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The Economic Motives for Foot-binding

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Abstract

We study foot-binding – a practice that reshaped millions of women's feet in historical China, yet in lack of a consistent explanation of its temporal, regional, class, and size variation. We present a model of foot-binding, where it serves as a premarital investment tool in response to a male-specific social mobility shock, and women trade off labor distortions for marriage prospects. Furthermore, the regional shifts on both sides of the trade-off explained its observed variation. Using county-level archival data on foot-binding, we corroborate the theory with empirical evidence.

JEL Codes: O15, J16, N35, Z10

Key Words: Gender Norm, Marriage Market, Labor, Foot-binding

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If you have lotus feet, you will marry a Literati, eating bread with meat;
If you have large feet, you will marry a blind man, eating bran with chili.

– *A ballad in Zhangde, Henan*

1 Introduction

Foot-binding was a prevalent and persistent practice that reshaped women's feet adopted by millions of women in historical China,[1] and it echoed other gender-biased social norms.[2] Despite a single-dimensional perception that associated foot-binding with a cult for tiny shoes and deformed feet, the practice had considerable variation with four stylized facts: (i) *Time*: it gained popularity during the Song dynasty ($10^{th} - 13^{th}$ century), (ii) *Class*: it had a greater intensity among the elite class than the working class, (iii) *Region*: it had greater prevalence in Northern China than Southern China, and (iv) *Size*: it had an escalated degree of the deformation over time. The stylized facts manifest foot-binding as a dynamic and multi-faced phenomenon that nested in the historical and social process. However, within the intellectual map across disciplines about foot-binding, most studies only speak to a subset of the stylized facts.[3] A challenge thus remains in the literature to consistently explain its observed variation.

This paper makes an effort toward this challenge. Specifically, we provide a theory that connects two substantial perspectives in the literature – the marriage market motives and the labor motives – which shaped the basic trade-off of foot-binding. On the one hand, foot-binding served as a marriage market competition tool among women, embodying both aesthetic and moral values that were appreciated by men. On the other hand, foot-binding constrained women's physical mobility and induced labor cost. Further, this basic trade-off between labor distortion and marriage prospects had

[1] This number comes from Bossen and Gates (2017)'s estimation that reflects the adoption of foot-binding in the 19^{th} century, based on assumptions of sex ratio and mortality rates.

[2] In a broader scope, harmful gender-specific practices have persisted historically and widely across the globe (Platteau et al., 2018), including female genital cutting (*e.g.*, Chesnokova and Vaithianathan 2010, Rai and Sengupta, 2013, Becker, 2018), son preferences and female infanticide (*e.g.*, Qian, 2008; Anderson and Ray 2010; Carranza 2014; Xue, 2018; Almond et al., 2019), early marriages (*e.g.*, Corno et al., forthcoming), dowries (*e.g.*, Rao, 1993; Zhang and Chan 1999; Edlund, 2000; Bloch and Rao 2002; Botticini and Siow, 2003; Anderson 2003, 2007; Bhalotra et al. 2018), and corsets/tight lacing, among others.

[3] Appendix Table A1 provides the intellectual map that we explore. Briefly, the explanations of foot-binding converged into three categories: (1) the marriage prospects (beauty, virtue, and status), (2) women's labor values, and (3) social motives. The horizontal dimension summarized *why* foot-binding, and the vertical dimension summarizes *who* provided such reasons.

shifted over time and across space, driven by changing marriage market conditions and women's labor values.

For the historical marriage market, we characterize the impact of a gender-specific shock in social mobility institution on the marriage market and premarital investment decisions. In particular, we examine the establishment of the Civil Examination System, which triggered a social transition from family-level heredity to individual-level meritocracy. Under the exam system, talented males regardless of their family background could climb up the social ladder by individual academic performances, while women did not have such opportunity, and their chance of obtaining higher status predominantly relied on marriages. As a result, the exam system transformed the marriage market by generating a more heterogeneous composition of men compared to that of women, thus escalated the marriage market competition among women. In this process, foot-binding was adopted by women to differentiate their *individual-level* traits in the marriage market, responding to men's demand in not only aesthetic preferences,[4] but also moral preferences in wive's domesticity and fidelity.[5] The theoretical mechanism stands in line with the speculation by Historian Dorothy Ko (2001, 2005), who bridged the frenzy of male exam success and the frenzy of female competition in foot-binding for better marriages and status.

In addition to the marriage market motives, foot-binding also induces women's labor cost. As foot-binding deforms women's feet, it limits women's physical mobility. Thus, the practice precludes women from engaging in intensive non-sedentary activities (*i.e.*, wetland farmland work), while puts a smaller constraint on sedentary activities (*i.e.*, household handicraft production). Therefore, among lower class women who played an active income-earning role within the household, foot-binding prevalence exhibited considerable regional variations, driven by the relative value of women's sedentary versus non-sedentary labor in different agricultural regimes.

Next, to evaluate the theory empirically, we collect new data of foot-binding from archives during the Republican period of China, and test the cross-sectional predictions of the theory. Specifically, we explain the regional distribution of foot-binding by variation in both the marriage market and labor incentives.

[4]For comparisons between foot-binding and high heels physically and aesthetically, see Linder and Saltzman (1998) and Jackson (1990).

[5]As observed by Ko (2001), foot-binding can also showcase women's handicraft skills, which arose from its specific feature – the size and shape of each woman's bound feet varied considerably, and no off-the-shelf shoes were ready except for customizing. Since women were often the shoemakers of the family, their shoe-making associated handicraft skills, plus patience and domesticity which fueled such sedentary skills, are of practical vital importance to future husband's family.

(i) First, better marriage market prospects provide stronger incentives for foot-binding. In this regard, we use a feature of the exam system that regulated the proportion of successful candidates regionally – the quota system. The quotas provide variation in men's mobility, thus women's competition incentives in the marriage market. To tackle the potential endogeneity of quota allocation, we employ an instrument based on an administrative re-arrangement event in the early Qing dynasty, which provided plausible exogenous variation in quota allocation at the county level. The results show that exam quotas significantly predict a higher incidence of foot-binding prevalence: a one standard deviation increase in logged exam quota leads to a 8.5 percentage point increase in the probability of foot-binding prevalence.

(ii) Second, a larger cost in women's non-sedentary labor compared to sedentary labor discourages foot-binding. Specifically, we proxy the labor cost of non-sedentary farmland work, by constructing the relative suitability of two dominant cereal crops – rice and wheat. As rice-cropping is highly labor-intensive and women have comparative advantages in rice cultivation, greater rice-to-wheat suitability predicts less foot-binding. For the labor cost of sedentary household handicraft work, we construct the proxy as the suitability of a major fiber during the Ming and Qing dynasty – the cotton. The results show that greater suitability of rice relative to wheat predicts lower foot-binding prevalence, while greater suitability of cotton predicts higher foot-binding intensity. Regarding magnitude, a one standard deviation increase in the relative rice-to-wheat (cotton) suitability leads to a decrease (increase) in the probability of foot-binding prevalence by 9.8 (19.7) percentage points.

Taken together, the empirical findings reveal economically sizeable effects of both marriage and labor incentives on foot-binding, and the results are robust to the inclusion of different sets of controls and empirical specifications.

Last but not least, we extend our baseline theory from *individual* motives to incorporating *social* concerns. Two new elements are added to the extension. First, we extend foot-binding from a binary choice to a continuous decision, to account for its observed intensive margin variation in size and shape. Second, we consider the formation of foot-binding as a social norm and analyze its adoption dynamics, where women have social image concerns to conform to this feminine icon, and deviation from this norm leads to disutility. While the key theoretical intuition stays the same, the extension explains the observed escalated deformation of foot-binding over time.

Our paper speaks to three strands of literature. First, in the literature of gender norms, seminal work have identified three aspects of gender asymmetry as the deep roots: (1) the gender asymmetry in economic values (*e.g.*, Boserup, 1970; Qian, 2008; Alesina et al., 2013; Becker, 2018; Xue, 2018; Baiardi, 2018), (2) the gender-specific legal rights and institutional opportunities (*e.g.* Anderson, 2003, 2018; Ambrus et al., 2010), and (3) the gender-specific efforts in marriage market competition (*e.g.* Anderson, 2007; Chesnokova and Vaithianathan, 2010; Mariani, 2012; Rai and Sengupta, 2013; Teso, 2019; Grosjean and Khattar, 2019).[6] In this vein, our work offers a new perspective by showing gender-specific social mobility systems as another crucial engine of gender norms.

Second, our work complements the literature on the economics of marriage (*e.g.*, Becker, 1973, 1974), premarital investments (*e.g.*, Peters and Siow 2002; Chiappori et al. 2009), and marriage institutions (*e.g.*, Tertilt, 2005; De la Croix and Mariani 2015) in two ways. First, we zoom in on a special type of women's premarital investment – body modification, which has played a role in the marriage market with modern applications (*i.e.,* plastic surgeries). Second, instead of providing a generalized marriage market matching theory, we nest our theory into a specific historical context, which enables us to explicitly characterize the linkage between social mobility institutions and its effects on the marriage market.

Finally, this paper contributes to the literature on foot-binding across disciplines.[7] Specifically, two challenges remained to scholars: first, given foot-binding was a multi-faced phenomenon, most studies speak to a subset of its stylized facts; second, while each explanation in the literature served as an intellectual dot with valuable insights, the linkage and interaction between the dots are ambiguous. For instance, a pure status-based explanation of foot-binding can account for the popularity among the upper class, but not the temporal and regional variation. The labor coercion-based theory can account for the tight association between foot-binding and women's high-value

[6] In addition to these three factors, wars (Fernández, Fogli, and Olivetti 2004; Goldin and Olivetti 2013), technology changes (*e.g.*, Goldin 1990, Goldin and Katz 2002), and other historical shocks also affect gender norms. See Jayachandran (2015) and Giuliano (2017) for summaries of the social and historical origins of gender inequality and gender norms.

[7] Our work is built upon existing studies of foot-binding across disciplines, including History (*e.g.*, Yang, 2003; Ko, 2001, 2005), Anthropology (*e.g.*, Gates, 2001; Bossen et al., 2011; Brown et al., 2012; Yang, 2012; Bossen and Gates, 2017; Shepherd, 2019), and Political Science and Sociology (*e.g.*, Mackie, 1996), among others. In the Economics literature, scholars have considered foot-binding as a symbol of social status (Veblen, 1899), as a way to enforce husbands' property rights over wives (Cheung, 1972), and as a signal of feminine virtue for marriage market competition (Rai and Sengupta, 2013).

handicraft work in the lower class, but the upper class dominance, temporal variation, and size dynamics remained a puzzle.[8] The culture-based explanation (that the Neo-Confucianism imposed a moral code for women to follow, thus the deformation, *e.g.,* Chen, 1928) is theoretically vague, and cannot explain the observed variation either. Thus, given the status of the current literature, our paper makes efforts towards the challenges, by bridging major perspectives and connecting the seemingly puzzling dots of foot-binding, in a unified conceptual framework with empirical validation.

The rest of this paper is organized as follows. Section 2 provides the stylized facts of foot-binding. Section 3 describes the benchmark model. Section 4 discusses our data and presents empirical results. Section 5 provides an extension, and Section 6 concludes.

2 Background: stylized facts of foot-binding

Foot-binding targeted girls whose feet were systematically reshaped during early childhood. The process was often initiated and practiced by mothers or grandmothers, lasting for years, when the bones and soft tissues were gradually modified. Even though deformation was finished during the childhood, a pair of bound feet calls for lifetime maintenance. To study the stylized facts of foot-binding, we consult and cross-check multiple sources and present a summary in Appendix 9.1.[9] In brief, four stylized facts emerge. (1) *Time variation*: Regarding the earliest evidence of foot-binding, the dominant view is that it emerged in the imperial palace among dancers during the Five Dynasties period (907-960). Starting from the Song dynasty (960-1279), foot-binding gradually gained popularity among upper class women, diffused from the upper class to the lower class during the Ming and Qing dynasties, and faded out in the early 20^{th} century. (2) *Class variation*: foot-binding was first adopted by the upper class and later by the lower class, and its prevalence among the upper class dominated that among the lower class. (3) *Regional variation*: among lower class women, the prevalence of foot-binding varied by regions. As illustrated in Figure 1, foot-binding

[8] An important strand of studies is from Anthropology (*e.g.*, Brown et al., 2012, Bossen and Gates, 2017, Brown and Satterthwaite-Phillips, 2018), which provides the labor coercion-based explanation that foot-binding in the rural area was adopted by the parents in order to boost the economic contribution of girls in household production. Within this framework, the labor distortion of foot-binding should be *positive* instead of negative, since handicraft work for girls is very boring and it's hard to force children sitting all day working on the production.

[9] In this paper, we only discuss the foot-binding practice by the Han Chinese women, which was the dominant ethnic group in China.

was most prevalent in Northern China, while it was much less prevalent in Southern China, especially in the Pearl River Delta (Qian, 1969; Davin, 1976; Xu, 1984; Turner, 1997). (4) *Size variation*: women with higher social status tended to bound feet more tightly (*e.g.*, Qian, 1969). Moreover, within the upper class, the size of the bound feet evolved smaller over time (Yao, 1941).

Speaking shoes. The evolving practice of foot-binding can also be partially revealed by women's footwear. In this regard, we gather information on women's shoes from Ko (2001)'s collection, and construct time-series measures of shoes from the 8^{th} century to the 20^{th} century. Specifically, we use two metrics of the shoes to detect the distortion of feet: (i) the length of the sole; and (ii) the angle of the instep.[10] Figure 2 shows the time-series pattern of the average length of the sole and angle of the instep of women's shoes. As shown by Figure 2, the average shoe length shrank from 16.7 cm in the 13^{th} century to 12.6 cm in the 19^{th} century, while the angle of the instep increased from around 30 degrees to 55 degrees from the 13^{th} century to the 19^{th} century. In fact, the most popular perception of foot-binding nowadays came from observations of women's feet and shoes after the 19^{th} century, when the distortion had already reached its peak that both the *phalanges* and *metatarsals* were deformed. The considerable variation in the deforming practice reveals that the intensity foot-binding had been evolving over time.

3 The theory

In this section, we provide a theory of foot-binding, incorporating two substantial perspectives in the literature – the marriage market motives and the labor motives. In particular, we model foot-binding as a premarital investment tool in response to a male-specific social mobility shock, and women trade off labor distortions for marriage prospects. Though our model does not serve as a generalized matching model, it echoes generic theoretical insights that the relative heterogeneity and quality distribution of the two sides determine the intensity of competition (*e.g.*, Hopkins, 2012; Hoppe, Moldovanu and Sela, 2009). It is also in line with the inequality explanation of women's virtue historically (Mariani, 2012) and dowry escalation in post-Modernization India (Anderson, 2003).

[10] For the measure of the shoe instep slope, the original measure can be found in Yao (1934). The normal slope of the instep is around 30 degrees.

3.1 Setup

Population. The society is populated by men and women, both of a continuum of one.[11] We index individual man by i and individual woman by j. Each individual is endowed with a binary level of family wealth, $F \in \{H, L\}$, indicating the family socioeconomic status being high or low. Each individual is also endowed with a binary level of ability being high or low, $A \in \{H, L\}$. For the distribution of wealth and talent, the proportion of high-family-wealth individuals is μ, and the proportion of high-ability individuals is p.

Marriage. Marriage decisions were made by parents, based on both family and individual traits. Hereafter, we label the two sides as men and women for abbreviation. The individual quality index in the marriage market reflects their socioeconomic status. Specifically, the quality index of a man is a combination of his natal family socioeconomic status and his individual status component: $q_i = (1-\delta)F_i + \delta\phi(A_i, F_i)$. Here, $\phi(A_i, F_i)$ is the production function of men's post-natal socioeconomic status, where social mobility institution plays a role in the status/wealth-generating process, and δ is the weight of $\phi(\cdot)$. For the quality index of women, it depends fully on her natal family status: $q_j = F_j$, because women had little return to her individual ability in the status/wealth-generating process (*i.e.*, in either bureaucratic or business arena). Given the quality indices on both sides, we take a tractable marriage output function to be $v(q_i, q_j) = q_i q_j$, that there's complementarity and symmetry regarding the socioeconomic status of spouses.

Taking the benefits and costs of foot-binding for both men and women into account, the total marital utility for each side is as follows:

$$V_i = v(q_i, q_j) + (q_i - q_0)B_j - \beta\frac{B_j}{F_i}$$

$$V_j = v(q_i, q_j) - \beta\frac{B_j}{F_j}$$

For the composition of the man's utility V_i, the first term $v(q_i, q_j)$ corresponds to

[11] Relaxing this assumption does not change the results qualitatively. To see this, consider we have men of a continuum of one and women of a continuum of $s < 1$, given social strata z. In the benchmark case when both genders are symmetric in quality distribution, women are on the short side of the market due to smaller population size, and there is no need to compete for men. After the marriage market shock which made men's quality distribution more dispersed than women's, women switch to the long side of the market to compete higher quality men, thus the competition was intensified on women's side and the main intuition remains the same.

the marriage output from the matching. The second term, $(q_i - q_0) B_j$, is the gain from marrying a foot-binding wife, and $B_j \in \{0,1\}$ represents the wife's binary foot-binding status. The setting captures two features of foot-binding. First, it reflects both men's aesthetic preferences (*e.g.*, Levy, 1966; Yao, 1941) and the demand in wive's domesticity and fidelity (*e.g.,* Cheung, 1972).[12] This is shown by $(q_i - q_0) B_j$, where q_0 takes a small value that $q_0 < L$, which can be considered as a reservation point of men's aesthetic and moral preferences, thus even the poorest men value the practice positively. Second, foot-binding was also considered as a "vector of status", as Mann (1997) put it, and as a form of conspicuous consumption and leisure, as Veblen (1899) put it. This arose from the fact that foot-binding naturally precluded women from daily heavy work, thus was often perceived as an icon of upper class lifestyle. In this spirit, the multiplicative form $(q_i - q_0) B_j$ captures that the marginal benefit of a foot-binding wife, as a status good, is increasing in men's quality. Together, foot-binding declared the key dimensions of men's moral, social, and aesthetic appreciation of women.[13] Finally, the last component of both V_i and V_j captures women's labor cost of foot-binding, not only as a wife $(\beta \frac{B_j}{F_i})$, but also as a daughter $(\beta \frac{B_j}{F_j})$, where the degree of labor distortion is β.[14] This emerges from the fact that foot-binding impedes physical mobility and the cost is decreasing in household wealth, since women's labor in poorer households plays a more laborious role in production than richer households. To make the analysis tractable, we formalize two assumptions:

Assumption 1. (Class wealth gap) $H - L > L > 1$

Assumption 1 suggests a large wealth gap between the upper class and lower class. Historically, the living standards across social class was sizable, that the average annual income of lowest level officials was 6.62 times that of commoners during the Qing dynasty (Chang, 1962).[15]

Assumption 2. (Talent is scarce) $p < p^*$, *where* $(1 - p^*) \delta L (H - L) - \frac{\beta}{L} = 0$

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[12]Aesthetically, foot-binding was valued as it lifted up the body, reshaped postures, induced wiggling motion of women, which echoed modern ill-fitting shoes (*e.g.*, high heels, cf. Linder and Saltzman, 1998, Jackson 1990).

[13]As an alternative way to model foot-binding decisions, we may introduce incomplete information and treat foot-binding as a signal of women's unobserved virtues – docility, as in Rai and Sengupta (2013). Specifically, as foot-binding is a painful process to undertake, a pair of tiny, well-shaped bound feet could reveal personal endurance, obedience, and submissiveness. However, the key incentives remain equivalent: bridal families use costly actions to compete for better marriages. Thus our analysis stands as a benchmark model that highlights the interaction between men's upward mobility and marriage market competition, instead of incomplete information.

[14]In particular, as girls could start working from around age 10 until marriage, their labor value is of considerable amount during these years to the parents (Gates, 2001, Bossen and Gates 2017).

[15]Appendix Table A2 provides the full gradient of officials' income.

Assumption 2 suggests that individuals with high ability are in scarcity. Intuitively, the upper bound p^* ensures the competition incentives towards the scarce talents. [16]

Equilibrium. In our model, women simultaneously make foot-binding choices first, then participate in marriage market competition, and receive payoffs when the marriage market clears (*i.e.* a stable matching is formed).[17] A woman's strategy, s_j, specifies her foot-binding choice, in response to the foot-binding choices of all other women. Denote the strategy profile for all women by vector $\boldsymbol{s}$, and the realized foot-binding choices as $a(\boldsymbol{s})$. After a stable matching is formed, they receive marriage payoffs (V_i, V_j). Denote a stable matching from the realized choices as $M(i, j, a(\boldsymbol{s}))$, the stable matching satisfies: (1) feasibility: all candidates in the marriage pool are paired; (2) no blocking pairs: no one in a pair has any incentive to find a better partner who also prefers the new pair. There might be multiple stable matchings. All stable matchings are selected with equal probability, and a woman evaluates the expected payoffs across all possible stable matchings she might end up with. We only consider pure strategy equilibrium, because foot-binding is a childhood commitment and cannot be altered upon marriage. Formally, we have the following definition:

Definition. An equilibrium in the game is a strategy profile $\boldsymbol{s}$, such that for every women $j \in J$:

$$\mathbb{E}_M \left[V_j \left(M\left(i, j, a\left(s_j, s_{-j}\right)\right)\right)\right] \geq \mathbb{E}_M \left[V_j \left(M\left(i, j, a\left(s_j^{'}, s_{-j}\right)\right)\right)\right], \forall s_j$$

3.2 Baseline analysis

This session proceeds to analyze how the changes in social mobility channels - the established Civil Exam System - affected the marriage market and women's pre-marital investment incentives. In the following, we first review the key features of the exam sys-

[16]The analysis may proceed without Assumption 2. To spell this out, we can specify the respective cutoffs of p for the upper and lower class, to discuss competition incentives. Therefore Assumption 2 mainly serves as a simplifying and realistic assumption to make the analysis concise.

[17]Here we explicitly focus on the market for wives, since the markets for wives and concubines were separated and differed by nature (*i.e.*, a formal marital procedure was required for wives, who enjoyed a more solid economic and legal status than concubines). Further, relaxing this assumption does not change the results qualitatively. Specifically, polygyny can be introduced by assuming that one upper class man can effectively marry η women, where $\eta > 1$ indicates the degree of polygyny. With the introduction of the exam system, the composition of men still becomes more heterogeneous, where upper class women compete for the scarce talented upper class men (*i.e.*, $\eta p < \mu$). Compared to the baseline model, the opportunity for women to marry up expands from p to ηp, which increases the expected payoff from foot-binding, thus the competition was intensified on women's side and the main intuition remains the same.

tem, then present the analysis that links the theoretical insights to qualitative historical evidence.

3.2.1 The Civil Exam System and the Marriage Market

The Civil Examination System is well known as an elite recruitment system in historical China, which had triggered profound political, economic, and social changes.[18] Several of its features are worth highlighting. First, only men were eligible to participate in the exams, regardless of family background or age. Second, the structure of the exams was hierarchical with multiple layers, and only those who had passed the lower level exams were eligible for the next level.[19] Third, the exams were meritocratic, and the degree of meritocracy varied across dynasty. Specifically, the Song dynasty (960-1279) witnessed a significant jump in the degree of meritocracy, as shown by increased procedural fairness and recruitment size (Chaffee, 1995).[20] Lastly, the exam was regulated by a regional quota system by quantifying the number of degrees granted per exam. During the Ming and the Qing dynasty, the elite-generation system created a large literate pool beyond formal bureaucracy and reshaped the social stratification.[21]

When the Exam system was established as men's predominant ladder towards power, fame, and wealth, a frenzy of succeeding in the exams became pervasive among males (Elman, 2000). For women, who were without direct access to such vital mobility device, the major tool of obtaining and maintaining social status is through marriages. Following the exams, a transformation of the marriage market took place, from single-dimensional matching (*i.e.*, family status) to multi-dimensional matching (*i.e.*, both family-level traits and individual-level traits) for both men and women. Historian Dorothy Ko provides the first speculation which bridged the frenzy of male exam success and the frenzy of female competition in foot-binding, that foot-binding was "*a ladder of success for women thus mirrored the fate of the civil service exam,*

[18] The social impact of the Exam system has been discussed by a rich literature (*e.g.*, Ho 1962, Hartwell 1982, Hymes 1986, Elman 2000, Shiue 2017, Chen et. al., forthcoming).

[19] The major layers of the exam include: (i) the *Licensing Exam*, (ii) the *Qualifying Exam*, and (iii) the *Academy Exam*. Those who passed the three levels of exam were entitled as *Literati*, *Recommended Men*, and *Presented Scholar*, respectively. Appendix Figure A1 maps exam degrees to their corresponding positions in the social hierarchy (Chang, 1955).

[20] In Appendix Figure A2, we quantify men's social mobility across dynasties by constructing a surname fractionalization index of upper class men using the China Biographical Database Project (CBDB), which pattern fits the qualitative evidence.

[21] An important social strata generated by the exam was the gentry class, which played a crucial role in local governance bridging formal bureaucracy and the grassroots, and enjoyed socioeconomic privileges and prestige (Chang, 1955, Wang, 1989).

a similar vehicle for men" (Ko 2001, 2005). More precisely, foot-binding was used as a fine-tuned competition tool, which emphasized women's individual traits that were valued by men. In the following, we formally analyze how social mobility changes affect the marriage market, by contrasting the pre-Song era the post-Song era.[22]

3.2.2 The Pre-Song era

In the pre-Song era, the wealth-generating process was mainly hereditary, and social mobility was rare. During this era, the production function of men's individual socioeconomic status can be captured by $\phi(A_i, F_i) = F_i$. As a result, individual quality index is determined purely by family status for both genders, *i.e.*, $q_i = F_i$, $q_j = F_j$. Proposition 1 characterizes the equilibrium in this case, with the matching pattern illustrated by the following table.

Table 1: Quality distribution of men and women: pre-Song era

Proportions	**Family status**	**Men's quality** (q_i)	**Women's quality** (q_j)
μ	H	H	H
$1-\mu$	L	L	L

Proposition 1. *In a segregated society with inherited status, marriages are positively assortative in family status. No foot-binding is practiced in either class.*

Proof. See Appendix of proofs. □

With inherited status, the quality of both brides and grooms within each class is homogeneous. The matching pattern is endogamy, where upper class women matched with upper class grooms and lower class brides matched with lower class grooms. This matching is stable since no one has an incentive to deviate or remain single. In particular, there is no incentive for women to make costly premarital investments, because practicing foot-binding cannot compensate upper class men sufficiently to marry down, due to marital complementary and the class wealth gap. Historically, Proposition 1

[22]In the baseline model, we focus on the pre-Song and the post-Song eras. A generalization of the model could be considered, so as to capture the exam system with continuous variation in the degree of meritocracy. Specifically, one may assume a more flexible quality function, $q_i = (1-\delta) F_i + \delta \left(\frac{A_i}{L}\right)^{\alpha} F_i$, where α resembles the degree of the meritocracy over time. In such example, in the earlier implementation of the Exams, such as in the Tang dynasty, α is relatively small; and α increases sharply during the post-Song era.

reflects the marriage market before the Song dynasty, wherein powerful clans enjoyed hereditary privileges and were interconnected through marriages, and marriages were well sorted along the social hierarchy (Zhang, 2003, Sun, 2016).

3.2.3 The Post-Song Exam era

In the Post-Song era, the Exam rocked the quality distribution of men. Unlike in the pre-exam era when a groom's status was fully determined by his natal family status, during the post-exam era, the quality composition of grooms became more heterogeneous because of the positive return to men's individual ability. This is captured by the individual status-wealth production function, $\phi(A_i, F_i) = \frac{1}{L} A_i F_i$. In $\phi(\cdot)$, family background and individual ability are complementary, because participation in the exam demands financial support from the families. The scaler $\frac{1}{L}$ ensures the lowest quality among all men as the benchmark remains unchanged in the social hierarchy. The following table exhibits the quality distribution of men and women during the post-Song exam era:

Table 2: Quality distribution of men and women: post-Song era

Family status	Proportions	Men's quality (q_i)	Women's quality (q_j)
H	μp	$q_1 = (1-\delta) H + \frac{\delta}{L} H^2$	H
	$\mu(1-p)$	$q_2 = H$	
L	$p(1-\mu)$	$q_3 = (1-\delta) L + \delta H$	L
	$(1-p)(1-\mu)$	$q_4 = L$	

As revealed by Table 2, the quality index q_i combines family endowment and individual ability, and divides men into four quality strata: (1) the high talent from rich families, with quality q_1; (2) the low talent from wealthy families, with quality q_2; (3) the high talent from poor families, with quality q_3; and (4) the low talent from poor families, with quality q_4. As a result, with the rising heterogeneity among men within each family strata, women are relatively homogeneous. Thus, the heterogeneity of men encouraged relatively homogeneous women to compete in the marriage market, and the premarital investment competition among women was escalated. Denote the proportion of footbinding among upper and lower class women as r_H, r_L, respectively, and we summarize the results in the following proposition.

Proposition 2. *In the post-Exam era, the proportions of women that bind feet are* $r_H^* = \min\left\{\frac{p\delta H^3(\frac{H}{L}-1)}{\beta}, 1\right\}$ *in the upper class, and* $r_L^* = \min\left\{\frac{p\delta L^3(\frac{H}{L}-1)}{\beta}, 1\right\}$ *in the lower class, where* $r_H^* \geq r_L^*$.

Proof. See Appendix of proofs. □

Proposition 2 shows that the proportion of foot-binding women is increasing in marrying-up benefits, and decreasing in the labor cost. In equilibrium, the proportions of women foot-binding in the upper and lower classes are pinned down when the net expected benefit of marrying up equals the cost of foot-binding.[23] Furthermore, we observe an upper class dominance, that foot-binding is more pervasive in the upper class than in the lower class (*i.e.*, $r_H^* \geq r_L^*$). Two elements contribute to this result: (i) women's marrying-up gain differentials generated by marital complementarity, meaning that lower class women would always have lower benefits from marrying up than upper class women, given men's quality distribution; (ii) women's cost differentials of foot-binding across class, since lower class women play a more laborious role in household production.

Historically, the observable changes in the marriage market after the Song dynasty were documented by historians (*e.g.*, Zhang, 1989, Ebrey, 1993, Xu, 2009, Tao 2001). First, a significant transition took place from single-dimensional matching (*i.e.*, family status) to multi-dimensional matching (*i.e.*, both family-level traits and individual-level traits). For men, the most-valued individual trait became his talent and exam achievement, as the exam result is a direct indicator of individual future prosperity. Second, the competition among women after the Song dynasty was significantly escalated (*e.g.*, Ebrey, 1993, Guo, 2000), including dowry escalation and a unique phenomenon during the period – the "*grabbing*", which refers to that fathers with unmarried daughters grabbed successful candidates as sons-in-law upon the fresh release of exam results. Thus, Proposition 2 captures the marriage market changes after the Song dynasty, where the men's individual marriage quality became vital and the competition among women were intensified.

[23] The result in Proposition 2 characterizes an asymmetric equilibrium in a symmetric game with many players, in the sense that if we swap players, their payoffs are not affected. This equilibrium resembles an approximate outcome of playing a specific symmetric mixed-strategy equilibrium, when each woman chooses foot-binding with a probability close to the fraction of foot-binding women within her class in this asymmetric pure-strategy equilibrium. With large numbers, the *ex-ante* probability and *ex-post* frequency are approximately the same (Cabral 1988).

3.3 Comparative statics

Based on Proposition 2, we present comparative statics in the following corollary:

Corollary 1. *The percentages of foot-binding among upper class women r_H and lower class women r_L are non-decreasing in the proportion of high-ability men p, and non-increasing in β.*

Proof. See Appendix of proofs. □

Corollary 1 shows that foot-binding prevalence would increase alongside its benefit and decrease alongside its cost. The comparative statics guide our analysis in understanding both temporal and regional variation of foot-binding. First, studies have explored the temporal changes of β and its effect on foot-binding. In this regard, Yao (2017) provides a rich qualitative analysis revealing how increasing values of women's handicraft labor encouraged the spread of foot-binding. Specifically, as a major fiber, the cotton handicraft products had high economic value since the 14^{th} century,[24] and the estimated ratios of a female handicraft labor to a male contract agricultural labor vary from 77% (Huang, 1990), 80% (Li, 1997), to 130% (Wang, 1988). As lower class women played a more laborious role in the household, the cotton shock lowered the opportunity cost of foot-binding. Thus, a smaller β brought by the cotton revolution could contribute to pervasive foot-binding among the lower class since the 14^{th} century. Second, we can also use cross-sectional variation in p and β to understand the regional variation of foot-binding, the data of which is available in Republican archives shown in the next section.

4 Archival evidence

To examine the theory predictions empirically, this section analyzes cross-sectional county data on foot-binding from the Republican China archives. We first introduce the archival data, then test the role of two economic forces of foot-binding – women's marital benefits and labor costs.

[24]Handicraft labor in historical China included spinning and weaving, and the main source of fiber and its production technology experienced profound changes. Before the 13^{th} century, household handicraft was predominately based upon silk and hemp, where hemp handicraft had low economic value, while silk handicraft was high-valued yet geographically limited. After the 14^{th} century, the diffusion of the cotton plantation (Wang, 2008) and technology breakthrough affected the household economy and women's economic value profoundly (Xue, 2018).

4.1 Data

Foot-binding. Data on foot-binding prevalence are from the survey conducted by the Republican government in the early 1930s. Since 1928, the Republican government initiated a nationwide campaign against foot-binding, using a survey to document the preexisting prevalence of foot-binding before the campaign (Yang, 2003). The Ministry of the Interior was responsible for the survey, the reports of which were stored in the Second Historical Archives of China (SHAC). The existing archives in SHAC cover part of the counties in four provinces – Shandong, Chahaer (now part of Hebei province), Hunan, and Yunnan. On foot-binding prevalence, the main question in the survey is: "*Describe the foot-binding prevalence among women before the implementation of the anti-foot-binding campaign.*" For instance, in *Yu* county of Chahaer, the answer is "*the foot-binding custom was exceedingly popular*"; in *Yongshun* county of Hunan, the answer is "*women always work along with men, so there was no foot-binding custom*".[25] Given the qualitative nature of the answers, we code foot-binding intensity using a binary variable, taking the value of one for high foot-binding prevalence, and taking the value of zero if foot-binding was rare. The geographic distribution of foot-binding prevalence from the archival data is shown in the left panel of Figure 3.

For our analysis, the archival data has both strengths and weaknesses. First, as illustrated by Figures 3 and 4, while the archival sample is small, it has observable variation in agricultural, geographical, and socioeconomic conditions.[26] Second, while we cannot accurately measure the proportion of foot-binding women, we cross-validate the quality of the archives with alternative sources, where the latter have been discussed in Section 2 and Appendix 9.1. As revealed by the archives (*cf.*, Figure 3a) and by alternative sources (*cf.*, Figure 1), the two regional distributions of foot-binding deliver a consistent pattern. Third, while the information from archives was not organized as in a modern census style, for the purpose of our analysis, it provides irreplaceable and valuable details in the foot-binding custom at the county level, with a unified survey framework.

Variation in women's marrying-up benefits. To test the comparative statics regarding women's marital prospects, we look for regional variation in the proportion of men passing the exams (p). In particular, we investigate an institutional feature of

[25] An example of the archives is shown in Appendix Figure A3.

[26] Further, to check if the counties in and out of the archival sample are systematically different, we conduct a balance check between sample counties and non-sample counties in Appendix Table A5. The results show no systematic differences regarding socioeconomic variables across the two groups.

the exams – the region-specific quota allocation. Historically, the exam quotas served as a tool to regulate elite recruitment and social mobility across regions. Specifically, we examine the quota allocation at the county level, which was first established by the Ming and then adopted by the Qing governors (Kun et al. 1899; Shang, 2004; Liang and Zhang, 2011). In the analysis, we focus on the county level quotas of the *Licensing* exam for recruitment of *Literati*, considering three facts. First, most of the *Literati* degrees were obtained during one's marriageable ages 16-25 (~63%, cf. Chang, 1955), and it was *the* prerequisite to obtaining upper-level degrees. Second, the marriage market was mostly local, and the county is a more precise unit than prefecture or province. Third, folk beliefs, as revealed from folklore across China, had clearly stated marrying a *Literati* as ideal marital outcomes (Zhang, 2015).

To understand the magnitude of the quota, we provide the following calculation. During the late Qing dynasty, the *Licensing* exam was held twice every three years, and approximately two million candidates sat for each *Licensing* exam, where around 30,000 of them (~1.5%) were entitled with degrees (Elman, 2000). Three features of quotas are worth noting here: (1) the quota is a *flow* measure, which means it is not immediately comparable to the *stock* of population;[27] (2) the stable functioning of the system allowed the Exams to steadily produce rolling streams of new talents, who were valued as rising stars; (3) though the chance of passing the exam was small, it created a large literate pool of men who were the reserve of the exams. As a result, conditional on local population size, the regional exam quotas provides a source of variation on the width of men's upward mobility tunnel and their quality distribution generated by the exam system.

Variation in women's value of labor. For the variation in women's labor value, we exploit agricultural suitability (FAO, Global Agro-Ecological Zones) that drives both non-sedentary (farming) and sedentary (household handicraft) labor values.[28] For non-sedentary labor, the two major cereal crops – rice and wheat – differed in both gender-specific comparative advantages and labor-input intensiveness. While wheat is more suitable for heavy plough usage where men have a comparative advantage, women have a comparative advantage in rice cultivation, especially in transplanting rice seedlings.

[27] We present detailed flow calculations in Appendix Table A3 based on Chang (1955).

[28] The suitability index of a certain crop is estimated based on a model, which considers the average climate of the baseline period 1961-1990, reflecting suitability levels and distributions within grid cells. All suitability indexes are taken under the condition of the rain-fed intermediate input level. Figure 6 illustrates the regional distribution of the suitability index of rice, wheat, and cotton.

Further, rice requires twice as much as labor input than wheat.[29] Thus in rice regions, women's labor is in higher demand and they frequently worked alongside their husbands in the rice paddies. Moreover, for the value of household handicraft work, we use cotton suitability as a proxy considering it was the dominant high-value fiber during the Qing dynasty.[30] Empirically, we use the relative suitability of rice to wheat as a proxy of high-value non-sedentary labor, whereas greater suitability of cotton predicts lower value of β.

4.2 Empirical strategy

The main analysis employs the following regression specification:

$$Y_{ij} = \alpha + \beta Suitability_{ij} + \gamma lnQuota_{ij} + \lambda lnPop_{ij} + \boldsymbol{X_{ij}}\mu + \theta_j + \epsilon_{ij} \quad (1)$$

Here Y_{ij} is a dummy indicating high foot-binding prevalence in county i, province j, taking one for high prevalence. $Suitability_{ij}$ include the relative standardized suitability of rice to wheat as well as the standardized suitability of cotton. $lnQuota_{ij}$ is the logged quotas for the *Licensing* exam at the county level. $lnPop_{ij}$ is the logged county population size.[31] To account for the potential non-linear effect of the local population on the marriage market, we also include $(lnPop_{ij})^2$ and $(lnPop_{ij})^3$ in our analysis. $\boldsymbol{X_{ij}}$ is a vector of control variables, including local demographic and geographic characteristics. θ_j include province fixed effects. ϵ_{ij} is the error term, and standard errors are clustered at the province level.

With the above specification, the suitability indices capture exogenous and predetermined geographical factors, which identify the labor cost of foot-binding driven by different agricultural regimes. The identification of the effect of exam quotas on foot-binding, on the other hand, requires exogenous variation. As discussed by scholars, the main determinants of quota allocation include: local population, tax contribution, historical talent distribution, and social stability (Chang, 1955, Shang, 2004, Zhang

[29] Appendix Table A4 presents the number of days of man-labor required per crop hectare for major crops (Buck,1937). The average number of labor days required for crops in the wheat regime was around 100, while the average number of labor days required in the rice region was almost double. In a double cropping system of rice, early and late rice were counted as a whole.

[30] This measure captures the access to sources of this fiber to proxy the sedentary labor value. Another dimension for suitability in household handicraft is spinning-weaving technology, determined by relative humidity, as discussed by Xue (2018).

[31] Since the nation-wide county-level population data during the Qing dynasty is not available, we use the population measure in 1931 as the closest proxy.

and Liang, 2013, Bai and Jia, 2016).[32] While reverse causality is unlikely to be the case (*i.e.*, local women's foot-binding affected centralized decisions in quota allocation), the main concern for the identification of the quotas is the omitted variable bias. Specifically, unobservable regional characteristics may affect quotas and foot-binding decisions at the same time, which leads to bias in OLS estimates. Furthermore, the direction of the bias can be two-fold: on the one hand, the counties with more quotas per capita could be richer, therefore foot-binding practice is more affordable. On the other hand, it is also possible that quota allocation served as a political stabilizer, so that disadvantaged regions would have more quotas.

Instrument Variable. To address the omitted variable bias issue, we proceed to exploit exogenous variation in quota allocation at the county level during the Qing dynasty. Conceptually, we shall look for two counties, which are similar regarding socioeconomic characteristics, yet were allocated with different numbers of quotas for plausibly random reasons. To track down the historical events that affected the quota allocation at the county level, we look into an administrative rearrangement in the early Qing dynasty – the reclassification of the Ming dynasty's garrisons to counties during the Qing.

As discussed, the county level quotas were established by the Ming dynasty, and the Qing governors largely adopted this allocation within its regime (Kun et al. 1899; Shang, 2004). However, one distinguishable feature of the Ming quota system was related to its military stations – the garrisons, which were stationary military-economic units dwelling with military-registration status residents. During the Ming, there were more than 400 garrisons built across the countries, and the location was driven by "military vital localities" (Zhang, 1974) and "the pattern of mountains and rivers" (Mao, 2001). Compared to other administrative units, the quota allocation for garrisons was generous and privileged (Li, 1985).[33] When the Qing took over the Ming regime, the Qing established the Eight Banner's stationary military system (Ding, 2003),[34] while the previous garrison system was gradually abolished by 1711 (Mao,

[32]For allocation of quota at a higher level – the prefecture-level, Bai and Jia (2016) examines the prefecture-level quota allocation system using the prefecture-level geographic features regarding small rivers (*i.e.* number and length), when investigating the impact of the abolition of the exam system on social uprisings.

[33]The number of military-registration originated *Recommended Men* and *Presented Scholar* was also disproportionally high during the Ming dynasty.

[34]In particular, the Manchurian had set up the Eight Banner's troop stationary military system across their new territory. Appendix figure A5 compares the locations of the Ming garrisons and the Qing Eight Banner's troop stations, which are different in both numbers and geographic distributions.

2018).[35] In the process, two types of administrative adjustment took place (Kun et al., 1899, Gu, 1988, Mao, 2018): (i) for garrisons located in densely populated areas, they were merged to one or more nearby counties, where the original population, land, and quotas were taken-over or split; and (ii) for garrisons located in sparsely populated areas, new counties were directly created incorporating its original population, land, and quotas. Thus, the adjustment generated quota's variation that were affected by counties' relative location to garrisons, where the second type of adjustment captured an even greater advantageous quota allocation than the first type.

Next, we construct the instruments for quota with this regional variation.[36] To be precise, the first stage regression is the following:

$$lnQuota_{ij} = \alpha + \beta Dist_{ijg} + \gamma Dist_{ijg} \times Sparse_{ijg} + \delta Sparse_{ijg} + \lambda lnPop_{ij} + \boldsymbol{X_{ij}}\mu + \theta_j + \epsilon_{ij} \quad (2)$$

Here, $Dist_{ijg}$ is the distance of county i in province j to its nearest Ming garrison g, and $Sparse_{ijg}$ is the corresponding garrison's neighboring population sparseness before the adjustment took place (*i.e.*, the year of 1650), measured by the reversed standardized population density of the prefecture where garrison g was located in. Both $Dist_{ijg}$ and $Dist_{ijg} \times Sparse_{ijg}$ are the instruments for quotas. Conceptually, a county's relative location to garrisons mattered in the adjustment process, and the effect of distance to garrisons had heterogeneity, which is driven by garrison's neighboring population sparseness. Before proceeding to the TSLS results, we first analyze whether the relative location of the Qing counties to the Ming garrisons captures certain aspects of socioeconomic characteristics even before the administrative adjustment took place. As shown by the results in Appendix Table A5, the distance to garrisons is not a significant predictor for local socioeconomic conditions before the adjustment.

4.3 Results

OLS Results. Table 4 shows the OLS results, and provincial fixed effects are controlled throughout. Column 1 controls for standardized agricultural suitability variables, and Column 2 accounts for county exam quotas and county population both in logarithm form. Column 3 adds the nonlinear terms of logged population, and Column

[35] Among all garrisons built by the Ming dynasty, 93% of them were abolished, and only 36 were exempted from the abolition.

[36] Specifically, we use two sets of geographical information: (i) the location of the Ming garrisons and their neighboring regional features, and (ii) the location of the Qing counties after the adjustment. Together, these information helps us to take advantage of the variation generated by the event.

4 further includes other demographic characteristics (*i.e.*, household size and population sex ratio at the county level). The estimates of key coefficients are stable across Column 2 to 4. As shown by Column 4, county exam quotas are positively correlated with foot-binding intensity, while the relative suitability of rice to wheat is negatively correlated with foot-binding intensity, both with statistical significance. Regarding the magnitude, a one standard deviation increase in logged quotas conditional on population leads to around 3 percentage points higher incidence in foot-binding prevalence. Compared to this effect, a one standard deviation's increase in the relative suitability of rice (cotton) leads to 9 (18) percentage points lower (higher) probability in foot-binding prevalence respectively.

TSLS Results. Next, we employ the instrument variable strategy and report the TSLS results in Table 5, where Panel A and B present results on the second stage and the first stage, respectively. In Column 1, we include nonlinear terms of county population, and Column 2 accounts for other demographic features. Column 3 further controls the geographic and transportation characteristics, including distance to the provincial capital, distance to main rivers, and distance to the Banner's military stations. As revealed by Columns 1-3, the estimated effects of agricultural suitability and exam quotas are stable. Specifically, in Column 3, a one standard deviation increase in logged quota leads to 8.5 percentage points higher incidence in foot-binding prevalence, while a one standard deviation increase in the relative suitability of rice (cotton) leads to 9.8 (19.7) percentage points lower (higher) probability in foot-binding prevalence respectively. Given the mean of the dependent variable is 0.8, the TSLS estimates are sizable effects economically.

For the first stage results, we examine Panel B, where each column adds different sets of control variables following the same order of Panel A. In Column 3, where we have controlled for both demographic and geographic characteristics, a one standard deviation decrease in distance to garrison ($Dist_{ijg}$) leads to approximately 17% more quotas, when the garrison's neighboring population sparseness fixed at the mean. Further, the marginal effect of distance to garrisons on quotas increases with garrison's neighboring population sparseness, as revealed by the interaction term ($Dist_{ijg} \times Sparse_{ijg}$). Across columns, the coefficients of both IVs are stable in magnitude, and statistically significant from zero, with F-statistics displayed in the bottom above conventional levels.

Lastly, in addition to testing our theory, we provide empirical tests for alternative explanations of foot-binding with accessible data. In particular, we test two theories:

(i) the Neo-Confucianism explanation, that the Neo-Confucianism imposed a moral code for women to follow, thus the deformation (e.g., Chen, 1928), and (ii) the ethnicity identity-based explanation, that the Han Chinese women used foot-binding to distinguish them from other ethnic minorities (e.g. Ebrey, 1990). In Column 4, we first account for the strength of local Neo-Confucianism. Specifically, we control for the number of chaste women at the prefecture-level during the Ming and Qing dynasty to proxy local Confucianism strength following Kung and Ma (2014). In Column 5, we further test the ethnic identity-based explanation, by controlling for historical Mongolian migration intensity since the Yuan dynasty (Wu and Cao, 1997). As shown by Column 4 and 5, none of the effects of the local Neo-Confucianism strength or historical Mongolian migration intensity are significant, and the coefficients are small, thus our results do not provide empirical support to the two theories. Taken together, the empirical results stand in line with the theoretical predictions regarding both marriage and labor incentives.

5 Extension: social motives for foot-binding

In addition to the *individual* marital and labor considerations for foot-binding, this section adds two new elements to the model, so as to capture the deeper complexity of the practice. The first new element regards its intensive margin variation, which relaxes the binary assumption in the baseline model and allows for foot-binding as a continuous decision. Mapping to the history, in the late 19^{th} century, the appreciation of bound feet include not only about the size, but also the shape, the fragrance, and the shoe styles (*cf.*, Yao, 1941). In the meantime, foot-binding became a fine-tuned tool of pre-marital investment, bearing women's value at different dimensions.[37] Thus, a model with continuous foot-binding decisions is helpful, given the deforming practice had varied considerably beyond a binary choice.

The second new element that we add is the strength of social conformity. As mentioned in women's interviews (Brown et al., 2012), men's reflections (*e.g.* Yao, 1934, 1941) and folklore (*e.g.* Yao, 1941, Zhang, 2015), foot-binding was a strong social norm, to which women strove to conform. In the extension, we combine both individual and social incentives for foot-binding, and introduce a social conformity force, that devia-

[37] Anecdotal evidence (Ke, 2003) revealed that, in the Qing dynasty, matchmakers often brought a pair of women's shoes to the men's parents, the size of the shoes showed women's feet and her associated domesticity and feminine, and the fine and delicate craft of shoes showed her superb household handicraft skills.

tions from this norm induce social punishment. We further present simple dynamics of the formation of the norm. The detailed extended model is presented in Appendix 9.2.

The extension carries several new insights. First, with continuous foot-binding, women differentiated themselves more precisely in the marriage market. Second, foot-binding had a socially top-down process that the lower class women imitated this status icon following the upper class women. Third, with social conformity, foot-binding intensity increased even *within* a social class as time went by, because social pressure accumulated and upgraded. Therefore, the extended theory further accounts for the social consideration of foot-binding and its dynamics in size, that women differentiate themselves more precisely, and the deformation increased over time.

6 Concluding remarks

Economic incentives fundamentally influence cultural practices. This paper explains the economic motives for foot-binding in historical China by considering the marriage market and labor incentives, accounting for its stylized facts regarding temporal, class, regional, and size variation. The key trade-off in foot-binding decisions lies between better marriage opportunities and the labor value distortions, where the better marriage prospects were driven by a male-specific upward social mobility shock in China - the Civil Exam System - that reshaped the quality distribution of men to be more heterogeneous than that of women. The dynamics of these two factors resulted in the observed dynamics of foot-binding, as we showed in our baseline model and extensions.

Based on the theoretical predictions, our empirical analysis uses county-level data from the Republican archives to present the profound impacts of social mobility institutions and women's labor value. For the former, the county-level exam quota predicts a higher incidence of foot-binding. For the latter, higher suitability of rice relative to wheat and higher suitability of cotton affected foot-binding among lower class women. Overall, we show that the economic forces that had shaped foot-binding temporally and regionally, are internally consistent, thus casting light on the formation of cultural practices from an economic perspective.

To this end, our study highlights the role of institutional and economic opportunities in shaping detrimental gender norms.[38] Towards a more effective social engineering in

[38]Scholars have studied gender asymmetries in economic value, marriage market competition, and institutional opportunities. In particular, the interaction of these aspects of gender asymmetries shapes the dynamics of gender norms. Seminal examples in this regard include the new veiling movement among the Muslim women during the 1970s (Carvalho, 2013), the dowry escalation in

eradicating harmful gender norms, we show that an equal-mobility institution without gender bias is protective against cultural customs that carry high disutility for women.

In the meantime, we also point to two directions for future research. First, while we do not intend to cover the decline of foot-binding, qualitative evidence has revealed similar economic forces in line with the theory above. Regarding labor costs, Bossen and Gates (2017) demonstrated that the demise of foot-binding was closely related to the rise of modernized textile industries, which replaced household handicraft production with mechanized production. Furthermore, during the post-Republican period, girls had more equalized educational and economic opportunities, and the gender asymmetry in quality distribution decreased. Under these circumstances, foot-binding lost its popularity as the benefits shrank while the cost increased.

The second direction of future research is located in the heart of the concept of *beauty*.[39] While this paper does not endogenize the aesthetic and erotic roots of foot-binding, we take our study as a first step to understand a more general set of questions on beauty: Is beauty purely a biological preference, or has it deeper economic roots? How to understand the variation of beauty standards across society, across gender, and overtime? We leave these questions open to future scholarly exploration.

post-modernization India (Anderson, 2003), the changing value and preferences of women's virtue and premarital sex (Mariani 2012, Fernández-Villaverde, Greenwood, and Guner, 2014), the economic empowerment of women (Doepke and Tertilt, 2009), and the transition of dowries in Bangladesh (Ambrus et al., 2010), among others.

[39]There's a rich literature in studying the return to beauty in the marriage market and the labor market (e.g., Hamermesh, 2013).

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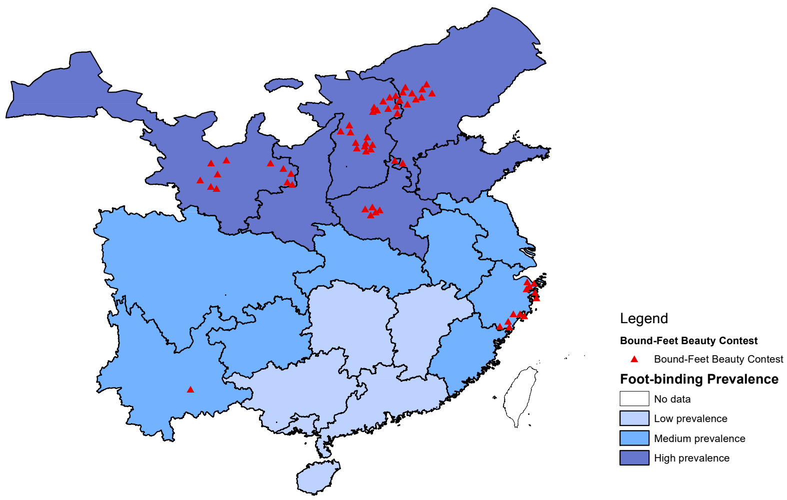
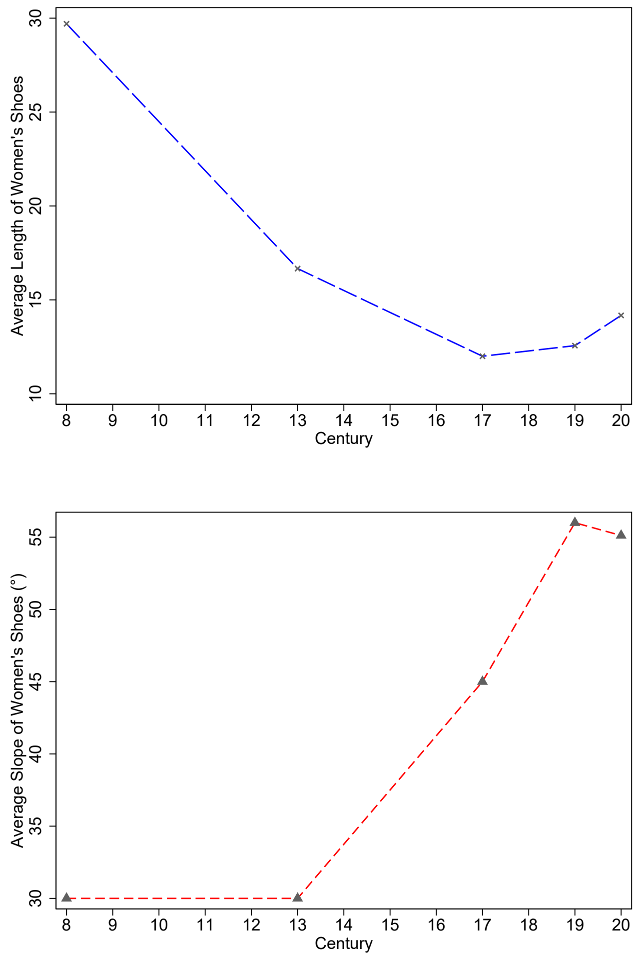
8 Figures and Tables

Figure 1: Regional Variation of Foot-binding Prevalence



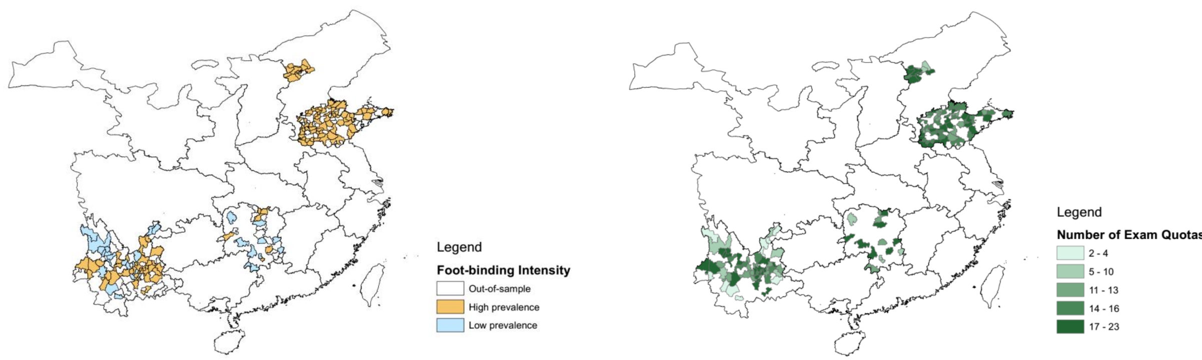
Notes: The foot-binding prevalence variable at the province level is based on Qian (1969), Xu (1984), Yao (1936), and Turner (1997). The counties noted by triangles are those with Bound Feet Beauty Contest (*Sai Zu Hui*, in Chinese), as recorded by Zhang(2015), Nagao(1973) and Yao(1934). The base map is from the CHGIS v5 (CHGIS, 2015).

Figure 2: The Metrics of Women's Shoes: Sole's Length and Instep's Slope



Notes: This figure illustrates, for each century on the x-axis, the average length of the sole in centimeters (the upper panel) and the average angle of the instep of women's shoes in degrees (the lower panel). The information of the shoes is constructed from Ko (2001), where the number of shoes observed in the 8^{th}, 13^{th}, 17^{th}, 19^{th}, and 20^{th} are 1, 3, 1, 11, and 44, respectively. The shoes from the 8^{th} to the 17^{th} century were from archaeological findings, which were either imperial or bureaucratic footwear. The shoes from the 19^{th} and 20^{th} centuries are mostly from private collections or the Bata Shoe Museum in Toronto.

Figure 3: Sample Counties: Foot-binding and Exam Quotas

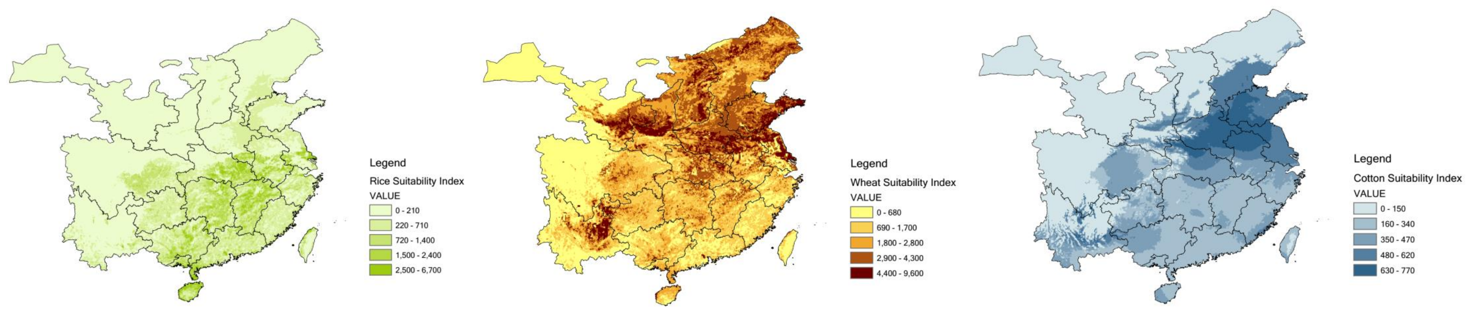


(A) Archival Counties: Prevalence of Foot-binding

(B) Archival Counties: Number of Exam Quotas

Note: Sample counties are from the Republican archives on foot-binding in the Second Historical Archives of China. Four provinces are covered by the archives: Shandong, Chahaer (now part of Hebei), Hunan, and Yunnan. Panel A shows rural foot-binding prevalence, and Panel B illustrates the distribution of county exam quotas (Kun et al. 1899). The base map is from the CHGIS v5 (CHGIS, 2015).

Figure 4: Regional Distribution of Agricultural Suitability



(A) Rice Suitability Index (B) Wheat Suitability Index (C) Cotton Suitability Index

Notes: The data in this map comes from the geographic distribution of crop suitability from the FAOs GAEZ (Global Agro-Ecological Zones). The suitability index of a certain crop is estimated based on a model, which has been applied considering the average climate of the baseline period 1961-1990 reflecting suitability levels and distributions within grid cells. All suitability indexes are taken under the condition of the rain-fed intermediate input level. Panel A shows the suitability index for rice, Panel B shows that for wheat, and Panel C is for cotton. The base map is from CHGIS v5.

Table 3: Descriptive Statistics

Variables	Mean	Std.Dev.	Min	Max	Sources
Foot-binding prevalence	0.797	0.403	0	1	A
Relative suitability (Rice-Wheat)	-0.359	1.531	-4.599	4.802	B
Cotton suitability	-0.176	1.181	-1.944	1.362	B
County exam quota	14.764	4.815	2	23	C
ln(Quotas)	2.604	0.501	0.693	3.135	C
ln(County population)	5.121	0.817	3.334	7.220	D
Population sex ratio	114.552	11.021	86.158	152.342	D
Average househould size	5.250	0.750	3.638	9.224	D
Distance to the nearest Ming Garrison	-0.050	0.916	-1.431	4.990	E
Distance to the Eight Banner's military stations	0.215	1.025	-1.146	2.439	F
Distance to provincial capital	-0.488	0.162	-0.743	0.013	G
Distance to main rivers	-0.057	0.900	-0.929	4.961	G
Number of chaste women of Ming and Qing	-0.167	0.702	-1.181	1.823	H
Mogolian migration intensity	-0.272	0.880	-1.008	1.307	I

Sources: A. The Ministry of the Interior Archives, Republic of China; B. FAO GAEZ Crop Suitability (1965-1990); C. Kun et al. (1899); D. Yearbook of Domestic Affairs of Republican China (1931); E. Berman (2017); F. Ding (2003); G. CHGIS version 5 (CHGIS, 2015); H. The Jiaqing Revision of a Unified Geography (1843); H. Wu and Cao (1997). The suitability variables, distance variables, as well as the number of chaste women of Ming and Qing and the Mogolian migration history intensity are standardized.

Table 4: Crop Suitability, Exam Quotas and Foot-binding Prevalence: OLS

	Dependent Var.: Foot-binding Prevalence			
	(1)	(2)	(3)	(4)
Relative Suitability (rice - wheat)	-0.095*	-0.086*	-0.092**	-0.091**
	(0.031)	(0.028)	(0.021)	(0.020)
Cotton Suitability	0.166**	0.171**	0.178**	0.176**
	(0.040)	(0.044)	(0.037)	(0.034)
LnQuota		0.071**	0.074**	0.063**
		(0.017)	(0.020)	(0.020)
$LnPop$		0.030	2.434*	2.331
		(0.108)	(0.959)	(1.036)
$(LnPop)^2$			-0.345	-0.319
			(0.215)	(0.233)
$(LnPop)^3$			0.014	0.012
			(0.015)	(0.017)
Population Sex Ratio				-0.041
				(0.032)
Average Household Size				0.013
				(0.020)
Prov. FE	Yes	Yes	Yes	Yes
Observations	148	148	148	148
R-squared	0.368	0.378	0.434	0.437

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors clustered by province are in parentheses. The dependent variable is a binary variable, taking the value of one for high foot-binding practice, and taking the value of zero if foot-binding was rare. The relative standardized suitability of rice to wheat is defined as the difference of the standardized values of rice and wheat suitability index. The cotton suitability is in standardized form as well. *LnQuota* is the logged quotas for the entry-level exam at the county level, and *LnPop* is the logged county population size. The county population sex ratio and average household size are both standardized.

Table 5: Crop Suitability, Exam Quotas and Foot-binding: IV Results

	Panel A. Second Stage: Foot-binding Prevalence				
	(1)	(2)	(3)	(4)	(5)
LnQuota	0.193***	0.187***	0.170***	0.171***	0.172***
	(0.024)	(0.039)	(0.039)	(0.047)	(0.048)
Relative Suitability (rice-wheat)	-0.082***	-0.082***	-0.098***	-0.093***	-0.093***
	(0.015)	(0.014)	(0.017)	(0.012)	(0.011)
Cotton Suitability	0.210***	0.208***	0.197***	0.184***	0.184***
	(0.045)	(0.041)	(0.066)	(0.048)	(0.048)
Chasty Women				-0.044	-0.043
				(0.053)	(0.047)
Mongolian Migration Intensity					-0.003
					(0.018)
Observations	148	148	148	148	148
R-squared	0.422	0.424	0.434	0.436	0.436
Prov. FE.	Yes	Yes	Yes	Yes	Yes
Population Controls	Yes	Yes	Yes	Yes	Yes
Other Demographic Controls	No	Yes	Yes	Yes	Yes
Geographic Controls	No	No	Yes	Yes	Yes
	Panel B. First Stage: County Exam Quota				
	(1)	(2)	(3)	(4)	(5)
Dist. to Garrison	-0.213***	-0.206***	-0.173**	-0.172**	-0.170**
	(0.032)	(0.033)	(0.037)	(0.038)	(0.040)
Dist. to Garrison x Pop. Sparseness 1650	-0.159***	-0.158***	-0.148***	-0.148***	-0.150***
	(0.005)	(0.004)	(0.003)	(0.006)	(0.007)
Pop. Sparseness 1650	-0.052	-0.038	0.075	0.077	0.076
	(0.096)	(0.088)	(0.049)	(0.072)	(0.073)
First Stage F-statistics	37.487	35.128	26.107	25.972	25.83
R-squared	0.494	0.500	0.532	0.534	0.534

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors clustered by province are in parentheses. The dependent variable is a dummy indicating high foot-binding prevalence in a county. The relative suitability of rice to wheat is defined as the difference of the standardized values of rice and wheat suitability. *LnQuota* is the logged quotas for the entry-level exam at the county level. Population controls refer to *LnPop.* and its non-linear terms. Other demographic controls include county population sex ratio and average household size. Geographic controls include distance to the provincial capital, distance to main rivers, and distance to the Banner's military stations. Both the number of Chasty Women and Mongolian migration intensity are standardized. The instruments are: (i) $Dist_{ijg}$: a county's distance to its nearest Ming garrison; (ii) $Dist_{ijg} \times Sparse_{ijg}$: the interaction term between the distance to garrison and the garrison's neighboring population sparseness before the administrative adjustment. Both distance to garrison and pre-adjustment population sparseness are standardized.

9 For Online Publication: Appendix

9.1 Foot-binding in Historical Accounts

In this section, we summarize the sources on foot-binding that have been consulted in this paper.

The first source on foot-binding we examine is official records by the Republican government. In the early 20th century, the Republican government prohibited foot-binding and conducted surveys to investigate the progress of prohibition from 1931 to 1934 (Yang, 2003). In this process, the local county governments conducted surveys on previous foot-binding prevalence and the progress of the anti-foot-binding campaign, then sent reports to the Republican government, which were later compiled by the Ministry of the Interior. This is the primary source used for the empirical analysis in this paper.

The second type of source on foot-binding is the gazetteers (at the province, prefecture, and county level), which are semi-official compared with governmental records. The authors of the gazetteers are mostly local gentry, scholars, and officials, and their compilations were largely based on local records and personal observations. Foot-binding in gazetteers was barely mentioned from the Song to the mid-Qing dynasty. For gazetteers published during the late Qing dynasty, most of the text on foot-binding appears in chapters on "local customs". Gazetteers published during the Republican years almost uniformly mentioned foot-binding as an undesirable custom alongside descriptions of anti-foot-binding campaigns. Taken together, only 230 regions mentioned foot-binding in their gazetteers, and their content concentrated on anti-foot-binding campaigns. Therefore, while gazetteers could be a good source for supplementary purposes, they are most useful for understanding the anti-foot-binding process.

Our third source on foot-binding are jottings (in Chinese, Biji), literature and privately compiled history. The authors of such works are mostly scholars, historians, and philologists (e.g., Qian 1969, Xu 1984, Hu 1936, Yao 1934). Their accounts offer the widest coverage of foot-binding history in terms of temporal scope.

The fourth source type we consider is the folkloric evidence and oral literature, i.e., folk ballads (e.g., Zhang, 2015). Compiled by domestic or foreign observers, the folk ballads described foot-binding in various ways, reflecting folk perceptions of foot-binding. However, the drawback of this source is also clear, since it is difficult to identify its time span and what kinds of ballads survived and why. Thus, the folk ballads will be taken as motivating and complementary sources.

The fifth source we discuss in this paper is the archaeological evidence (bound feet shoes/lotus shoes) (e.g., Ko 2001). The key advantage of this source is that it is the retrievable source through dynasties. Figure 2 provides a summary of women's shoes, which information is compiled from Ko (2001).

9.2 Extension: foot-binding as a social norm

Setup. In this section, we present a more comprehensive model incorporating additional features of foot-binding. Specifically, the first new element is the intensive margin variation of foot-binding, which relaxes the binary assumption in the baseline model and allows for foot-binding as a continuous decision. The second new element that we add is the strength of social conformity, considering the fact that foot-binding was also a strong social norm, as a customary norm to which women strove to conform. Third, we also add disutility of foot-binding to account for parent's altruism towards daughters. [40]

To begin with, we introduce a continuous foot-binding choice, $B_j \in \left\{0, \left[\underline{B}, \overline{B}\right]\right\}$, that delivers a foot-binding benefit up to $\overline{B} = 1$, to be consistent with the baseline model, at cost $c(B_j) = \eta B_j$[41]. The lower bound comes from the fact that bound feet are not visible unless the feet are deformed to an observable extent, so that $\underline{B} > 0$. The upper bound comes from the fact that there exists a physical limit of deformation.

Meanwhile, the adoption of foot-binding carries social motives. In particular, foot-binding had a socially top-down process that the lower class women imitated it as a status icon following the upper class women, and deviations from this norm could induce social punishment as disutility. The utility functions are as follows:

$$V_i^m = v(q_i, q_j) + (q_i - q_0) B_j - \beta \frac{B_j}{F_i}$$

$$V_j^w = v(q_i, q_j) - \beta \frac{B_j}{F_j} - \eta B_j - \underbrace{\gamma \left(\mathbb{I}_{B_j} - 1\right)^2}_{social\ conformity}$$

As the last term of V_j^w, γ measures the strength of social conformity, in which we adopt the following assumption. $\mathbb{I}_{B_j} = 1$ when $B_j \in \left[\underline{B}, \overline{B}\right]$, and is zero otherwise, to reflect that the social conformity enforces only the extensive margin, instead of the intensive margin, because the details of the feet are usually hard to be observed as closely by the public. To proceed the analysis, we still adopt Assumption 1 and Assumption 2, and introduce Assumption 3 such that marry-up through minimal foot-binding is beneficial.

Assumption 3. $\underline{B} < \underline{B}^*$, where $\delta(1-p)(H-L)L - \frac{\beta \underline{B}^*}{L} - \eta \underline{B}^* + \gamma = 0$.

[40] We refrain from providing separate models which progressively add the new element, for the qualitatively similar results and conciseness.

[41] The results are qualitatively the same, if we assume a quadratic cost function.

9.2.1 Static analysis

In the pre-Song era, $\gamma = 0$, and by the same reasoning of Proposition 1, there is no cross-class marriages and no foot-binding is adopted due to family-level marital complementarity.

In the post-Song era, $\gamma > 0$. With continuous foot-binding, brides differentiate themselves more precisely in the marriage market. Given the heterogeneous composition of men's quality within class, there will be a finer gradient of foot-binding choices. Specifically, for upper class women, μp choose a greater foot-binding intensity $\overline{B_H}$,and the rest $\mu(1-p)$ choose a lower intensity $\underline{B_H}$, where $\overline{B_H} \geq \underline{B_H}$. Among lower class women, $p(1-\mu)$ choose a greater intensity $\overline{B_L}$, and $(1-\mu)(1-p)$ choose a lower intensity$\underline{B_L}$, where $\overline{B_L} \geq \underline{B_L}$.[42] The mechanism here that generating more foot-binding women is social conformity pressure, since certain amount of either class of women who fail to marry up also have to bind their feet, to the extent that they are indifferent between foot-binding or not. To summarize, we have the following proposition:

Proposition 3. *There are four levels of foot-binding choices. For upper class women, μp choose foot-binding intensity $\overline{B_H}$, $\mu(1-p)$ choose intensity $\underline{B_H}$, where $\overline{B_H} \geq \underline{B_H}$. For lower class women, $p(1-\mu)$ choose intensity $\overline{B_L}$, $(1-\mu)(1-p)$ choose intensity $\underline{B_L}$, where $\overline{B_L} \geq \underline{B_L}$.*

When social conformity is sufficiently strong, that is, when $\gamma \geq \overline{\gamma}$, foot-binding intensities are sorted top-down: $\overline{B_H} \geq \underline{B_H} \geq \overline{B_L} \geq \underline{B_L} \geq 0$.

Proof. See Appendix of proofs. □

To compare the extended model with the baseline, we have the following corollaries:

Corollary 2. *The average foot-binding intensity are non-decreasing in the proportion of high-ability men p, and non-increasing in β.*

Proof. See Appendix of proofs. □

As Corollary 2 shows, the insights from the baseline model remains robust in the extension. Foot-binding is pervasive, and is positive-assortative in social classes, when social pressure is high.

[42] In both classes, we assume when a woman is indifferent between binding her feet or not, she breaks the tie by binding her feet.

9.2.2 Simple Dynamics

Given the formation and establishment of social norms was often a dynamic process, here we provide a simple extension to the above setting to illustrate how social conformity intensified foot-binding as a norm by endogenizing γ. Consider an infinite-period game, where in period t we have

$$V_{i,t}^{m} = v\left(q_i, q_j\right) + \left(q_i - q_0\right) B_j - \beta \frac{B_j}{F_i}$$

$$V_{j,t}^{w} = v\left(q_i, q_j\right) - \beta \frac{B_j}{F_j} - \eta B_j - \underbrace{\gamma_t \left(\mathbb{I}_{B_j} - 1\right)^2}_{dynamic\ social\ conformity}$$

The evolution of social conformity follows $\gamma_t = f\left(\tilde{B}_{t-1}\right)$, where $\tilde{B}_{t-1}$ is the average foot-binding intensity in the previous period $t-1$. Moreover, $f(0) = 0$ and $f^{'} > 0$. That is, if more women were binding their feet in the previous period, the social pressure for girls' families to bind their daughters' feet would be higher.

To specify the clock of events, we define the following time table:

Table: Simple Dynamics

Time	Conformity	Foot-binding Intensity
$t = 0$	$\gamma_0 = f(0) = 0$	No foot-binding.
$t = 1$ (Marriage market shock)	$\gamma_1 = f(0) = 0$	$\overline{B_{H,t=1}} > \underline{B_{H,t=1}} = 0$, $\overline{B_{L,t=1}} > \underline{B_{L,t=1}} = 0$
$t = 2$	$\gamma_2 = f(\tilde{B}_1) > 0$	$\overline{B_{H,t=2}} > \underline{B_{H,t=2}} > 0$, $\overline{B_{L,t=2}} > \underline{B_{L,t=2}} > 0$
...	...	...
$t = k$ (Handicraft shock)	$\gamma_k = f(\tilde{B}_{k-1}) > 0$	$\overline{B_{H,t=k}} > \underline{B_{H,t=k}} > 0$, $\overline{B_{L,t=k}} > \underline{B_{L,t=k}} > 0$
$t = k+1$	$\gamma_{k+1} = f(\tilde{B}_k) > 0$	$\overline{B_{H,t=k+1}} > \underline{B_{H,t=k+1}} > 0$, $\overline{B_{L,t=k+1}} > \underline{B_{L,t=k+1}} > 0$
...	...	...

As illustrated by the above table, Time 0 corresponds to the pre-Song era, where women from either class practice no foot-binding. The marriage market shock starts from $t = 1$, when the shock stirred the marriage market, inducing more fierce competition among women. The second shock – the increasing value of women's handicraft work (*i.e.*, the Cotton shock), took place in $t = k$, and this decreased the cost of foot-binding especially for lower class women. As time goes by, with accumulated social conformity (*i.e.*, γ_t is increasing), foot-binding intensity increases even *within* class. The result from the above analysis is summerzied in Proposition 4.

Proposition 4. *Each levels of foot-binding intensity,* i.e.*,* $\overline{B_H}, \underline{B_H}, \overline{B_L}, \underline{B_L}$*, is increasing as time goes by. That is,* $\overline{B_{H,t+1}} \geq \overline{B_{H,t}}$*,* $\underline{B_{H,t+1}} \geq \underline{B_{H,t}}$*,* $\overline{B_{L,t+1}} \geq \overline{B_{L,t}}$*,* $\underline{B_{L,t+1}} \geq \underline{B_{L,t}}$*, for all* $t \geq 0$*.*

Proof. See Appendix of proofs. □

9.3 Proofs

Proof for Proposition 1.

Proof. Consider a positive assortative matching in family status. An upper class woman has no incentives to pursue marrying up, because she has already married an upper class man. A lower class woman, on the other hand, may consider foot-binding to attract an upper class man. With cross-class marriage, the marrying-down loss for an upper class man is: $H(H-L)+\frac{\beta}{H}$, while the gain by marrying a lower class foot-binding wife is $(H-q_0)$. Based on marital complementarity and Assumption 1, it is impossible for the lower class woman to compensate the marriage down loss from an upper class man by foot-binding. Consequently, no one wants to deviate and the original matching is stable.

Now consider an alternative matching that is not positive assortative. Then there exists at least two pairs of cross-class married couples. By the same reasoning as above, the upper class man and the upper class woman in the two couples form a blocking pair. Thus all stable matchings have to be positive assortative, and unique in social classes.

□

Proof for Proposition 2.

Proof. First, we examine whether there could exist any cross-class marriages. Cross-class marriages may take place when a lower class woman with bound feet aims to marry up to men with either quality q_1 or q_2. Similar to the proof of Proposition 1, with cross-class marriage, the marrying-down loss for an upper class man with quality q_1 and q_2 is larger than the gain by marrying a lower class foot-binding wife. Based on marital complementarity and Assumption 1, it is impossible for the lower class woman to compensate the marriage down loss from an upper class man by foot-binding. Consequently, there is no cross-class marriage.

Next, we solve for r_H, the proportion of foot-binding women in the upper class. Starting from the case where no one binds feet, the expected marriage payoff is: $U_0^H = pH\left((1-\delta)H+\frac{\delta}{L}H^2\right)+(1-p)H^2$. Suppose someone does bind feet, she can ensure the marriage to a man with quality q_1, which gives payoff $U_1^H = H\left((1-\delta)H+\frac{\delta}{L}H^2\right)-\frac{\beta}{H}$. $U_1^H - U_0^H = (1-p)\delta H^2\left(\frac{H}{L}-1\right)-\frac{\beta}{H}$. Based on Assumption 2, $U_1 - U_0 > 0$, so that women retain from matching randomly, and there will be some woman who binds feet to marry up. In equilibrium, an upper class woman is indifferent between foot-binding or not:

$$\underbrace{\frac{p}{r_H}\left[v(q_1,H)-\frac{\beta}{H}\right]}_{marry-up}+\underbrace{\left(1-\frac{p}{r_H}\right)\left[v(q_2,H)-\frac{\beta}{H}\right]}_{marry-down}=\underbrace{v(q_2,H)}_{non-FB}$$

Re-arrange the terms, we get: $r_H=\frac{\delta pH^3}{\beta}\left(\frac{H}{L}-1\right)$. As the proportion is bounded by 1, the actual adoption rate should be $r_H^*=\min\{r_H,1\}$.

Similarly, we solve for r_L. In equilibrium, a lower class woman is indifferent between foot-binding or not. That is,

$$\underbrace{\frac{p}{r_L}\left[v(q_3,L)-\frac{\beta}{L}\right]}_{marry-up}+\underbrace{\left(1-\frac{p}{r_L}\right)\left[v(q_4,L)-\frac{\beta}{L}\right]}_{marry-down}=\underbrace{v(q_4,L)}_{non-FB}$$

Re-arrange the terms to get: $r_L=\frac{\delta pL^3}{\beta}\left(\frac{H}{L}-1\right)$. Of course, the actual adoption rate should be $r_L^*=\min\{r_L,1\}$.

□

Proof for Proposition 3.

Proof. First, we check whether cross-class marriage can take place in equilibrium. Similar to the proof of Proposition 1, with cross-class marriage, the marry-down loss for an upper class man with quality q_1 and q_2 is larger than the status gain by marrying a lower class foot-binding wife. Based on marital complementarity and Assumption 1, it is impossible for the lower class woman to compensate the marriage down loss from an upper class man by foot-binding. Consequently, cross-class marriage cannot take place in equilibrium.

We start from the bottom to construct the equilibrium. Assume all solutions are interior at the moment.

The lower class women who marry men with quality q_4 are indifferent between foot-binding or not, that is:

$$L^2-\beta\frac{\underline{B_L}}{L}-\eta\underline{B_L}=L^2-\gamma$$

which we can solve $\underline{B_L}=\frac{\gamma}{\eta+\frac{\beta}{L}}$.

Next, the lower class women who marry up to men with quality q_3 are indifferent between adopting $\overline{B_L}$ and $\underline{B_L}$:

$$((1-\delta)L+\delta H)L-\beta\frac{\overline{B_L}}{L}-\eta\overline{B_L}=L^2-\beta\frac{\underline{B_L}}{L}-\eta\underline{B_L}$$

Thus $\overline{B_L}=\underline{B_L}+\frac{\delta L^2\left(\frac{H}{L}-1\right)}{\eta+\frac{\beta}{L}}=\frac{\gamma+\delta L^2\left(\frac{H}{L}-1\right)}{\eta+\frac{\beta}{L}}>\underline{B_L}$.

Similarly, the upper class women that marry to men with q_2 quality bind feet until they are indifferent between conforming to social norms or not, that is:

$$H^2-\beta\frac{\underline{B_H}}{H}-\eta\underline{B_H}=H^2-\gamma$$

which we can solve $\underline{B_H}=\frac{\gamma}{\eta+\frac{\beta}{H}}$.

Relatedly, the upper class women who marry up to q_1 men are indifferent between adopting $\overline{B_H}$ and $\underline{B_H}$:

$$\left((1-\delta)H+\frac{\delta}{L}H^2\right)H-\beta\frac{\overline{B_H}}{H}-\eta\overline{B_H}=H^2-\beta\frac{\underline{B_H}}{H}-\eta\underline{B_H}$$

Thus $\overline{B_H}=\underline{B_H}+\frac{\delta H^2\left(\frac{H}{L}-1\right)}{\eta+\frac{\beta}{H}}=\frac{\gamma+\delta H^2\left(\frac{H}{L}-1\right)}{\eta+\frac{\beta}{H}}>\underline{B_H}$.

Lastly, $\underline{B_H}-\overline{B_L}=\frac{\gamma}{\eta+\frac{\beta}{H}}-\frac{\gamma+\delta L^2\left(\frac{H}{L}-1\right)}{\eta+\frac{\beta}{L}}=\frac{\beta\left(\frac{H}{L}-1\right)}{H\left(\eta+\frac{\beta}{H}\right)\left(\eta+\frac{\beta}{L}\right)}\left(\gamma-\left(\frac{H\eta}{\beta}+1\right)\delta L^2\right)$. Therefore $\underline{B_H}\geq\overline{B_L}$ if and only if $\gamma>\overline{\gamma}=\left(\frac{H\eta}{\beta}+1\right)\delta L^2$.

To close the proof, consider that foot-binding has an upper bound of $\overline{B}=1$, therefore:

$\underline{B_L}=\min\left\{\frac{\gamma}{\eta+\frac{\beta}{L}},1\right\}$; $\overline{B_L}=\min\left\{\frac{\gamma+\delta L^2\left(\frac{H}{L}-1\right)}{\eta+\frac{\beta}{L}},1\right\}$; $\underline{B_H}=\min\left\{\frac{\gamma}{\eta+\frac{\beta}{H}},1\right\}$; $\overline{B_H}=\min\left\{\frac{\gamma+\delta H^2\left(\frac{H}{L}-1\right)}{\eta+\frac{\beta}{H}},1\right\}$. □

Proof for Proposition 4.

Proof. From Proposition 3, $\underline{B_L}=\min\left\{\frac{\gamma}{\eta+\frac{\beta}{L}},1\right\}$; $\overline{B_L}=\min\left\{\frac{\gamma+\delta L^2\left(\frac{H}{L}-1\right)}{\eta+\frac{\beta}{L}},1\right\}$; $\underline{B_H}=\min\left\{\frac{\gamma}{\eta+\frac{\beta}{H}},1\right\}$; $\overline{B_H}=\min\left\{\frac{\gamma+\delta H^2\left(\frac{H}{L}-1\right)}{\eta+\frac{\beta}{H}},1\right\}$. Therefore, each of $\overline{B_H},\underline{B_H},\overline{B_L},\underline{B_L}$ is increasing in the strength social conformity (γ).

We use induction. Suppose $\overline{B_{H,k}}\geq\overline{B_{H,k-1}}$, $\underline{B_{H,k}}\geq\underline{B_{H,k-1}}$, $\overline{B_{L,k}}\geq\overline{B_{L,k-1}}$, $\underline{B_{L,k}}\geq\underline{B_{L,k-1}}$,for some $k\geq1$. Then $\gamma_k\geq\gamma_{k-1}$, and $\tilde{B_k}\geq\tilde{B_{k-1}}$.

Since $f'>0$, $\gamma_{k+1}=f(\tilde{B_k})\geq f\left(\tilde{B_{k-1}}\right)=\gamma_k$. Consequently, $\overline{B_{H,k+1}}\geq\overline{B_{H,k}}$, $\underline{B_{H,k+1}}\geq\underline{B_{H,k}}$, $\overline{B_{L,k+1}}\geq\overline{B_{L,k}}$, $\underline{B_{L,k+1}}\geq\underline{B_{L,k}}$.

Lastly we check the case where $k=1$. $\gamma_0=0$, $\overline{B_{H,1}}>\overline{B_{H,0}}=0$, $\underline{B_{H,1}}=\underline{B_{H,0}}=0$, $\overline{B_{L,1}}>\overline{B_{L,0}}=0$, $\underline{B_{L,1}}=\underline{B_{L,0}}=0$: the condition is satisfied. By induction, the proof is complete.

$\square$

Proof for Corollary 1.

Proof. From Proposition 2, $r_H^* = \min\left\{\frac{p\delta H^3\left(\frac{H}{L}-1\right)}{\beta}, 1\right\}$ in the upper class, and $r_L^* = \min\left\{\frac{p\delta L^3\left(\frac{H}{L}-1\right)}{\beta}, 1\right\}$ in the lower class. It is immediate that both r_H^* and r_L^* are increasing in p, and decreasing in β.

$\square$

Proof for Corollary 2.

Proof. The average foot-binding intensity is $B_{avg} = \mu p\overline{B_H} + \mu(1-p)\underline{B_H} + (1-\mu)p\overline{B_L} + (1-\mu)(1-p)\underline{B_L}$. By Proposition 3, $\overline{B_H} > \underline{B_H}$ and $\overline{B_L} > \underline{B_L}$. Therefore, $B_{avg} = \left[\mu\left(\overline{B_H} - \underline{B_H}\right) + (1-\mu)\left(\overline{B_L} - \underline{B_L}\right)\right]p + \mu\underline{B_H} + (1-\mu)\underline{B_L}$ is increasing in p.

Meanwhile, from the proof of Proposition 3, $\underline{B_L} = \min\left\{\frac{\gamma}{\eta+\frac{\beta}{L}}, 1\right\}$; $\overline{B_L} = \min\left\{\frac{\gamma+\delta L^2\left(\frac{H}{L}-1\right)}{\eta+\frac{\beta}{L}}, 1\right\}$; $\underline{B_H} = \min\left\{\frac{\gamma}{\eta+\frac{\beta}{H}}, 1\right\}$; $\overline{B_H} = \min\left\{\frac{\gamma+\delta H^2\left(\frac{H}{L}-1\right)}{\eta+\frac{\beta}{H}}, 1\right\}$. It is easy to check that the each foot-binding intensity is decreasing in β, thus the average intensity is also decreasing in β.

$\square$

9.4 A Spatial Discontinuity Case: Agricultural Regimes and Foot-binding

This section complements the empirical case with a spatial discontinuity analysis. As Figure A4 illustrates, the Jiangsu Province was located at the border of Northern and Southern China along the Huai River, and wheat and rice dominated the northern and southern banks, respectively. With such geographic proximity, comparing different agricultural regimes to the north and south of the river provides us an opportunity to investigate the differential intensity of foot-binding. Indeed, as recorded by a Jiangsu gazetteer (Li, 1936), it was historically observed that women in the north specialized in household handicrafts, while those in the south worked more on farms. The northern areas had a greater prevalence of foot-binding in rural areas than the southern areas.

9.5 Appendix Tables and Figures

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A List of Figures:

Table A1: An intellectual map of understanding foot-binding

	Marriage prospects				Labor	Social motives
Reasons for foot-binding	**Erotic values**	**Beauty**	**Feminine virtue**	**Status**	**Labor**	**Conformity**
Panel A. Reasons from the people						
Women's interviews (Brown et. al, 2012)		√	√			√
Men's poems and essays (Yao, 1934, 1941)	√	√	√			
Folk ballads (Yao, 1941, Zhang, 2015)		√	√			
Panel B. Scholarly explanations (selected)						
Ko (2001, 2005)		√	√	√	√	√
Gates (2001), Brown et. al (2012), Bossen and Gates (2017), Brown and Satterthwaite-Phillips (2018)		Mixed			√	
Gates (2008)	×					
Levy (1966)	√					
Shepherd (2019)			√	√	×	√
Veblen (1899)				√		
Cheung (1972)			√			
Rai and Sengupta (2013)			√			
Yao (2017)					√	
Mackie (1996)			√			Coordination
Greenhalgh (1977)						Patriarchy
Ebrey (1990)						Ethnic identity
Chen (1928)						Neo-Confucianism

Note: This table provides a brief summary of the intellectual map of understanding foot-binding. Notation for three types of standpoints are: "✓" means a certain perspective or explanation is proposed; "x" means a certain perspective or explanation is denied by the scholar(s); and "Mixed" means mixed conclusions.

Table A2: The Income of Gentry Class by Occupation

			Avg. Annual Income/Avg. Labor Income		
Category	Gentry Occupation	Average Annual Income (in taels)	Col.3/Lower Bound	Col.3/Upper Bound	Col.3/Category 14
(1)	(2)	(3)	(4)	(5)	(6)
1	Rank (Central/local 1st)	180	36	18	12.00
2	Rank (Central/local 2nd)	150	30	15	10.00
3	Rank (Central/local 3rd)	130	26	13	8.67
4	Rank (Central/local 4th)	105	21	10.5	7.00
5	Rank (Central/local 5th)	80	16	8	5.33
6	Rank (Central/local 6th)	60	12	6	4.00
7	Rank (Central/local 7th)	45	9	4.5	3.00
8	Rank (local 8th)	40	8	4	2.67
9	Rank (local 9th or none)	33.11	6.62	3.31	2.21
10	Gentry services	120	24	12	8.00
11	Secretaries to officials	250	50	25	16.67
12	Teaching	100	20	10	6.67
13	Practice of traditional medicine	200	40	20	13.33
14	Scholarship Awardees	15	3	1.5	1.00

Notes: Calculation based on Chang (1962). The lower bound of the male labor annual income is 5 taels of silver and the upper bound is 10 taels of silver.

Table A3: The Flow of Literati Degrees by Province

$Province$	$\#Quotas$	$Pop.(year = 1842, unit = thousands)$	$\frac{\#Quotas}{MalePop.}$	$\frac{\#ExamTakers}{MalePop.}$	$\frac{\#Literati(16-25)}{MalePop.(16-25)}$	$\frac{\#ExamTakers(16-25)}{MalePop.(16-25)}$
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Zhili	5263	36900	0.03%	1.68%	0.06%	4.24%
Jiangsu	2594	29600	0.02%	1.03%	0.04%	2.60%
Anhui	2385	36600	0.01%	0.77%	0.03%	1.94%
Zhejiang	3330	30400	0.02%	1.29%	0.05%	3.26%
Jiangxi	2498	26500	0.02%	1.11%	0.04%	2.80%
Fujian	2196	25800	0.02%	1.00%	0.04%	2.53%
Henan	3017	29100	0.02%	1.22%	0.05%	3.08%
Shandong	3386	36200	0.02%	1.10%	0.04%	2.78%
Shanxi	2842	10300	0.05%	3.25%	0.12%	8.20%
Hubei	2011	28600	0.01%	0.83%	0.03%	2.09%
Hunan	2225	20000	0.02%	1.31%	0.05%	3.31%
Shanxi and Gansu	3450	29800	0.02%	1.37%	0.05%	3.44%
Sichuan	2527	22300	0.02%	1.34%	0.05%	3.37%
Guangdong	2453	21100	0.02%	1.37%	0.05%	3.46%
Guangxi	1885	8100	0.04%	2.74%	0.10%	6.92%
Yunnan	2453	6200	0.07%	4.67%	0.18%	11.76%
Guizhou	1393	4800	0.05%	3.42%	0.13%	8.63%

Note: This table calculates the flow of the *Literati* by province based on total number of quotas at province level, based on Chang (1955). To facilitate the calculation, we take the following numerical assumptions: (1) sex ratio to be 130 men per 100 women, (2) the proportion of males aged 16-25 account for 25% of the total male population, and (3) the passing rate of the Licensing exam is around 1.5% (Elman, 2000). Column 4 presents the fraction of men who were granted a degree of *Literati* in each round of the Licensing exam among male population, and Column 5 shows the fraction of exam takers among male population. Column 6 presents the fraction of men in marriageable ages (*i.e.*, 16-25, which accounted for around 63% of the all newly granted degree holders), among male population aged 16-25. Column 7 shows the fraction of exam takers in marriageable ages among male population aged 16-25.

Table A4: Number of days of man-labor required per crop hectare for major crops

	Major Crops in the Rice Region					
	Rice	*Rice, early*	*Rice, late*	*Rice, glutinous*		
Average	186.4	120.7	104.9	201.6		
	Major Crops in the Wheat Region					
	Wheat	*Spring Wheat*	*Maize*	*Kaoliang*	*Millet*	*Millet, proso*
Average	95.4	114.6	108.7	101.9	103.9	127.8

Source: Buck, J. L. (1937). Land Utilization in China: A Study of 16,786 Farms in 168 Localities, and 38,256 Farm Familites in Twenty-two Provinces in China, 1929-1933–Statistics (Vol. 2). Commercial Press, Limited, Agents in the United States, The University of Chicago Press. It can be shown that the average number of person-days of labor required in the wheat regime was approximately 100, while that for the rice regime was almost twice as large. For rice double cropping systems, early and late rice should be combined to derive the comparison.

Table A5: Sample counties and non-sample counties

	Non-sample Counties		Sample Counties		T-test
	N1	**Mean1**	**N2**	**Mean2**	**p-value**
Shandong					
Pop. Density (1393)	17	0.701	67	1.088	0.2
Pop. Density (1580)	17	0.925	67	1.035	0.55
Pop. Density (1630)	17	0.882	67	0.943	0.72
Pop. Density (1650)	17	1.478	67	1.396	0.47
County exam quota	19	14.053	67	15.582	0.06
Hunan					
Pop. Density (1393)	41	-0.516	16	-0.353	0.09
Pop. Density (1580)	41	-0.47	16	-0.33	0.42
Pop. Density (1630)	41	-0.439	16	-0.309	0.53
Pop. Density (1650)	41	-0.62	16	-0.48	0.19
County exam quota	46	14.522	16	15.063	0.69
Chahaer					
Pop. Density (1393)	127	0.201	9	0.268	0.71
Pop. Density (1580)	127	0.264	9	0.463	0.41
Pop. Density (1630)	127	0.326	9	0.317	0.97
Pop. Density (1650)	127	0.032	9	-0.034	0.69
County exam quota	127	16.559	9	15.889	0.63
Yunnan					
Pop. Density (1393)	8	-1.029	56	-0.951	0.45
Pop. Density (1580)	8	-1.194	56	-1.089	0.4
Pop. Density (1630)	8	-1.207	56	-1.099	0.39
Pop. Density (1650)	8	-1.122	56	-1	0.41
County exam quota	8	10.75	56	13.518	0.24

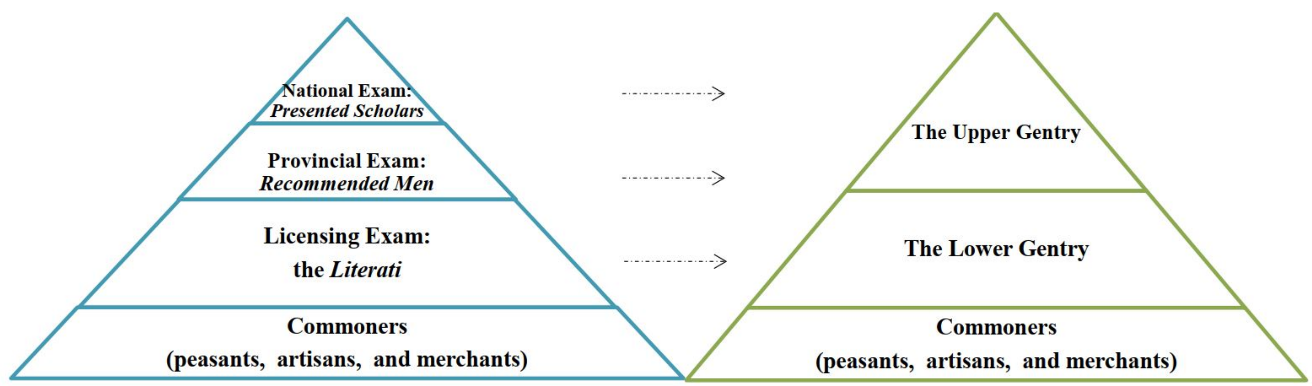
Notes: This table provides a balance check for sample counties and non-sample counties, for each province covered by the Republican archives. The last column provides p-values for the t-test between the two groups. County exam quota is the number of quotas for the *Licensing* exam at the county level. Population density variables include the prefecture-level population density, in the year of 1393, 1580, 1630, and 1650, respectively, which are standardized.

Table A6: Distance to garrison and pre-adjustment socioeconomic characteristics

	Dep. variables: Pre-adjustment socioeconomic characteristics: the Ming and early Qing				
Variable Names	**#Households (*Bianhu*)**	**Pop. Density (1393)**	**Pop. Density (1580)**	**Pop. Density (1630)**	**Pop. Density (1650)**
	(1)	(2)	(3)	(4)	(5)
Distance to Garrison	0.013	-0.048	-0.016	-0.003	-0.032
	(0.078)	(0.051)	(0.107)	(0.124)	(0.103)
Observations	107	148	148	148	148
R-squared	0.296	0.597	0.767	0.758	0.898
Prov. FE	Yes	Yes	Yes	Yes	Yes

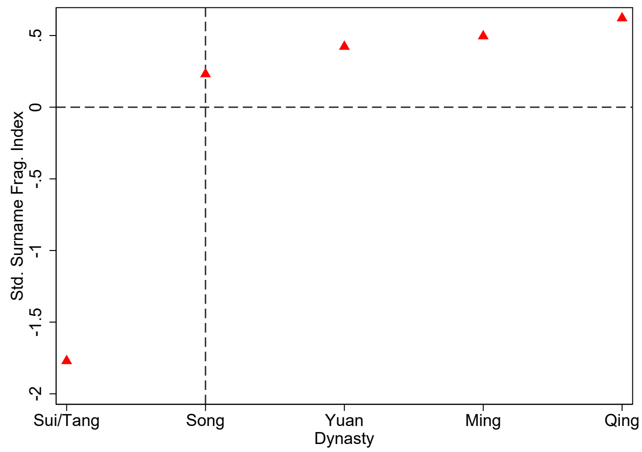
Note: *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Standard errors clustered by province are in parentheses. The explanatory variable Distance to Garrison is a county's distance to its nearest Ming garrison. The dependent variables of each columns are: (1) number of *registered households* (*Bianhu*) of the Ming, which unit is one *Li*, and each *Li* includes 110 households, measured at county level; Column (2) to (5) are prefecture population density, in the year of 1393, 1580, 1630, and 1650, respectively. All variables are standardized.

Figure A1: The Civil Exam System and the Social Stratification



Note: Illustration based on Chang(1955). Description of degree holders of the exam system is presented in Section 3, including the Presented Scholars (*Jinshi*), the Recommended Men (*Juren*), and the Literati (*Shengyuan*). Tribute Students (*Gongsheng*) refer to those who are accepted into the Imperial Academy (*Guozijian*), and *Jiansheng* refers to those who purchased the Literati degree without taking actual exams at the entry level.

Figure A2: Men's mobility trend: a calculation based upon the CBDB

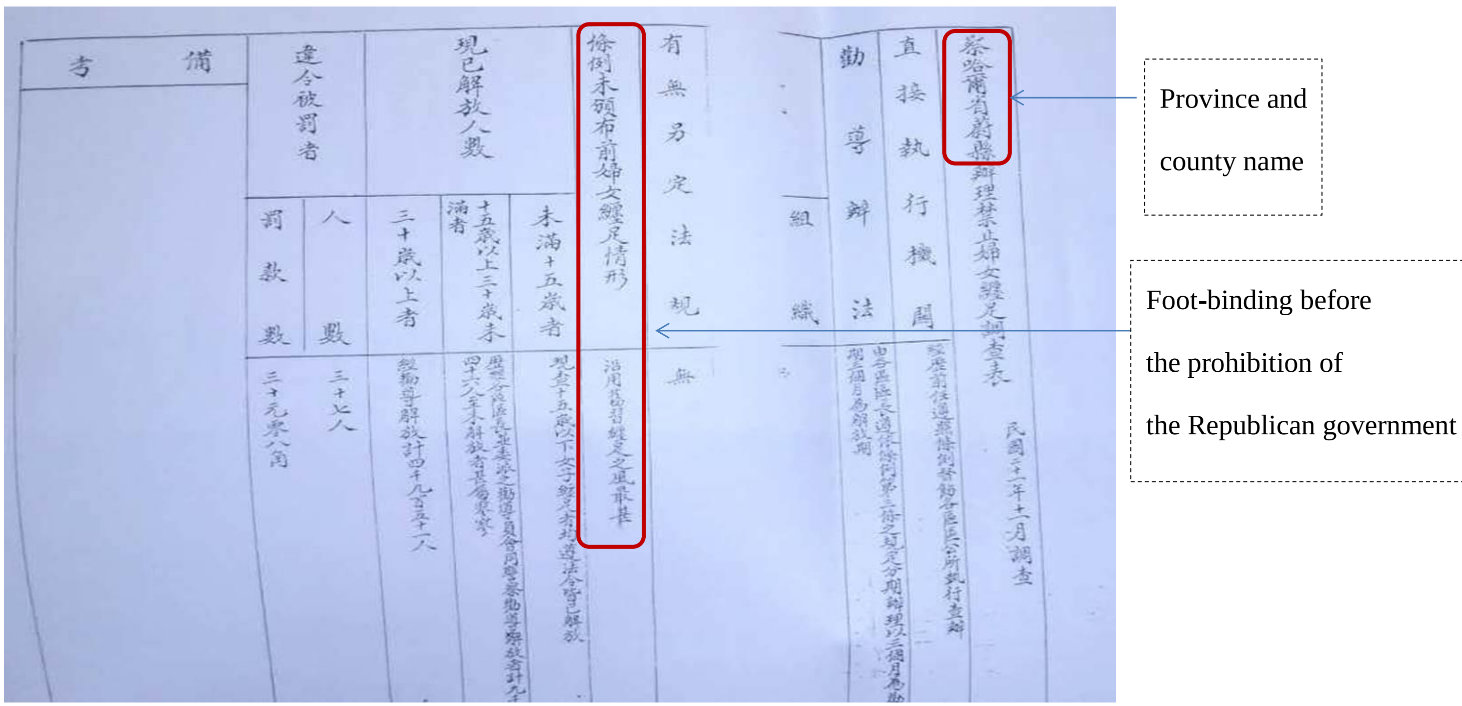


Note 1: The idea of this graph is to quantify men's social mobility across dynasties by constructing a surname fractionalization index of upper class men using the China Biographical Database Project (CBDB), where the upper class is defined as officials, scholars, and celebrities. Thus a concentrated distribution of surnames indicates relatively restricted mobility, while a higher level of fractionalization of surnames indicates greater mobility across surname clans. The figure shows a jump in the fractionalization index during the Song compared to previous dynasties, thus reconfirming the qualitative evidence on the varying degree of social mobility and the exam system.

Note 2: Data source is CBDB (version: 2015-03-18). We calculate the surname fractionalization index with a sample of male celebrities with single character surnames (a proxy of Han ethnicity). The y-axis is standardized surname fractionalization index, which is constructed following Alesina et al. (2003): $Frac_d = 1 - \sum_{i=1}^{N} S_i^2$, where S_i is the share of surname group i in dynasty d.

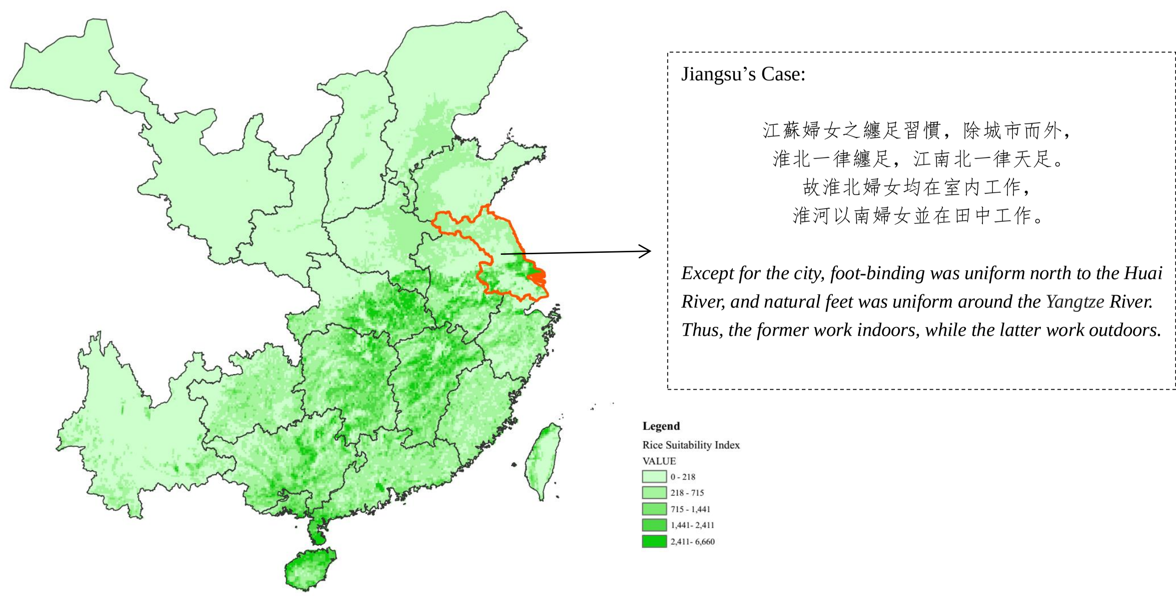
Note 3: Labels of the x-axis are as follows: 0 = Qin-Han Dynasty (BC221-220), 1 = Sui-Tang Dynasty (581-907), 2 = Song Dynasty (960-1127), 3 = Yuan Dynasty (1271-1368), 4 = Ming Dynasty (1368-1644), 5 = Qing Dynasty(1636-1911) and 6 = Republic of China (1912-1949).

Figure A3: An Example from the Archive: The Yu County



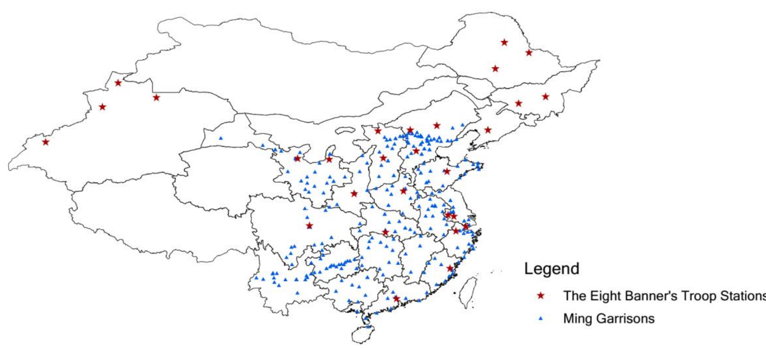
Note: This figure shows an example of the archives: Yu county in Chahaer province (now part of Hebei province).

Figure A4: A geographical discontinuity in women's labor value and foot-binding: the case of Jiangsu Province

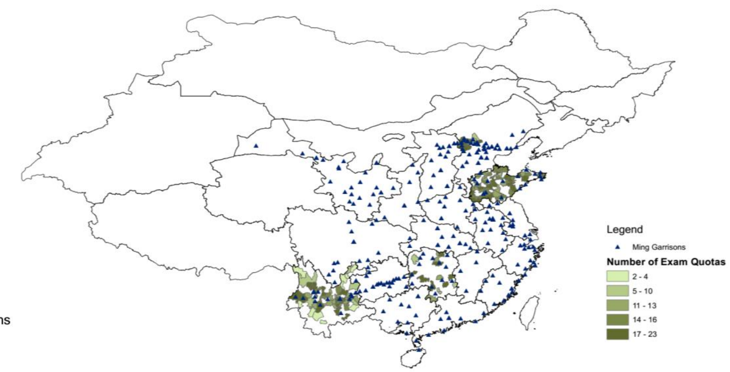


Note: The background layer in this map comes from geographic distribution of rice suitability from the FAOs GAEZ (Global Agro-Ecological Zones). The two rivers denotes Huai River and Yangtzi River from north to south respectively. The source of this qualitative case is provincial gazetteer of Jiangsu province (Li, 1936).

Figure A5: Ming Garrisons and Exam Quotas



(A) Ming Garrisons and Eight Banner's Stations



(B) Ming Garrisons and Number of Exam Quotas

Note: Panel A shows the geographic distribution of Ming garrisons (Berman, 2017) and the Qing Eight Banner's troop stations (Ding, 2003). Panel B shows the locations of Ming garrisons and the distribution of county exam quotas (Kun et al. 1899). Sample counties in Panel B are from the Republican archives with information on foot-binding. To show the full geographic span of the military stations across dynasties, we use the base map from CHGIS v5.