columns, I show that my results are not sensitive to at what geographic level standard errors are clustered.

Table A.VIII: By Gazetteer Frequency

	Dependent variable: sex ratio at birth in 2000						
	(1)	(2)	(3)	(4)	(5)	(6)	multicolumn1c(7)
Mean of Dep. Var.	118.0	119.1	118.0	119.0	118.6	118.6	119.2
Cotton textiles (1300-1840)	-3.891***	-3.478***	-4.208**	-3.647***	-3.646***	-3.799***	-4.077***
	(1.089)	(1.007)	(1.679)	(0.778)	(0.739)	(0.900)	(0.876)
# county-level gazetteers					-0.360	-0.465	
					(0.274)	(0.417)	
Cotton textiles (1300-1840)						0.178	
×# county-level gazetteers						(0.534)	
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Socioeconomic Macroregion FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.354	0.372	0.375	0.368	0.369	0.368	0.384
Observations	708	781	320	1388	1489	1489	1163

Notes: The table reports the impact of cotton textiles (1300-1840) on sex ratio imbalances varying by frequencies of gazetteers. The unit of observation is a county in 2000 Census. The dependent variable is sex ratio at birth. Column 1 includes counties with no county-level gazetteer. Column 2 includes counties with at least one county-level gazetteer. Column 3 includes counties with at least two county-level gazetteers. Column 4 includes counties with no more than two county-level gazetteers. In column 5 the number of county-level gazetteers is included as a control. In column 6, an interaction term between number of Cotton textiles (1300-1840) and county-level gazetteers is added. Column 7 restricts the sample to counties with identifiable sources in Wang (2006).Robust standard errors are used in all specifications. Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

F.2 Biases in Gazetteer Data

Although I control for a range of indicators for past development in the baseline regression, as well as show estimates based on the matched sample, one might still think there exists a spurious correlation between cotton textiles (1300-1840) and present-day outcomes through the intricate relationships between past development and modern development. This concern rises to higher importance given the uneven distribution of gazetteers across time and space as discussed in Appendix D.2. If the frequency of gazetteers is correlated with past development, I might be picking up a lack of economic development rather than a lack of cotton textiles in my main treatment variable.

To address this concern, I restrict my samples to counties with a varying number of gazetteers based on the gazetteer database *zhongguo fangzhi ku*. Granted that a prefecture-level gazetteer often contains ample information on a governed county, I focus on county-level gazetteers in this exercise as it is more tied to local development. Table A.VIII summarizes the results.

In column 1, I restrict my sample to counties with no county-level gazetteer in the gazetteer database.[59] In columns 2-4, I includes counties with at least one county-level gazetteer, at least two county-level gazetteers, or with no more than two county-level gazetteers. The sample size changes dramatically across columns, ranging from 320 to 1388 observations. Coefficient estimates do change somewhat, but only within the range of -3.478 to -4.208.

In column 5 the number of county-level gazetteers is included as a control. In column 6, an interaction term between cotton textiles (1300-1840) and the number of county-level gazetteers is added. In both cases, coefficients of interest remain similar to baseline estimates. The interaction term is not significant. Column 7 restricts the sample to counties with a description on textile production from gazetteers in Wang (2006). Within that set, every county has known information on textile production, either from its historical equivalent, or from the historical prefecture that governed more than half of the land of the modern county. This eliminates any county coded as zero due to a lack of historical sources. With this new sample, the size of the coefficient estimate increases slightly, possibly due to the reduction of measurement errors.

F.3 Subsamples: Past Development and Modern Migration

My results are robust to other subsamples varying on the level of past or modern development as well. The Yangtze Delta was and has continued to be of special importance to Chinese economy (G. W. Skinner, 1980; B. Li and P.-C. Li, 1998). In Table A.IX, I test to see

[59] To note, information on cotton textiles (1300-1840) remains possible for counties with no county-level gazetteer, as such information can usually be found in prefecture-level gazetteers.

Table A.IX: The Yangtze Delta and Net In-Migration

	Dependent variable: sex ratio at birth					
	(1)	(2)	(3)	(4)	(5)	(6)
	Yangtze Delta			Net in-migration		
Mean of Dep. Var.	118.6	118.8	119.1	118.6	118.6	120.8
Cotton textiles (1300-1840)	-3.733***	-4.249**	-3.912***	-3.708***	-3.455***	-4.898***
	(0.731)	(1.709)	(0.776)	(0.730)	(0.710)	(1.094)
Yangtze Delta	-3.982***	-6.625***				
	(1.536)	(1.491)				
Cotton textiles (1300-1840)		3.110**				
× Yangtze Delta		(1.285)				
Net in-migration				-1.274*	-13.61	
				(0.705)	(8.432)	
Cotton textiles (1300-1840)					12.46	
× Net in_migration					(8.432)	
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Socioeconomic macroregion FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1489	1511	1409	1489	1489	841
Adjusted R^2	0.370	0.313	0.366	0.369	0.369	0.378

Notes: The table reports the impact of cotton textiles (1300-1840) on sex ratio at birth excluding places with high levels of past development or modern migration. The unit of observation is a county in the 2000 Census. Baseline controls are the same as in column 3 of Table II. Column 3 omits all yangtze Delta provinces. Column 6 omits all counties with positive net migration. Robust Standard errors are used in all specifications. Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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if my results are robust to the control or the omission of the Yangtze Delta. The interaction term in column 2 suggests that the effect of the cotton revolution is actually far smaller for the Yangtze Delta. This is likely due to being more gender equitable in 1300, and a higher level of development throughout the history. This is indicated by the negative and significant coefficient estimate of the Yangtze Delta dummy. In addition, I look at counties with different rates of migration. In historical China, labor was less mobile due to the long-standing clan system. From the 1990s on, the speed of migration has increased. The perception of women being inferior in the less developed regions of China could become more entrenched if more progressive individuals are more likely to move to more developed areas. Hence my results could be biased if cotton textiles (1300-1840) are correlated with unobserved characteristics of counties that are now home to migrants. For robustness, I control for net in-migration, omit counties with positive net in-migration, and control for cotton textiles (1300-1840) interacted with the extent of net in-migration. My results continue to hold when controlling for net in-migration or omitting counties with positive net in-migration, and the interaction term in column 5 is not significant.

F.4 Historical and Modern Confounders

Pre-1300 Commercial Networks Prior to the cotton revolution, Song China (960-1279) had a highly developed commercial society. It is possible that economic development and commercialization could have led to both cotton textile production and gender equality. I include pre-1300 commercial tax quota in column 1 of Table A.X. The pre-1300 commercial tax quota have been used to proxy for the size of the market in Song China (see Appendix D.4). I find a small increase in the size of coefficient of interest. The coefficient estimate of pre-1300 commercial tax quota is insignificant. In contrast to Bertocchi and Bozzano (2015), I do not find that past commerce *per se* improved the status of women.

Table A.X: Historical and Modern Confounders

	Dependent variable: sex ratio at birth		
	(1)	(2)	(3)
Mean of Dep. Var.	118.6	118.6	118.6
Cotton textiles (1300-1840)	-3.770***	-3.729***	-3.695***
	(0.740)	(0.730)	(0.733)
Pre-1300 commerce	0.0257		
	(0.0960)		
# courier routes		-0.387	
		(0.369)	
Modern textile industry			-0.431
			(0.279)
Baseline controls	Yes	Yes	Yes
Province FE	Yes	Yes	Yes
Socioeconomic Macroregion FE	Yes	Yes	Yes
Adjusted R^2	0.368	0.368	0.369
Observations	1489	1489	1489

Notes: The table reports the impact of cotton textiles (1300-1840) on sex ratio at birth accounting for historical and modern confounders. The unit of observation is a county in 2000 Census. The dependent variable is sex ratio at birth. Baseline controls are those used in column 3 of II. Pre-1300 commerce is measured by log (1+commercial tax quota in 1077). # courier routes refers to number of imperial courier routes passing a county. Robust standard errors are included in all specifications. Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Historical State Presence Historically, the state played a key role in the association of women and textile production. Women's specialization in textile work was partly induced by the system of state in-kind taxes (Section III.A.2). One might suspect that there is a degree of persistence in state presence, and historical state presence might have influenced both cotton textiles (1300-1840) and modern state capacity. Modern state capacity can influence gender inequality.[60] I include the number of imperial courier routes through a county as a proxy for historical state presence, which is a similar idea to Acemoglu, Garca-Jimeno, and

[60]For example, historical state presence could affect the enforcement of state policies in modern China, such as the one-child policy or the compulsory education reform launched in 1986.

Robinson (2015). In column 2 of Table A.X, I find that greater historical state presence does improve relative outcomes of women, but the coefficient of interest does not change much. For the historical role of imperial courier routes, please refer to Appendix D.4.

Modern Textile Industry One possibility is that the cotton revolution could shape gender inequality through persistence in industrial composition. Equipped with modern humidification technologies, textile manufactures are no longer exclusively located in humid areas. In addition, skills developed from at-home work might be transferable to industrial production. In both cases, the cotton revolution would have a direct impact on modern textile industry. In column 3 of Table A.X, I include the number of textile manufacturers as a control. I find that the scale of modern textile production is negatively correlated with sex ratio at birth, but the size of the coefficient of interest falls by as 0.1 only. This suggests that the impact of the cotton revolution on sex selection is partially mediated by modern textile industry.

F.5 Plough, Neolithic Settlements and Soil Texture

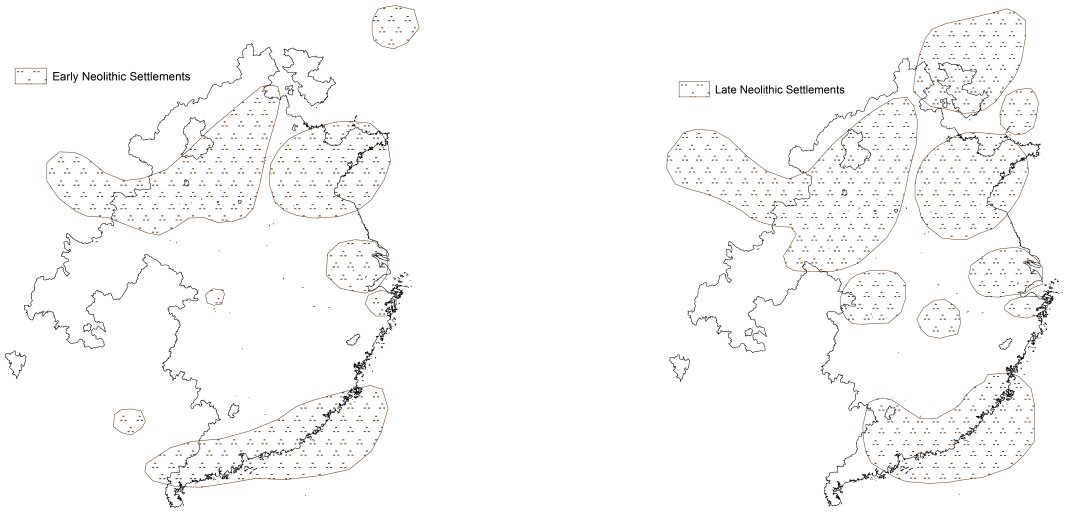
Ancestral Plough Use Alesina, Giuliano, and Nunn (2013) proposes that the plough has shaped gender roles and gender norms. In addition, the plough might have affected the production of cotton textiles by being a highly productive technology. Cotton textiles were likely to be produced in order to offset lower productivity associated with the absence of the plough. If that is true, I might be picking up the effects of not using the plough, rather than the effects of producing cotton textiles. Historically, the plough was widely used in much of China proper, but there was still some variation. Following Alesina, Giuliano, and Nunn (2013), I use a 200km radius to identify the territory of each ethnic group in the Ethnographic Atlas, and assign one to areas within the 200km radius of an ethnic group that used the plough. In column 1, I include ancestral plough use as my control. I find ancestral plough use is indeed associated with a more skewed sex ratio at birth, but that only leads to a small decrease in my coefficient of interest.

The Neolithic Revolution The intensification of agriculture is considered to have led to the deterioration of women's status (Hansen, Jensen, and Skovsgaard, 2015). *Years since the Neolithic Revolution* is often used to proxy for exposure to intensification of agriculture but is only known at the country level or above. I use Neolithic settlements to proxy for exposure to advanced agriculture. I do not find Neolithic settlements to be correlated with a more skewed sex ratio, whether settlements during the Early or Late Neolithic Period. This is likely due to the migration from Neolithic settlements to more peripheral regions over thousands of years. My coefficient of interest remains close to the baseline estimate. Data on early and late Neolithic settlements are originally produced by Chang (1963). Figure A.VIII are digitized maps available at the digitized map collection of Harvard University.

Table A.XI: Plough, Neolithic Settlements and Soil Texture

	Dependent variable: sex ratio at birth										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Mean of Dep. Var.	118.6	118.6	118.6	118.6	118.6	118.6	118.6	118.6	118.6	118.6	118.6
Cotton textiles (1300-1840)		-3.533***		-3.691***		-3.690***		-3.632***	-3.514***	-3.158***	
		(0.732)		(0.734)		(0.731)		(0.740)	(0.740)	(0.752)	
Plough	4.614***	3.900**									
	(1.578)	(1.579)									
Early Neolithic					-1.862**	-1.660*					
					(0.937)	(0.932)					
Late Neolithic			-2.185**	-2.061**							
			(0.911)	(0.899)							
Slit%							0.00334	-0.00272			
							(0.0371)	(0.0368)			
Clay%							-0.0171	-0.00952			
							(0.0496)	(0.0487)			
Clayey									-2.040		
									(1.316)		
Loamy									-1.746		
									(1.120)		
USDA soil texture class	No	No	No	No	No	No	No	No	No	Yes	No
Language group	No	No	No	No	No	No	No	No	No	No	Yes
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Socioeconomic Macroregion FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Adjusted R^2	0.363	0.371	0.362	0.371	0.360	0.369	0.360	0.368	0.364	0.371	0.377
Observations	1489	1489	1489	1489	1489	1489	1474	1474	1458	1474	1489

Notes: The table checks the role of ancestry plough use, Neolithic settlements and soil texture. The unit of observation is a county in 2000 Census. The dependent variable is sex ratio at birth. Baseline controls are those used in column 3 of baseresults. Robust standard errors are included in all specifications. Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$



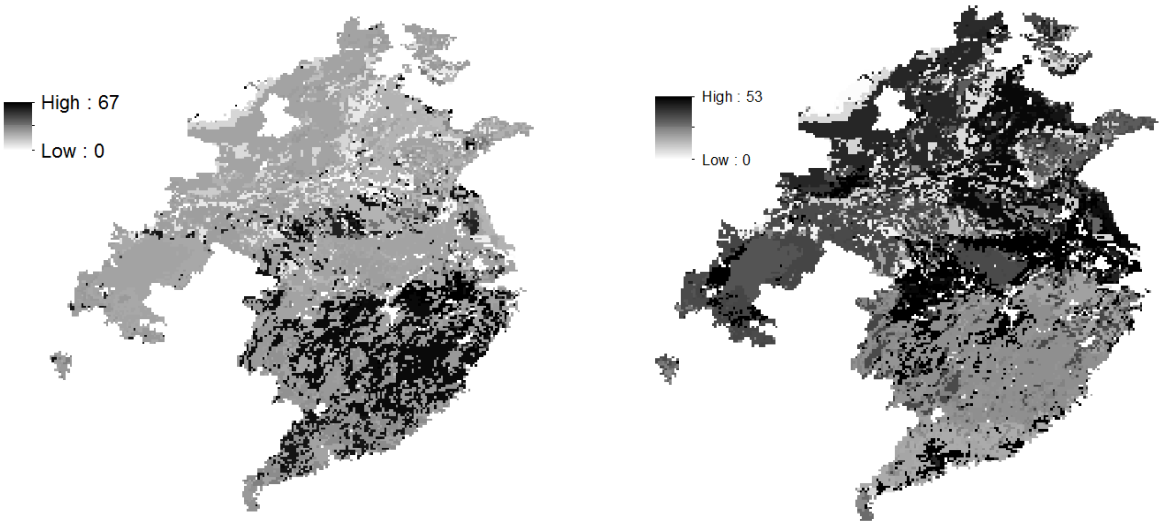
a: Early Neolithic Settlements b: Late Neolithic Settlements

Figure A.VIII: Neolithic Settlements

Soil Texture Carranza (2014) highlights the impact of soil texture on female infanticide in rural India. She proposes that clayey and loamy soil can affect the survival rates of girls due to differential demand for female labor. In rural China, soil texture can affect demand for female labor as well. Following Carranza (2014), I use two variables from the Harmonized World Soil Database (Nachtergaele et al., 2008)—fraction in clay and fraction in slit (loam)—to estimate the effects of clayey and loamy soils on sex ratio at birth. Data are available at a resolution of 5 arc-minute (10km*10km grid cells).

In column 7, I regress these two variables on sex ratio at birth with all controls. Following Carranza (2014), I subtract the coefficient on clay from the coefficient on slit. The magnitude of the difference is small (-0.013), which is small compared to Carranza (2014).[61] In column 8, I add my treatment variable and find the coefficient of interest to be highly similar to my baseline estimate. For robustness, I use alternative formulations of soil texture variables. I construct a categorical variable from the variable *USDA soil texture classes* to indicate clayey and loamy soils. Based on the dominant soil—the raster point that appears most frequently in a county—I link a county to a soil class defined by USDA. From Class 1 to 4, the categorical variable takes the value of one (clayey soils). From Class 5 to 9, the categorical variable takes the value of two for soils that are more loamy. The rest are sandy soils. The categorical variable take the value of three for sandy soils. I run a regression on this categorical variable

[61] One unit change in the difference between fractions in clay and fraction in slit corresponds with a reduction of sex ratio of 20 girls per 1,000 boys in Carranza (2014).



Fraction in Clay (%) Fraction in Slit (%)

Figure A.IX: Soil Texture

with all baseline controls. Column 9 suggests loamy soils are indeed associated with a slightly more skewed sex ratio, but the coefficient is small (0.294) and insignificant. In column 10, I control for soil texture using a categorical variable encompassing all twelve soil classes, which reduces my coefficient of interest somewhat (from -3.753 to -3.514). But the magnitude of the reduction is rather small and there is no change in the level of statistical significance.

The lack of correlation between soil texture and sex ratio at birth is not overly surprising. First, it is likely that soil texture only affects sex selection through the economic channel, i.e. the economic value of female labor, as emphasized in Carranza (2014). Second, a higher demand for female labor might not be sufficient to dissuade parents from choosing a boy over a girl. Even on clayey soils, men are still responsible for preparing the land; so it is unlikely that women have more economic value than men. The cultural valuation of women would still be negative had there been a cultural channel for clayey soils. Under the one-child policy, assuming away all costs and constraints, parents likely would only choose a girl if their cultural valuation of women is the same as or more positive than that of men. Indeed, China's female labor force participation was one of the highest in the world, when mass sex selection was taking place.

G Accounting for Selection

G.1 Selection on unobservables based on selection on observables

To estimate the degree of selection on unobservables, I use the approach suggested by Altonji, Elder, and Taber (2005) and Oster (2014). The results of this analysis suggest that

Table A.XII: Selection on Observed and Unobserved Variables

Varying Controls, R_{max}=1.3$\tilde{R}$							
	Baseline Effect [R^2]		Controlled Effect [R^2]		Null Reject	δ	Identified Set
Col. 1 of Table II	-3.361	[0.156]	-3.753	[0.386]	Yes	[<0]	[-3.946, -3.753]
Col. 2 of Table II	-3.611	[0.245]	-3.753	[0.386]	Yes	[<0]	[-3.868, -3.753]
Col. 4 of Table II	-4.049	[0.331]	-3.753	[0.386]	Yes	4.165	[-3.753,-3.149]
Col. 5 of Table II	-3.887	[0.322]	-3.753	[0.386]	Yes	10.041	[-3.753,-3.552]
Col. 6 of Table II	-4.067	[0.303]	-3.753	[0.386]	Yes	5.723	[-3.753,-3.326]

Notes: The table estimates the degree of selection on unobservables that is required to explain away the effects of premodern cotton textile production. Column 3 of Table II has the maximum number of controls."Controlled effect" refers to the estimate obtained where all controls in Column 3 of Table II are included. "Baseline effect" refers to estimates obtained when controls in more restricted sets are included. Those controls, from Row 1 to Row 5, correspond with controls included in columns 1, 2, 4, 5 & 6 of Table II. δ shows the magnitude of selection on unobservables relative to selection on observables needed to produce a treatment effect of zero under R_{max}=1.3$\tilde{R}$. Negative δ indicates a positive correlation between observables and the outcome variable, suggesting that unobservables bias my estimates towards zero (if the unobservables share covariance properties with the observables). "Identified set" shows estimated treatment effects under the assumption of equal selection on observables and unobservables.

the ratio of selection on unobservables relative to selection on observables has to be four to ten times larger to explain away my results. Based on the reasoning outlined by Altonji, Elder, and Taber (2005) that unobservables should not be more important than observables in explaining the treatment, it is highly unlikely that unobservables are biasing my results.

Table A.XII shows δ and the range of coefficients corresponding with δ under $R_{max} = 0.5$. $R_{max} = 0.499$ is based on the cutoff suggested by Oster (2014): $R_{max} = 1.3\tilde{R}$. δ is the ratio of selection on unobservables relative to selection on observables required to produce a treatment effect of zero. The identified set of coefficients is coefficients estimated between two extreme cases: the case there is no selection on unobservables and the case the ratio of selection on unobservables relative to selection on observables is δ. In each column, I compare estimates with a full set of controls ("controlled effect") with estimates with a limited set of controls ("baseline effect"). The set of controls in each column is identical to the set of controls used in the corresponding column of Table {baseresults. In columns 1-2, the limited set of controls is socioeconomic macroregion fixed effects and socioeconomic macroregion fixed effects plus province fixed effects respectively. The R^2 moves from 0.156 to 0.386 in column 1, and from 0.245 to 0.386 in column 2, suggesting the additional observables account for a sizable share of overall variation. δ is negative in both columns, indicating that the full set of control

variables has a positive correlation with the outcome variable, and a positive correlation with cotton textiles (1300-1840), in which case unobservables bias my estimates towards zero if they share covariance properties with the observables. In columns 3-5, ratio of selection on unobservables relative to selection on observables has to be two to twelve times larger to explain away my results. When the ratio of selection on unobservables is four times as large as selection on observables, the coefficient estimate is still far away from zero (-3.149), which is the case in column 3.

G.2 Ethnolinguistic Groups

I include a control for ethnolinguistic groups to capture pre-1300 differences. Languages spoken by various groups within Han Chinese are sufficiently different from each other. Local norms and customs, including pre-existing gender norms, can vary. By adding language fixed effects, I take out variation across groups including differences in the use of the plough, patrilocality, concern for women's purity and etc and only exploit variation in cotton textile production within the ethnolinguistic group. Table A.XIII suggests that my results are robust to the inclusion of this most demanding control.

G.3 Matched Samples

By matching counties on their pretreatment characteristics, I can ensure counties were as comparable as possible in 1300. I use a propensity score matching method to match counties with and without cotton textiles. Matching covariates include agricultural suitability, whether on the major trade network, population density in 1300, ruggedness, distance to coast, longitude, latitude, province and socioeconomic macroregions. In columns 1-6 of Table A.XIV, I vary matching criteria by the caliper size and the range of propensity scores. A tighter caliper is less biased but usually less precisely estimated, due to reduced sample sizes. In Panel A, I show nonparametric estimates that summarize the differences in sex ratios at birth between a county and its nearest neighbor with respect to their propensity scores. To account for the fact that propensity scores are estimated, I use bootstrapped standard errors as opposed to regular standard errors. In Panel B, I show regression estimates run on the matched samples.

On average, matching estimates are slightly larger than regression estimates based on matched samples. This could indicate the "true" effect of the cotton revolution is even larger than my OLS estimates. In columns with a tighter caliper or a narrower range of propensity scores, sample sizes are significantly smaller, but results remain highly robust. R^2 increases for columns 5-6, suggesting a better fit is achieved on a more homogeneous sample. And it is reassuring to see matching estimates are also bigger in size for those two columns.

Overall, a matching exercise indicates that selection on pretreatment characteristics is

Table A.XIII: Language Group

	Dependent variable: sex ratio at birth in 2000					
	(1)	(2)	(3)	(4)	(5)	(6)
Mean of Dep. Var.	118.3	118.3	118.6	118.6	118.6	118.6
Cotton textiles (1300-1840)	-2.360***	-2.836***	-3.158***	-3.378***	-3.230***	-3.417***
Log per capita GDP			-2.960***			
			(0.486)			
% in agriculture			0.372			
			(0.393)			
% in service			-0.586			
			(1.289)			
Years of schooling (male)			-2.117***			
			(0.735)			
% ethnic population			-0.622**	-1.070***		
			(0.254)	(0.255)		
Provincial capital			2.755***	-0.271	-0.522	
			(1.018)	(0.961)	(0.957)	
Self-governed			-2.649*	4.645***	5.523***	
			(1.352)	(0.880)	(0.853)	
Governed by province			-1.995	3.587***	4.247***	
			(1.246)	(1.071)	(1.065)	
Historical controls	No	No	Yes	Yes	Yes	Yes
Geographic controls	No	No	Yes	Yes	Yes	Yes
Province FE	No	Yes	Yes	Yes	Yes	Yes
Socioeconomic Macroregion FE	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.162	0.236	0.377	0.326	0.319	0.301
Observations	1622	1622	1489	1489	1489	1489

Notes: The table reports the impact of cotton textiles (1300-1840) on sex ratio imbalances. The unit of observation is a county in 2000 Census. The dependent variable is sex ratio at birth. ——— Robust standard errors are used in all specifications. Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.XIV: Cotton textiles (1300-1840) and Sex Ratio Imbalances: Matching

	Dependent variable: sex ratio at birth					
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: Matching estimates					
ATT	-3.381***	-4.006***	-3.901***	-4.329***	-4.541***	-5.590**
	(1.184)	(1.350)	(1.181)	(1.446)	(1.685)	(2.486)
ATE	-2.894***	-3.828***	-3.678***	-4.182***	-4.633***	-4.984**
	(1.012)	(1.226)	(1.037)	(1.330)	(1.515)	(2.272)
	Panel B: Regression estimates on matched samples					
	-2.793***	-4.283***	-4.123***	-3.900***	-4.803***	-3.143**
	(0.905)	(1.029)	(0.920)	(1.079)	(1.180)	(1.583)
Propensity score range	All	All	All	[0.1-0.9]	[0.1-0.7]	[0.3-0.7]
Caliper size	0.005	0.001	0.01	0.001	0.001	0.001
Adjusted R^2	0.499	0.468	0.490	0.485	0.518	0.594
Observations	565	426	591	394	318	201

Notes: This table reports results on matched samples. Panel A reports nonparametric matching estimates taking the difference of sex ratios at birth of a matched pair. Both average treatment effects (ATE) and average treatment effects on the treated (ATT) are provided. Bootstrapped standard errors (1000 interations) are used in all columns. Panel B reports regression estimates based on regressions run on the matched samples. Baseline controls, province FE and socioeconomic macroregion FE are included in all regressions. Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

unlikely to be a threat to my identification. If anything, there seems to have been some negative selection on preexisting gender inequality, i.e. counties with more gender inequality in the counterfactural are more likely to have been positively impacted by the cotton revolution.

H Instrumental Variable Strategy

H.1 Relative Humidity and Cotton Weaving

A few factors are known to be crucial for cotton spinning and weaving, one of which is a suitable range of relative humidity. Scientists, engineers and industry experts highlight the importance of relative humidity in producing cotton textiles. Lewis (1913) devotes its entire length to physical testings of cotton yarns. An extended analysis is provided on how yarn-count, twist and tensile strength vary by relative humidity. In a report on the textile industry in China (1909), the word "humidity" occurs more than 100 times, suggesting the pivotal role of humidity in textile manufacturing. Cotton weaving depends crucially on a suitably wet climate. Lander (1914) provides a vivid account of how relative humidity makes a good day or a bad day for cotton weaving:

> "It is well-known fact that on certain days weaving is more difficult than on others, and this difficulty is generally associated with a dry, east wind. On such occasions weaving is difficult even with the bulbs in the factory showing a percentage

humidity which would be considered ample on an average day".

When spinning and weaving is carried out in unfavorable climates, finished cloth is of much poorer quality. Low humidity has a substantially impact on high-ended cotton cloth; high-quality cotton cloth can only be produced when relative humidity is greater than 70%.

The possession of a spinning wheel or a weaving loom entails a fixed cost; it helps to justify the cost if the equipment is used frequently. Many parts of China have dry winters, which lowers cotton textile output for those months. Likewise, dry afternoons lower cotton textile output. Since the bulk of spinning and weaving was performed in the daytime, humidity in the daytime (rather than at night) matters the most. To capture seasonal and within-24-hour variance in weaving suitability, I use both monthly and hourly information on relative humidity.

H.2 Humidity-for-Weaving Index

To derive an exogenous source of variation in cotton textiles (1300-1840), I use a Humidity-for-Weaving Index to proxy suitability for spinning and weaving. A number of studies have been conducted to estimate optimal suitability for cotton weaving. Most of the estimates fall between 60% and 85% RH. . Iqbal et al. (2012) tests the effect of relative humidity on the tensile properties of different fibers and shows that for cotton, the gain from higher humidity continues until at least 85% (Figure A.X). Stamper and Koral (1979) lists two sources regarding suitable ranges of relative humidity in cotton weaving: one is 70%-80%; the other, 70%-85%. Cotton spinning can be done with slightly less moisture in the fiber. A relative humidity of 60 to 70% is still required based on Stamper and Koral (1979).

The first set of data I use is the 30-year monthly average relative humidity series from the Climate Research Unit of University of East Anglia. Those data are available across 10 arc-minute by 10 arc-minute grid cells (20km*20km) globally. The second set of data is the 6-hour relative humidity series from the National Oceanic and Atmospheric Administration where relative humidity was measured four times a day (6am, 12pm, 6pm and 12am) from 1981 to 2010. This data is at a higher frequency but with a lower resolution (2.5 degree by 2.5 degree).

I take the following steps to construct the Humidity-for-Weaving Index. As the first step, I back out daytime humidity from full-day humidity. NOAA has data on relative humidity from 1980 to 2010 at a frequency of four times a day, and day by day. Data, however, are at a low resolution (2.5 degree by 2.5 degree, or roughly, 250km by 250km grid cells). For full-day relative humidity at a monthly level, I have data on a resolution of 5 arc-minute (10km by 10km). To make full use of both data sources, I extrapolate relative humidity at each coordinate pair to the nearby area with a radius of 250km. I then take the mean of relative

humidity measured at 6am, 12pm and 6pm and convert it into a daytime humidity measure, calculate the ratio of daytime humidity to full-day humidity, and multiply its monthly mean with average full-day relative humidity at the monthly level. As the high-resolution relative humidity data are only available at the monthly level, I take the monthly mean of daytime-to-full-day ratios that are available at the daily level. I use this full-day relative humidity measure and multiply it by the monthly mean of ratios of daytime humidity to full-day humidity to obtain a measure of daytime relative humidity.

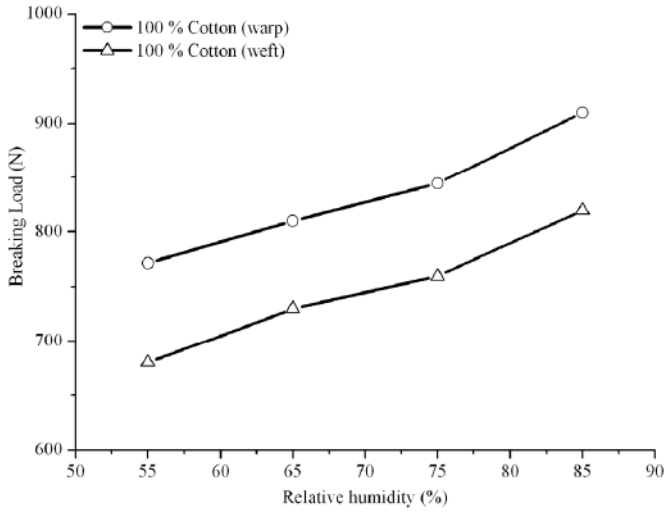


Figure A.X: Tensile Strength of Cotton at Different Relative Humidity Values.
Source: Iqbal et al. (2012)

Secondly, I use the following equation to compute the distance between actual (daytime) humidity and optimal humidity for spinning and weaving month by month. For each county, if relative humidity equals or exceeds 85%, a value of zero is assigned. As air becomes drier, a higher value is assigned to denote the longer distance between the actual humidity and optimal humidity. A less suitable county should get a higher value due to longer distances to optimal humidity for spinning and weaving. The maximum value for a county to receive for a particular month is 25. This is based on the knowledge that spinning and weaving cannot be performed normally when relative humidity is below 60%. Results are robust to setting cutoffs just above or below 60% and 85% (Appendix H.3).

$$\text{Distance to Optimal RH} = \begin{cases} 25\% & \text{if RH} \leq 60\% \\ \text{RH} - 60\% & \text{if } 60\% < \text{RH} < 85\% \\ 0\% & \text{if RH} \geq 85\% \end{cases}$$

Thirdly I aggregate monthly values over twelves months at a county level. Lastly, I take the inverse of the total aggregated value to construct my Humidity-for-Weaving Index and multiply it by 1000. [62]

Figure A.XI shows the distribution of the Humidity-for-Weaving Index at a county level in eight quantiles. The index values range from 3.379 to 15.124. Darker shades represent higher relative humidity and hence, higher suitability for cotton weaving. Missing values are shaded white.

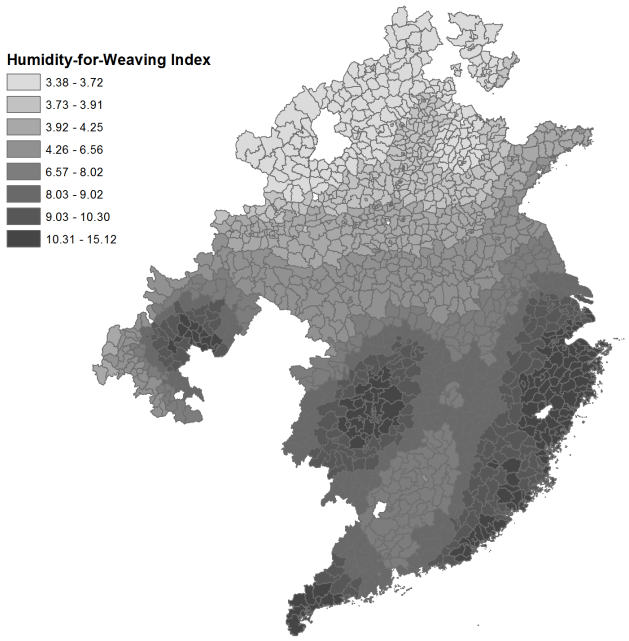


Figure A.XI: Humidity-for-Weaving Index

H.3 The Impact of State Socialism

Having established that the effects of the cotton revolution do not go away even under a strict socialist regime, I turn to an analysis of how state socialism interacted with the cotton revolution. The Chinese Government has been promoting gender-equitable laws, policies and institutions from the onset of state socialism (Johnson, 2009). A cohort analysis in Table A.XV suggests that the cotton revolution has less impact on cohorts exposed to state socialism than on older cohorts, which is consistent with the view that state socialism weakened cultural norms. I first interact my treatment with all age groups and find the interaction terms are

[62] This assumes being close to optimal humidity is particularly valuable, which is consistent with industrial research on this topic.

positive for older cohorts (column 1). In column 2, I compare individuals who were at least 14 by 1949 (born before 1935) and those who were younger. I find a greater effect of the cotton revolution on individuals who were under 14 by 1949.[63] In column 3, I compare individuals born before and after 1949. The interaction term remains positive but is no longer significant. This suggests that the impact of the cotton revolution is more or less uniform for the individuals subject to state socialism in their formative years.

I Additional Historical Background

I.1 Confucianism and status of women

Traditional Chinese society was shaped in important ways by Confucian values. A set of political and moral doctrines based on the teachings of Confucius became an important basis for the Chinese state since the Han Dynasty (206 BC–220 AD). By the late imperial period, the Chinese state had standardized family practices across regions, classes and dialect groups, with far fewer time and space variation in inheritance practices, marriage rates, naming practices and patrilocality (P. Ebrey, 1990; Paul S Ropp, 1994). Throughout the period where the shock ("cotton revolution") was in place (1300-1840), the state adhered to unified political and legal institutions based on Confucianism.

Confucianism had a twofold impact on attitudes toward women. On the one hand, the Confucian tradition strongly disfavored women. Confucianism lays a particular emphasis on continuing the family line, and only male offspring can fulfill this purpose. Daughters are seen as a liability, or *pei qian huo* in local languages.[64] The term was consistent with economic reality prior to the emergence of the textile industry: daughters could not work outside home due to concern for women's "purity" and therefore had to rely on family resources to survive.[65] And unlike a son, a daughter would not be able to support her own parents once she became married because a married woman had to move into the home of her husband's family and became an official family member of that family. As a result of the high cost of dowries, having too many daughters could cause a household serious financial distress (Harrell, 1995; Watson and P. B. Ebrey, 1991). For these reasons, parents wanted to control the number of daughters they had to raise.[66] On the other hand, mothers and grandmothers had important

[63]Teenage years are usually considered the most impressionable stage of the life. The results are robust to small shifts near the cutoff point of age 14.

[64]It is generally believed that a family would suffer economically from the birth of a daughter. In the play *Qujiang Chi* from the early Yuan period, the heroine refers to herself as *pei qian huo*, which literally means a money-losing proposition. The term is still used in Mainland China, Singapore, Malaysia, Taiwan, Macau and Hong Kong today. In 2007, the Yahoo dictionary in Taiwan was discovered to have the English-language translation of the Chinese term *pei qian huo* as a. "a money-losing proposition" and b. "a girl; a daughter" (http://news.tvbs.com.tw/entry/305992).

[65]Chow (1991) regards non-western women's "purity" or "chastity" as both sexual and nationalistic.

[66]Historian James Z. Lee and sociologist Cameron D. Campbell (2007) document excess female mortality

Table A.XV: Wife Heading the Household: A Cohort Analysis

Dependent variable: wife	(1)	(2)	(3)
Mean of Dep. Var.	0.0589	0.0589	0.0589
Cotton textiles (1300-1840) × born before 1935		0.256**	
		(0.117)	
Cotton textiles (1300-1840) × born before 1949			0.115
			(0.123)
Cotton textiles (1300-1840) × 20 to 24	0.130		
	(0.571)		
Cotton textiles (1300-1840) × 25 to 29	0.205		
	(0.570)		
Cotton textiles (1300-1840) × 30 to 34	0.170		
	(0.582)		
Cotton textiles (1300-1840) × 35 to 39	0.175		
	(0.573)		
Cotton textiles (1300-1840) × 40 to 44	0.155		
	(0.583)		
Cotton textiles (1300-1840) × 45 to 49	0.118		
	(0.592)		
Cotton textiles (1300-1840) × 50 to 54	0.261		
	(0.588)		
Cotton textiles (1300-1840) × 55 to 59	0.427		
	(0.571)		
Cotton textiles (1300-1840) × 60 to 64	0.378		
	(0.579)		
Cotton textiles (1300-1840) × 65 to 69	0.540		
	(0.566)		
Cotton textiles (1300-1840) × 70 to 74	0.683		
	(0.576)		
Cotton textiles (1300-1840) × 75 to 79	0.474		
	(0.593)		
Cotton textiles (1300-1840) × 80+	0.769		
Cotton textiles (1300-1840)	Yes	Yes	Yes
Born before 1935	No	Yes	No
Born before 1949	No	No	Yes
Controls	Yes	Yes	Yes
Socioeconomic macroregion FE	Yes	Yes	Yes
Province FE	Yes	Yes	Yes
# cluster	88	88	88
Pseudo R^2	0.067	0.067	0.067
Observations	701263	701263	701263

Notes: The table reports the impact of cotton textiles (1300-1840) on the probability of wife heading the household. The unit of observation is a individual in the 1990 Census. The sample is restricted to individuals who are the head of the household, married and Han Chinese. All estimates are based on Logit regressions. Controls include baselineline controls, age group and family size. The omitted category in column 1 is age 15-19. Robust standard errors are clustered at the prefecture level. Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

and respected places in their families, and older women were often very powerful within their families.

In addition, Confucianism celebrated the virtue of hard work (Yu, 1985; Yu, 1992). It assigned high moral worth to individuals who worked hard to provide for their families, including hard working women. This attitude provided women with an avenue whereby they could earn the respect due to them for their contribution to the household. Regardless of social clas, performing productive manual labor was seen as a virtue for all women (Mann, 1997).

I.2 Neo-Confucianism and Widow Suicide

In contrast to the Europe Marriage Pattern (De Moor and Van Zanden, 2010; Voigtländer and Voth, 2013a), premodern China featured universal and early marriage. Unmarried and married women alike had few opportunities to engage in public life. However, widows were granted some autonomy in making economic decisions for herself and for the household (Afeng, 2002). Prior to the cotton revolution, women typically lacked the means to support themselves after their husband's death. Before the 11th century, remarriage was quite common, and then things took another turn. Influenced by Song-Ming Neo-Confucianism, which was first developed in the Song Dynasty (960–1279), inheritance laws became more unfriendly to women, creating barriers for a woman to inherit wealth from her deceased husband. Song-Ming Neo-Confucianism also stigmatized remarriage. Premodern China was not unique in terms of the circumstances widows had to face. Widows in developing countries today often find themselves in similar circumstances: upon widowhood, women not only lose the main breadwinner of the household, but also have restricted access to economic resources due to property ownership laws and employment norms. Many studies document the role of widowhood in excess mortality of unmarried adult women (S. Anderson and Ray, 2015; Miguel, 2005; Oppong, 2006; Sossou, 2002).

Before 1300, among all "virtuous" women, half of the women were "chaste windows" who provided for her in-laws and children for a number of decades, the other half were "heroic widows" who committed suicide upon their husband's death to demonstrate their exemplary character (Dong, 1979). After 1300, cotton textiles began to financially empower women. The percentage of women who chose chaste widowhood over suicide likely increased. I hypothesize that cotton textiles tilted women's decision towards chaste widowhood from suicide, as availability of financial means was key to widow survival.[67] All else equal, women

during infancy and childhood. They find that girls between ages one and five had a 20 percent higher mortality rate than boys of the same age.

[67]To be awarded "chase widow" status, a long wait is required. According to Qing regulations, to be eligible to the title of " chase widow", a woman either had to remain widowed since before the age of 30 years

with no financial means would be at a higher risk to commit suicide.

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old to the age of 50 years old, or had been widowed for ten years or more but died before reaching 50 (Mann, 1987). The long time frame required to be eligible to the "chase widow" status heightened the importance of having financial resources at one's disposal. Here I do not try to argue that having financial means was the single key factor in widows' decision making; I acknowledge that many factors could be at play (Theiss, 2005; Paul Stanley Ropp, Zamperini, and Zurndorfer, 2001).

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