The Price of Cotton and Older Women's Health: Evidence from China*

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Abstract

Population aging poses a major challenge for developing countries. Within this demographic shift, older women are particularly vulnerable due to persistent socioeconomic disadvantages, yet we know surprisingly little about what improves their health. While existing research shows that female-biased labor market opportunities can enhance women's well-being, it remains unclear whether these benefits persist into old age. This study addresses these gaps by examining cotton cultivation—one of the world's most important cash crops that relies heavily on female labor—to study the long-term effects of women's employment opportunities on late-life health. Using a difference-in-differences design that exploits China's 1989 cotton price reform, we find that increases in cotton cultivation significantly improved the general health of older women in rural China. Evidence from multiple individual-level surveys shows that women in cotton-suitable counties experience better health in later life. We identify three mechanisms: higher dowries at marriage, greater household bargaining power, and increased co-residence with adult children. These findings highlight how gendered labor demand shapes women's long-term well-being and have important implications for pension and health-care systems in rapidly aging developing economies.

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1   Introduction

Population aging is accelerating worldwide, especially in developing countries (Edmonds et al. 2005). China exemplifies this shift: the share of its population aged 65 and above is projected to rise from 12.6 percent in 2020 to 27.9 percent by 2050, straining health-care systems, labor supply, and long-term growth.[1] Within this demographic transition, older women are among the most vulnerable groups, due to their limited access to formal pensions and health insurance and their limited economic resources. Yet despite their growing demographic and economic importance, older women remain relatively understudied. Understanding the determinants of their health is therefore essential in rapidly aging societies.

Gender inequalities that accumulate over the life cycle contribute importantly to the disadvantages women face in later life in developing economies. While the phenomenon of "missing women" at birth has been extensively documented (see, e.g., Sen 1990; Rosenzweig and Schultz 1982; Jayachandran and Kuziemko 2011), gender inequality does not end with early life or the reproductive years. Nearly half of missing women in China and India are aged 45 or older (Anderson and Ray 2010), highlighting the severity of missing older women. Compared with the large literature on missing girls at birth, however, far less is known about late-life female disadvantage, particularly how to reduce poor health and excess mortality among older women.

How, then, can older women's health be improved in developing countries where formal long-term care systems are limited? A related literature shows that female-biased labor market opportunities—by raising income, bargaining power, and gender-equitable norms—can improve women's welfare. Yet almost all existing work focuses on sex ratios at birth, prime-age women's bargaining power, or gender norms. Whether labor market opportunities that favor women generate benefits that persist into old age remains largely unknown. Filling this gap is particularly important for developing economies facing rapid population aging and substantial gender disparities in elderly health.

This paper addresses these gaps by studying the impacts of female-biased employment opportunities on women's late-life health in rural China, using cotton cultivation as a novel and highly relevant setting. Cotton is one of the world's major cash crops and is widely recognized as female-labor-intensive: women have historically performed core tasks such as picking and sorting. Globally, cotton is grown in more than 80 countries, accounts for about 2.5 percent of arable land, and supports roughly 31.5 million farmers (FAO 2023).

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[1]https://news.cctv.com/2020/10/05/ARTIWAeuX1XNDELg71z9L8ZU201005.shtml (in Chinese).

Although economists have long noted women's comparative advantage in cotton-related work (Schultz 1985; Beckert 2014; Danzer and Grundke 2020), surprisingly little is known about how such employment shapes women's well-being in later life. We assemble a new county-level panel of cotton cultivation in China, enabling fine-grained analysis of long-run regional variation in female-oriented labor demand. Linking this gendered agricultural sector to older women's later-life health provides new evidence on how labor demand shapes women's well-being across the life course.

Ex ante, the impact of cotton cultivation on older women's health is ambiguous. On the one hand, female-labor-intensive employment could increase women's income, strengthen their intra-household bargaining position, and shift gender norms—mechanisms that may generate lasting improvements in well-being even after women exit the labor force (see, e.g., Rosenzweig and Schultz 1982; Qian 2008; Xue 2024). On the other hand, in settings with entrenched gender bias, women may have limited control over their earnings (Field et al. 2021), attenuating any long-run health benefits. Moreover, cotton cultivation often involves physically demanding tasks and exposure to pesticides, and expanded labor opportunities may increase women's total workloads, potentially harming health in later life. The impact is thus theoretically ambiguous, and this paper empirically determines which force dominates.

Our empirical setting exploits a nationwide cotton price reform implemented in 1989, which dramatically increased cotton prices while leaving staple grain prices relatively stable. This reform raised the returns to female labor in cotton-suitable regions but had limited effects in other rural areas. To study its consequences, we construct a county-level panel of older women's general health using population census data from 1982, 1990, 2000, and 2010. We implement a difference-in-differences strategy that compares changes in older women's health before and after the reform across counties with higher versus lower agro-climatic suitability for cotton cultivation. We further complement this analysis with individual-level health data from the China Longitudinal Aging Social Survey (CLASS).

We find that greater cotton cultivation significantly improves older women's health. Counties with higher cotton suitability experience larger improvements in longevity-based measures of women's general health after the 1989 reform. Individual-level data from the CLASS show that older women in cotton-suitable counties are less likely to suffer from chronic conditions and report better self-rated health. In contrast, the estimated effects for older men are small and statistically insignificant, suggesting that the impacts operate primarily through gendered labor demand rather than general local development.

We then explore the mechanisms underlying the main results using the China Family Panel Studies (CFPS), the China General Social Survey (CGSS), and the Social Status Survey of Chinese Women (SSSCW). First, we show that cotton cultivation increases both the likelihood of dowry provision and the value of dowries, strengthening women's marital resources. Second, cotton-suitable areas exhibit patterns consistent with greater intra-household bargaining power: women earn higher relative incomes, hold more egalitarian gender-role attitudes, experience more respectful marital relationships, and report better nutrition. Third, as cotton-producing households relied more on older women for domestic work, older women were more likely to co-reside with their adult children who can provide companionship and informal care.

Our study relates to the literature on how changes in gender-specific employment opportunities affect women's welfare.[2] In particular, we relate to papers examining the impact of crops. For example, Qian (2008) shows that China's tea price reform increased women's relative income, thereby reducing parental gender selection and increasing children's education. Other studies similarly document that the expansion of textile industries and the prevalence of rice or sugarcane cultivation empowered women (Liang et al. 2021; Cheng et al. 2022; Fan and Wu 2023; Xue 2024). However, female-biased sectors do not uniformly improve women's welfare. For instance, the availability of light textile work was associated with the reinforcement of foot-binding, an extremely costly gender norm (Gates 2014).[3]

This study advances this literature in two ways. First, it highlights a long-term and policy-relevant dimension of women's well-being, the health of older women, which has received little attention in prior work. Second, it provides new evidence on cotton, another important crop that is widely cultivated not only in China but also in many other countries. In doing so, the study links gendered labor demand to enduring gender inequalities in health and to broader discussions on demographic aging in developing economies.

Another closely related literature examines gender imbalance in late-life health in developing countries (Anderson and Ray 2010; Calvi 2020), yet evidence remains scarce. A

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[2]Existing research has examined how gender-specific labor productivity or employment opportunities shape a wide range of gender-related outcomes, including gender roles (Alesina et al. 2013; BenYishay et al. 2017; Teso 2019), women's decision-making power (Majlesi 2016), gender-based violence (Aizer 2010; Bulte and Lensink 2019), sex ratios (Qian 2008; Carranza 2014; Xue 2024), restrictions on women's sexuality (Becker 2022), and women's education and health (Jensen 2012; Majlesi 2016). While much of this literature finds that female-favoring labor market opportunities improve women's welfare, some studies show that such opportunities can also generate backlash and increase abuse against women (Bulte and Lensink 2019).

[3]Foot-binding was a centuries-long Chinese practice in which young girls' feet were tightly wrapped to keep them small, causing lifelong pain and disability. Families bound daughters' feet because small feet were viewed as a mark of beauty, virtue, and higher marriageability.

large body of work studies how old-age health is shaped by early-life conditions, socioeconomic status, and family support,[4] but few papers analyze gender differences or the mechanisms underlying them. Given the unequal resource access over the life cycle, men and women likely follow different health trajectories. Our study provides new causal evidence by identifying a novel link between women's occupational specialization in cotton cultivation to their health in old age.

To our knowledge, this study is among the first to provide causal evidence on the long-run health consequences of gendered labor demand. Our findings provide potential solutions to the "missing post-reproductive women" documented by Anderson and Ray (2010) and Calvi (2020). Beyond this specific context, the results have broader policy implications. By shaping labor market opportunities earlier in life, policies that expand female-biased employment can generate durable health benefits in old age, complementing—or partially substituting for—public transfers and formal eldercare in resource-constrained settings. Taken together, our findings underscore the lasting influence of gendered labor demand on welfare and health across the life cycle.

2   Data and Empirical Strategy

2.1   Data

The primary data come from individual-level samples of the 1982, 1990, 2000, and 2010 population censuses. These four waves are used to examine the effects of the 1989 national cotton price reform on the general health of older women, measured by the share of women aged 60 and above among those aged 50 and above. Additionally, we use the 2005 mini-census (a 1% population sample), which contains detailed individual-level income information.

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[4]The first strand of literature investigates the impacts of growth environment of fetus and children on the health of the elderly, and finds that the experience of famine, malnutrition, infection by infectious disease, bad economic conditions have negative effects on health for elderly (Grimard et al. 2010; Mceniry and Palloni 2010; Cui et al. 2020; Fang and Feng 2021). A second literature focuses on the determinants during the adulthood and finds that stable job positions, higher wage level and higher socioeconomic status significantly improve the health for elderly (Moore and Hayward 1990; Huang et al. 2013; Payne and Xu 2022), while unstable jobs or unemployment, or working overtime are harmful to the health for elderly (Deb et al. 2011; Bell et al. 2012; Browning and Heinesen 2012). A third strand finds that more accompany and care from children and children's social status can help improve their old parents' health conditions (Zimmer et al. 2007; Antman 2010; Torssander 2012; Friedman and Mare 2014; Böhme et al. 2015; Barnay and Juin 2016; Huang et al. 2016; Zimmer et al. 2016; Scheffel and Zhang 2019; Chen and Fang 2021; Liu et al. 2022; Fang et al. 2023).

The second data source is the 2014, 2016, 2018, and 2020 waves of the China Longitudinal Aging Social Survey (CLASS),[5] conducted by the Institute of Gerontology at Renmin University of China. Targeting the aging population, CLASS employs a multi-stage stratified random sampling method and covers 28 provinces, representing more than 95% of the population in China. Its nationally representative sample and comprehensive indicators on physical health and elderly welfare allow us to examine how cotton cultivation affects the health of older women in rural China.

Several additional individual-level surveys are used in the mechanism analysis, including the 2010-2022 waves of the China Family Panel Studies (CFPS), the 2010 wave of the China General Social Survey (CGSS), and the 2010 wave of the Social Status Survey of Chinese Women (SSSCW). All three datasets are nationally representative and widely used in economic research. The CFPS, conducted by the Institute of Social Science Survey at Peking University, provides detailed individual- and household-level information across 25 provinces, covering about 94.5% of China's population.[6] The CGSS, administered annually since 2003 by the China Survey and Data Center at Renmin University, surveys roughly 10,000 households and collects multi-level data on individuals, families, communities, and society, including rich measures of gender roles.[7] The SSSCW, jointly conducted by the All-China Women's Federation and the National Bureau of Statistics, includes waves from 1990, 2000, and 2010 and surveys more than 20,000 adult women, collecting detailed information on health, education, social status, social protection, lifestyle, and spousal relationships.

To minimize potential confounding from migration, all analyses restrict the sample to individuals with rural Hukou who reside in rural areas and whose Hukou is registered in the survey county.

2.1.1 Measures of Older Women's Health

To assess older women's health, we construct a proxy variable at the county level using Census data from 1982, 1990, 2000, and 2010. Specifically, we calculate the following ratio:

$$\text{Proxy1}_{c,t}^{\text{women}} = \frac{\text{Number of women aged 60 and above in county } c \text{ year } t}{\text{Number of women aged 50 and above in county } c \text{ year } t} \times 100 \quad (1)$$

where subscript c denotes the county and t refers to the census year. This ratio captures

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[5]For more information, see: http://jkzgyjy.ruc.edu.cn/sjzy/CLASSsjsq/ade1ba3977354553a798c8f10221c2ad.htm
[6]For more information, see: https://www.isss.pku.edu.cn/cfps/index.htm
[7]For more information, see: http://cgss.ruc.edu.cn/

the share of women aged 60 and above among those aged 50 and above, serving as a proxy for general health conditions at the county level. The underlying assumption is that better population health is associated with greater longevity, so a higher proportion of older women reflects better health outcomes. This proxy is strongly correlated with other health measures in household surveys,[8] and similar measures have been used in prior work (e.g., Black et al. 2015).

As a robustness check, we redefine the denominator as the number of women aged 45 and above, denoted by $\text{Proxy2}_{c,t}^{\text{women}}$, and we also explore alternative age thresholds. Older women in cotton-producing counties tend to have better health outcomes (higher proxy values) compared to those in non-cotton counties, suggesting a positive correlation between cotton cultivation and older women's health.[9]

The limitation of this proxy is that it does not capture specific health conditions at the individual level. To address this concern, we supplement the analysis with detailed health measures from the CLASS data. We examine both self-rated health and indicators for whether respondents report having been diagnosed with chronic conditions such as osteoporosis, glaucoma, or chronic bronchitis. Each indicator equals one if the respondent reports the condition and zero otherwise.

2.2 Empirical Strategy

2.2.1 Difference-in-Differences (DID) Approach

To identify the causal effect of cotton cultivation on the health of older women, we employ a difference-in-differences (DID) strategy similar to Qian (2008). The identification relies on two sources of variation. The first source of variation comes from a nationwide cotton price reform implemented in 1989. Prior to 1989, cotton prices were low and relatively stable. With the expansion of the textile industry and international trade, demand for cotton increased sharply, prompting the central government to raise cotton prices through a nationwide policy reform. Appendix Figure A.1 presents the relevant policy document. As a result, cotton prices rose markedly. As shown in Figure 1, cotton prices experienced a pronounced jump in 1989, while staple grain prices remained relatively stable. We treat this

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[8]The county-level proxy constructed from the 2010 Census is strongly positively correlated with the CFPS 2010 county-level share of elderly women reporting good health, and strongly negatively correlated with the share reporting chronic conditions.

[9]We classify a county as cotton county if the suitability index of cotton is greater than 0.
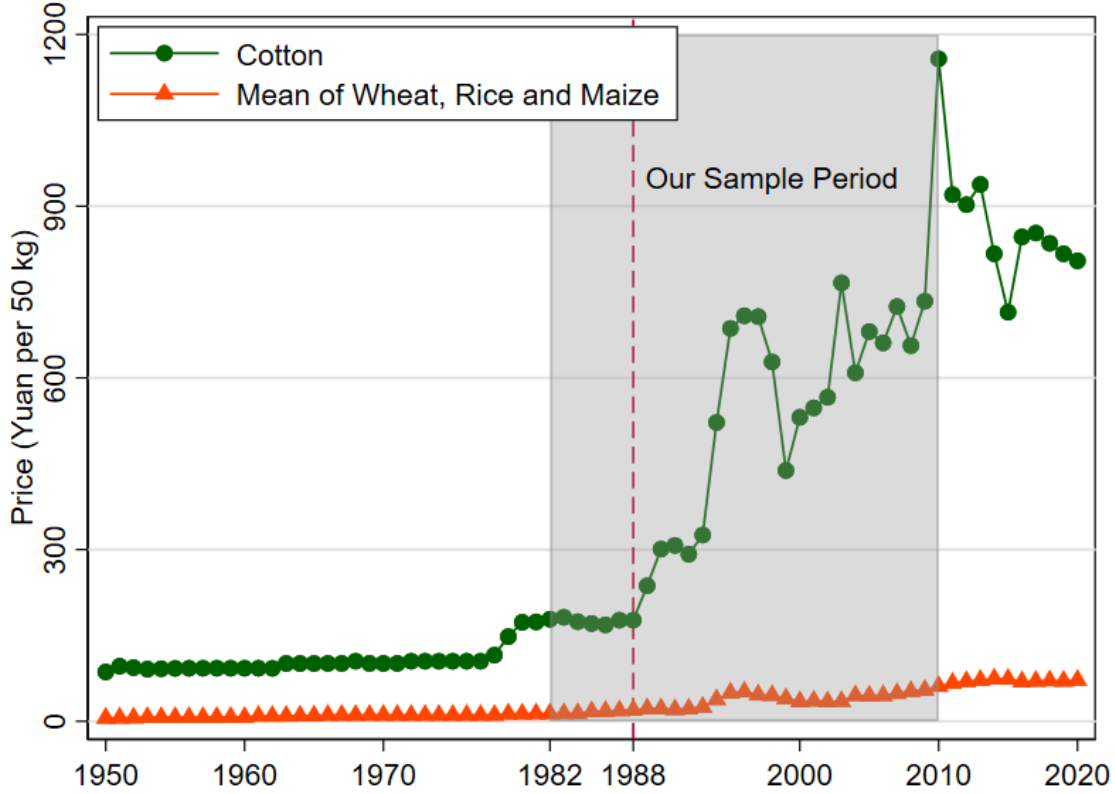
Figure 1: Price of Cotton in China 1950–2020

Data Source: China Statistical Yearbook.

reform as an exogenous shock to the returns to cotton cultivation, which in turn affected women's relative income in counties where cotton production was prevalent.

We also exploit geographical variation in the county-level cotton suitability index from the FAO Global Agro-Ecological Zones (GAEZ v4) dataset.[10] This index reflects potential yield and agro-environmental suitability for cotton cultivation, based on soil type, accumulated temperature, and precipitation—factors determined by geographic and climatic conditions. The index ranges from 0 to 10,000, with higher values indicating greater suitability for cotton cultivation; for ease of interpretation, we rescale the index by dividing it by 10,000. Although exogenously determined, cotton suitability may be correlated with the suitability of other crops, such as staple grains (rice, maize, wheat) or cash crops (tea, tobacco), which may also affect older women's health.[11] To isolate the impact of cotton

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[10]We use the cotton suitability index based on irrigated water supply for the period 1971–2000.

[11]For example, Qian (2008) shows that the tea price reform in rural China in the late 1970s significantly

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cultivation, all regression specifications control for county-level suitability indices of these crops, or their interactions with the corresponding price indices.

Using county-level panel data, we implement a difference-in-differences strategy to estimate the causal impact of cotton cultivation on the health of older women. The following equation is estimated:

$$\text{Proxy1}^{\text{women}}_{c,t} = \beta_0 + \beta_1 \, \text{CottonSuitability}_c \times \text{Post}_t + \beta_2 X_{c,t} + \alpha_c + \gamma_t + \varepsilon_{c,t} \qquad (2)$$

where the dependent variable, $\text{Proxy1}^{\text{women}}_{c,t}$, is constructed as described in Equation 1 using female samples from the 1982, 1990, 2000, and 2010 population censuses. Subscripts c and t index counties and census waves, respectively. $\text{CottonSuitability}_c$ denotes the county-level cotton suitability index, and $Post_t$ is a post-reform indicator equal to one for 1990, 2000, and 2010, and zero for 1982. The coefficient of interest, β_1, captures the differential change in older women's health after the 1989 price reform between counties that are more versus less suitable for cotton cultivation.

The vector $X_{c,t}$ includes a rich set of controls: the county-year share of Han ethnicity, county-year average years of schooling, and the county-year share of girls aged 0–4; interactions between county-level suitability indices for the three major staple crops (rice, maize, and wheat), tea, and tobacco and their corresponding price indices; and additional socioeconomic controls, including interactions between the county-level infant mortality rate in 1981 and a linear time trend, interactions between the county-level log distance to the provincial capital and a linear time trend, and province-year log GDP per capita. County and census-wave fixed effects are denoted by α_c and γ_t, respectively. Standard errors are clustered at the county level.

To minimize potential confounding from migration, all analyses restrict the sample to individuals with rural Hukou who reside in rural areas and whose Hukou is registered in the survey county.

Note that because we have only one pre-reform period, we cannot conduct a formal parallel-trends test using the main dataset. Following Huang and Zhang (2021), we therefore use an alternative dataset to assess pre-trends. The goal is to provide suggestive evidence that no major pre-reform health shocks differentially affected areas with higher versus lower cotton suitability. Specifically, we draw on the 1989 wave of the China Health

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improved girls' educational attainment and reduced parental gender selection. In addition, tobacco farmers may have a higher likelihood of smoking, which can adversely affect their health (Martins-da Silva et al. 2022).

and Nutrition Survey (CHNS) and estimate the following equation using individual-level data:

$$Y_{i,p,t} = \beta_0 + \sum_t \beta_t \, \text{Cotton}_p \times \mathbf{1}\{\text{born in year } t\} + \beta_2 X_{p,t} + \alpha_p + \gamma_t + \varepsilon_{i,p,t} \qquad (3)$$

where subscripts i, p, and t index individuals, provinces, and birth years, respectively. The outcome variable Y is the log of height or weight. The vector $X_{p,t}$ includes interactions between province-level suitability indices for the three major staple crops (rice, maize, and wheat), as well as tea and tobacco, and their corresponding price indices. α_p and γ_t denote province and birth-year fixed effects, respectively. We restrict the sample to rural residents and divide the sample by gender.

We plot the estimated β_t for birth cohorts 1983–1988 in Appendix Figure A.2. These co-efficients capture differences in the log height or weight of boys and girls living in provinces with higher versus lower cotton suitability.[12] The intuition is that if pre-reform health shocks differentially affected regions with varying cotton suitability, such shocks would generate cohort-specific variation in these coefficients. For example, a shock occurring in 1986 would be expected to produce systematically different estimates for the 1986–1988 birth cohorts relative to the 1983–1985 cohorts. Instead, the estimated coefficients are close to zero and display little variation across birth years. Overall, these patterns provide little evidence of major pre-reform health shocks that differentially affected areas with higher versus lower cotton suitability.

2.2.2 Further Empirical Tests Using Individual-level Survey Data

To complement our analysis with alternative measures of individual health conditions, we use data from the 2014, 2016, 2018, and 2020 waves of the CLASS and estimate the following equation for women aged 60 and above with rural Hukou who reside in rural areas and whose Hukou is registered in the survey county:

$$\text{Health}_{i,c,k,t} = \beta_0 + \beta_1 \, \text{CottonSuitability}_c + \beta_2 X_{i,c,k,t} + \alpha_k + \gamma_t + \varepsilon_{i,c,k,t} \qquad (4)$$

$\text{Health}_{i,c,k,t}$ denotes the self-rated health and chronic diseases. Subscripts i, c, k, and

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[12]The analysis is restricted to rural children born in 1983 or later, as physical examinations were conducted only for children aged 0–6 or for adults. We focus on children because height and weight change rapidly during early childhood and thus provide sensitive indicators of health during the growth period.

t represent the individual, county, prefecture, and survey year. CottonSuitability$_c$ denotes the county-level cotton suitability index. The coefficient of interest, β_1, captures the effect of cotton cultivation on older women's health and is expected to be positive. $X_{i,c,t,k}$ is a vector of control variables, including county-level suitability indices for rice, maize, wheat, tea, and tobacco; a dummy for Han ethnicity; a dummy for widowed status; an indicator for being employed; as well as individual-level controls such as age, age squared, years of schooling, and number of children. α_k and γ_t are prefecture and year fixed effects, respectively. Standard errors are clustered at the county level.

In Section 4, a similar estimation strategy is employed following Equation 4, but with alternative dependent variables that capture various aspects of welfare and bargaining power among married women or older women within the household. Definitions of variables and descriptive statistics are provided in Appendix Tables A.3 and A.4 in the Appendix.

3 Main Results

3.1 Cotton and Older Women's Health: Evidence from County-Level Panel Data

Using the 1989 cotton price reform in combination with the cotton suitability index, we implement a difference-in-differences design. Before examining the effects on older women's health, we first verify that the reform led to increases in cotton cultivation. Specifically, we construct a county-year panel spanning 1971–2000 and regress the share of land cultivated in cotton on the interaction between the cotton suitability index and an indicator for years at or after 1989.

Appendix Table A.1 reports the results. The coefficients on the interaction term are positive and statistically significant both with and without controls, indicating that the reform indeed increased cotton cultivation.

We then estimate the difference-in-differences model specified in Equation 2. The coefficient on the interaction term is expected to be positive, implying that price-induced increases in cotton cultivation improve health outcomes for older women.

Table 1 presents the estimation results. Column (1) reports the impact of the interaction term on the general health conditions of older women. The estimated coefficient is 3.29 and statistically significant at the 1% level, suggesting that a one-SD increase in the cotton

suitability index is associated with about 1 percentage point increase in the share of women aged 60 and above among those aged 50 and above after the price reform, relative to the pre-reform period.

Column (2) presents a robustness check by replacing the dependent variable $Proxy1^{women}$ with $Proxy2^{women}$, defined as the share of women aged 60 and above among those aged 45 and above. The results remain consistent, with the interaction term positive and significant at the 1% level. Taken together, the results in Table 1 provide strong evidence that cotton cultivation improves the general health of older women in rural China.

Table 1: Cotton and Older Women's General Health: County-Year Panel

Dep. Var.	$Proxy1^{women}$	$Proxy2^{women}$	$Proxy1^{women}$	$Proxy2^{women}$
	(1)	(2)	(3)	(4)
Cotton Suitability × Post	3.290***	2.819***	2.490***	2.201***
	(0.659)	(0.587)	(0.713)	(0.621)
Socioeconomic Var.	N	N	Y	Y
Control Var.	Y	Y	Y	Y
County FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Observations	7,891	7,917	7,891	7,917
Adjusted R^2	0.316	0.382	0.317	0.383
Mean of Dep. Var.	53.697	41.037	53.697	41.037

Notes: The dependent variable is winsorized at the 5th and 95th percentiles. Cotton Suitability is the county-level cotton suitability index, and Post is a dummy variable which equals 1 for the years 1990, 2000, and 2010, and 0 for 1982. Control variables include share of Han ethnicity at county-year level, women's average years of schooling at county-year level, and interaction terms between county-level suitability indices of rice, maize, wheat, tea, and tobacco, along with their corresponding price indices. Socioeconomic variables include interaction term between county-level infant mortality rate in 1981 and year, interaction term between county-level log of distance to the provincial capital and year, share of girls aged 0-4 at county-year level, and log of GDP per capita at province-year level. Numbers in the parentheses are standard errors clustered at county level. * $p < .10$, ** $p < .05$, *** $p < .01$.
Data source: 1982, 1990, 2000, and 2010 Census.

We conduct several robustness checks. First, in Appendix Table A.5, we replace the continuous measure CottonSuitability with a binary equal to one for counties with above-average suitability. Second, Appendix Table A.6 uses alternative age thresholds to construct the outcome variables: (i) the share of women aged 65 and above among women aged 50 and above, and (ii) the share of women aged 65 and above among women aged 45 and above. Third, Appendix Table A.7 reports standard errors clustered at the prefecture level. The results remain robust across all specifications.

3.2 Cotton and Older Women's Health: Evidence from Individual-Level Data

Using detailed health information from four waves of the CLASS, we further examine whether cotton cultivation improves older women's health. Table 2 reports the estimation results from Equation 4, where the dependent variables include binary indicators for three chronic conditions—osteoporosis, glaucoma, and chronic bronchitis—as well as measures of self-rated health. The self-rated health variables indicate whether a respondent reports poor health relative to peers or poor health overall. Each outcome is coded as one if the condition is present and zero otherwise.

Table 2 shows that the coefficients on cotton suitability are consistently negative and statistically significant across all outcomes. This suggests that women living in counties with higher cotton suitability are less likely to suffer from chronic diseases or report poor physical health. Specifically, a one-SD increase in cotton suitability is associated with a 6.5–10.0 percentage point reduction in the likelihood of having osteoporosis, glaucoma, or chronic bronchitis, and approximately a 16.2 percentage point improvement in self-rated health. Taken together, these results provide further evidence that cotton cultivation leads to substantially better health for older women in rural China.[13]

Table 2: Cotton and Older Women's Health: Individual-level Survey

Dep. Var.	Chronic Disease			Self-rated Health	
	Osteoporosis	Glaucoma	Chronic Bronchitis	Poorer Physical Health than Peers	Bad Health
	(1)	(2)	(3)	(4)	(5)
Cotton Suitability	−0.387***	−0.251**	−0.388**	−0.620***	−0.624*
	(0.063)	(0.100)	(0.175)	(0.193)	(0.352)
Control Var.	Y	Y	Y	Y	Y
Prefecture FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
Observations	6,603	6,605	6,608	6,556	6,586
Adjusted R^2	0.062	0.040	0.041	0.119	0.141
Mean of Dep. Var.	0.069	0.068	0.071	0.259	0.273

Notes: Control variables include a dummy for Han ethnicity, a dummy for widowed status, an indicator for being employed, age, age squared, years of schooling, number of children, and county-level suitability indices for rice, maize, wheat, tea, and tobacco. Numbers in the parentheses are standard errors clustered at county level. * $p < .10$, ** $p < .05$, *** $p < .01$.
Data source: 2014–2020 CLASS.

So far, we have provided evidence that cotton cultivation significantly improves older

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[13]We also examine a broader set of chronic conditions, including hypertension, heart disease, cerebrovascular disease, kidney disease, arthritis, urinary system disease, gastroenteritis, and deafness. The estimated effects are consistently negative, though not always statistically significant.

women's health. To assess the robustness of these findings, we conduct two additional tests. First, we estimate non-linear Probit and Logit models in place of the baseline linear specifications. Second, we cluster standard errors at the prefecture level rather than the county level in the OLS regressions. The results, presented in Appendix Tables A.8 to A.10, consistently show that cotton cultivation has a significant positive effect on older women's health outcomes, reinforcing the robustness of our main conclusions.

4 Potential Mechanisms

Having established that cotton cultivation improves older women's health, we now examine the mechanisms underlying this relationship. We propose three potential channels through which cotton cultivation may improve older women's health: (i) higher marital transfers at the time of marriage, namely dowries; (ii) enhanced women's bargaining power and more favorable intra-household allocation; and (iii) increased co-residence with adult children in later life.

We test these channels using multiple household survey datasets. First, we show that cotton suitability significantly increases the probability and value of dowry transfers, and that higher dowries are associated with better self-rated health among married women, including those aged 60 and above. Second, we document that cotton suitability raises wives' relative income, promotes more egalitarian gender attitudes, improves nutritional intake, and reduces spousal mistreatment. Third, we demonstrate that cotton suitability increases the likelihood that older women co-reside with their married children, that co-residing older women contribute more to household chores, and that such co-residence is associated with higher household income. Together, these results provide a coherent picture in which a female-labor-intensive agricultural sector strengthens women's bargaining position over the life course and enhances their health in old age.

4.1 The Value of Dowry

In rural China, parents commonly provide dowries, typically in the form of jewelry or property transferred from the bride's family to the marital household. Prior research shows that dowries serve as signals in the marriage market and enhance women's bargaining power within marriage (Zhang and Chan 1999; Brown 2009; Chan 2014). Variation in dowry values may therefore translate into differences in women's post-marital bargaining positions,

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with potential impacts on health in later life.

Cotton cultivation can increase dowry values through two related mechanisms. First, cotton production is highly labor-intensive and relies disproportionately on female labor. Adolescent daughters often assist their parents—particularly their mothers—in cotton picking and related household tasks. In recognition of daughters' contributions, parents may provide higher dowries as a form of intergenerational compensation and as an investment in their daughters' marital prospects. Second, cotton cultivation strengthens mothers' bargaining power within the household by increasing their contribution to household income, as discussed in the literature review and examined further in the next subsection. Enhanced maternal bargaining power can influence intra-household allocations, including the size of dowries transferred to daughters.

By signaling parental resources and commitment in the marriage market, larger dowries can enhance women's bargaining power after marriage, enabling them to secure greater allocations of household resources toward nutrition, health care, and medical expenditures over the life cycle. Using data from the 2014–2022 China Family Panel Studies (CFPS), which report both dowry values and women's self-rated health, we test whether cotton cultivation increases dowries and whether higher dowry values are associated with better health outcomes among older women.

Table 3: Cotton and Dowry

Dep. Var.	Log(Dowry Value) (1)	Dowry (2)
Cotton Suitability	2.037***	0.271***
	(0.683)	(0.100)
Control Var.	Y	Y
Prefecture FE	Y	Y
Year FE	Y	Y
Marriage Year FE	Y	Y
Observations	16,566	16,566
Adjusted R^2	0.368	0.227
Mean Dep. Var.	5.104	0.707

Notes: Control variables include a dummy for Han ethnicity, age at marriage, years of schooling, and county-level suitability indices for rice, maize, wheat, tea, and tobacco. Numbers in the parentheses are standard errors clustered at county level. * $p < .10$, ** $p < .05$, *** $p < .01$.
Data source: 2014–2022 CFPS.

Using a sample of married women with rural Hukou in the surveyed counties, the es-

Table 4: Dowry and Women's Self-rated Health

Dep. Var.	Self-rated Health					
Ever-Married Women	All		Aged 50 and Above		Aged 60 and Above	
	(1)	(2)	(3)	(4)	(5)	(6)
Log(Dowry value)	0.008***		0.011***		0.009**	
	(0.002)		(0.003)		(0.005)	
Dowry		0.042***		0.038**		0.018
		(0.012)		(0.017)		(0.027)
Control Var.	Y	Y	Y	Y	Y	Y
County FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Marriage Year FE	Y	Y	Y	Y	Y	Y
Observations	12,644	12,644	6,223	6,223	2,856	2,856
Adjusted R^2	0.144	0.143	0.090	0.088	0.112	0.110
Mean of Dep. Var.	0.636	0.636	0.522	0.522	0.488	0.488

Notes: Control variables include a dummy for Han ethnicity, a dummy for widowed status, an indicator for being employed, age, age squared, years of schooling, number of children, log household income, and county-level suitability indices for rice, maize, wheat, tea, and tobacco, along with their corresponding price indices. Numbers in the parentheses are standard errors clustered at county level. * $p < .10$, ** $p < .05$, *** $p < .01$. Data source: 2014–2022 CFPS.

timated effects of cotton cultivation on dowry are reported in Table 3. The dependent variables are $Log(Dowry\_value)$, the log of the dowry's monetary value plus one, and Dowry, a binary indicator equal to one if the woman's parents provided a dowry at the time of her marriage. As shown in Table 3, the coefficients on the key independent variable, the suitability index for cotton cultivation, are significantly positive. This suggests that higher cotton suitability is associated with a greater likelihood of receiving a dowry and with higher dowry value, indicating that cotton cultivation increases dowries.

Table 4 presents the estimation results of the relationship between dowries and women's health, measured by self-rated health. Columns (1) and (2) use the full sample of married women with rural Hukou living in the surveyed counties. Columns (3) and (4) restrict the sample to women aged 50 and above, while Columns (5) and (6) focus on women aged 60 and above. The results show that both receiving a dowry and higher dowry values are positively and statistically significantly associated with better self-rated health among married women. This relationship remains robust in the subsample of women aged 50 and above and of women aged 60 and above.

Appendix Table A.11 shows a positive association between dowry and women's self-

rated health for women married both before and after 1989. When the sample is further restricted to women married at or after 1989 and aged 50 and above, the estimates remain positive, though less precisely estimated. Overall, the results are consistent with a positive relationship between dowry and women's health for women married before and after the cotton price reform and for both young and old women.

4.2 Women's Bargaining Position in the Household

4.2.1 Wife's Relative Income

Cotton cultivation may increase wives' relative income and thereby strengthen their bargaining power within the household, leading to improvements in health later in life. To test this hypothesis, we use data from the 2005 Population Census, the only census in China that reports individual income information. Using these data, we construct two measures of a wife's relative income: (i) the ratio of the wife's income to the couple's total income, and (ii) the ratio of the wife's income to total household income. We expect the estimated coefficients on cotton suitability to be positive.

Restricting the sample to married couples with rural Hukou in the surveyed cities and aged 18 to 60, the estimation results are presented in Table 5.[14] The results show that the coefficients on the cotton suitability index are significantly positive. The results indicates that cotton cultivation significantly increases a wife's relative income, which likely enhances her bargaining power within the household, which may contribute to better health outcomes later in life.

Because cotton cultivation offers women employment opportunities, it may influence the gender role attitudes and, in turn, improve their health outcomes. Table A.12 presents the estimation results. Consistent with our hypothesis, the results suggest that cotton cultivation plays a role in shaping more egalitarian gender attitudes among women, supporting the view that greater access to female-oriented employment opportunities can shift social norms within the household.

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[14]The data from the 2005 Census does not provide county-level administrative codes, so we construct the cotton suitability index at the prefecture level.

Table 5: Cotton and Wife's Relative Income

Dep. Var.	Share of Wife's Income in Total Spousal Income (1)	Share of Wife's Income in Total Household Income (2)
Cotton Suitability	11.121***	8.584***
	(2.614)	(2.230)
Control Var.	Y	Y
Province FE	Y	Y
Observations	217,645	217,645
Adjusted R^2	0.091	0.072
Mean of Dep. Var.	36.215	31.766

Notes: Control variables include suitability indices for rice, maize, wheat, tea, and tobacco at prefecture level. Numbers in the parentheses are standard errors clustered at prefecture level. * $p < .10$, ** $p < .05$, *** $p < .01$. Data source: 2005 Census.

4.2.2 Nutritional Intake

Nutritional intake is a key determinant of health. In many societies, women with weaker bargaining power face intra-household discrimination that limits their access to adequate nutrition. If cotton cultivation enhances women's economic contributions to household income, it may strengthen their intra-household bargaining power and, in turn, improve their access to higher-quality nutrition. Using data from the 2010 China Family Panel Studies (CFPS), we examine whether cotton cultivation increases the likelihood that older women consume fish, meat, and milk—regarded as high-quality, protein-rich foods in China—at least once per week.

Table 6 presents the estimation results. Consistent with our hypothesis, the coefficients on the cotton suitability index are significantly positive in most regressions. This suggests that cotton cultivation enhances the nutritional intake of women, likely by strengthening their bargaining position. The effect holds not only for the full sample of married women but also for subsamples of women over age 50 and 60, indicating that the nutritional benefits of cotton cultivation persist into later life.

4.2.3 Harmonious Marital Relationship

In theory, a married woman's bargaining power within the household affects not only her access to nutrition but also the quality of her relationship with her husband—an important determinant of health in later life. Therefore, we hypothesize that cotton cultivation, by in-

Table 6: Cotton and Nutritional Intake of Women

Dep. Var.	Fish	Milk	Meat	Fish	Milk	Meat	Fish	Milk	Meat
Ever-Married Women		All			Aged 50 and Above			Aged 60 and Above	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Cotton Suitability	0.236**	0.253**	0.121	0.237**	0.251**	0.052	0.302**	0.261*	0.094
	(0.103)	(0.116)	(0.166)	(0.114)	(0.120)	(0.183)	(0.133)	(0.140)	(0.190)
Control Var.	Y	Y	Y	Y	Y	Y	Y	Y	Y
Prefecture FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	24,809	18,705	24,807	11,565	8,211	11,561	6,001	4,353	5,999
Adjusted R^2	0.382	0.115	0.177	0.381	0.097	0.199	0.374	0.100	0.213
Mean of Dep. Var.	0.470	0.218	0.752	0.478	0.206	0.729	0.466	0.230	0.717

Notes: Control variables include a dummy for Han ethnicity, an indicator for being employed, age, age squared, years of schooling, number of children, log household income, and county-level suitability indices for rice, maize, wheat, tea, and tobacco. Numbers in the parentheses are standard errors clustered at county level. * $p < .10$, ** $p < .05$, *** $p < .01$.
Data source: 2010, 2012, 2014, 2020, and 2022 CFPS.

creasing women's access to higher-wage employment, fosters greater respect and affection from their husbands.

To test this hypothesis, we use data from the 2010 wave of the Social Status Survey of Chinese Women (SSSCW). This survey includes three questions capturing distinct dimensions of marital relationship quality: (i) whether the respondent's husband has ever insulted her; (ii) whether he has ever ignored her for several consecutive days; and (iii) whether he has ever restricted her personal freedom. Each question is measured on a four-point scale, with higher values indicating worse relationship quality (1 = Never, 2 = Occasionally, 3 = Sometimes, and 4 = Often). Using these measures as dependent variables, Table 7 reports the corresponding regression results.

Since the 2010 SSSCW only includes province-level administrative codes, the key independent variable is the province-level cotton suitability index. Panel A of Table 7 shows that the coefficients on cotton suitability are significantly negative across all three regression models for the full sample of married women, indicating that higher cotton suitability is associated with a lower likelihood of experiencing disrespectful or controlling behavior from husbands.

We conduct the same analysis using subsamples of married women aged 50 and above, and aged 55 and above, presented in Panels B and C.[15] The coefficients remain negative,

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[15]Because the number of married women aged 60 and above is fewer than 400, we expand the sample to include women aged 55 and above.

Table 7: Cotton and Marital Harmony

Dep. Var.	Being Insulted	Being Ignored	Being Restricted
	(1)	(2)	(3)
Panel A: Ever-Married Women			
Cotton Suitability	−0.388**	−0.207**	−0.048*
	(0.150)	(0.094)	(0.027)
Observations	5,461	5,460	5,462
Adjusted R^2	0.050	0.034	0.005
Panel B: Ever-Married Women Aged 50 and Above			
Cotton Suitability	−0.522**	−0.286*	−0.046
	(0.234)	(0.150)	(0.038)
Observations	1,643	1,643	1,643
Adjusted R^2	0.035	0.043	0.010
Panel C: Ever-Married Women Aged 55 and Above			
Cotton Suitability	−0.518**	−0.089	−0.024
	(0.229)	(0.169)	(0.059)
Observations	1,014	1,014	1,014
Adjusted R^2	0.035	0.032	0.017
Control Var.	Y	Y	Y
Region FE	Y	Y	Y

Notes: The Social Status Survey of Chinese Women (SSSCW) provides only province-level codes. Control variables include a dummy for Han ethnicity, an indicator for being employed, age, age squared, years of schooling, number of children, log of GDP per capita at provincial level, and province-level suitability indices for rice, maize, wheat, tea, and tobacco. We classify all provinces into six regions, including Northeast, North China, East China, Central South, Southwest, and Northwest regions and control five fixed effects of these regions. Numbers in the parentheses are standard errors clustered at provincial level. * $p < .10$, ** $p < .05$, *** $p < .01$.
Data source: 2010 SSSCW.

though with lower levels of statistical significance, likely due to smaller sample sizes and the use of more aggregated (province-level) cotton suitability data. Taken together, the results in Table 7 support the hypothesis that cotton cultivation promotes more respectful and harmonious relationships between wives and husbands, which may ultimately benefit women's health as they age.

4.2.4   Older Women's Cohabitation with Children and Contribution to the Family

Extensive research shows that co-residence with adult children significantly improves the health of aging parents by increasing daily companionship and care (see, for instance, Barnay and Juin (2016) and Fang et al. (2023)). However, declining fertility rates in China have reduced the availability of such support, contributing to higher levels of stress and isolation among older adults (Chen and Fang 2021). Similarly, studies have shown that children's migration can heighten parents' feelings of loneliness and depression due to reduced caregiving and interaction (Antman 2010; Huang et al. 2016; Scheffel and Zhang 2019).

We hypothesize that cotton cultivation increases the likelihood that older women co-reside with their adult children. This hypothesis is motivated by two features of cotton production. First, as a female-labor-intensive activity, cotton cultivation allows older women to remain economically active through tasks such as cotton picking.[16] Their continued contribution to household income makes them valuable members of their children's households. Second, when daughters or daughters-in-law are engaged in cotton-related work, mothers or mothers-in-law may substitute into household chores, enabling younger women to devote more time to market work. This substitution can increase overall household income, thereby strengthening incentives for co-residence.

This hypothesis is consistent with the existing literature. For example, Sun et al. (2019) shows that mothers' labor supply increases by approximately 2.9 days per month when they live with grandparents. In this context, female-labor-intensive cotton cultivation can raise the economic value of older women within the household, increasing their likelihood of co-residing with their children and, in turn, improving their health.

We use the 2005 Census data to examine whether cotton cultivation increases the likelihood of cohabitation between older women and their adult children. The analysis pro-

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[16]Cotton cultivation is also substantially more labor-intensive than other crops, which increases the value of additional household labor. For example, Appendix Table A.13 shows that, in rural China, the average time required to cultivate one mu (approximately 0.067 hectares or 0.165 acres) of cotton is about two to two-and-a-half times that required to cultivate one mu of cereals.

ceeds in two steps. First, we construct a subsample of households that include at least one married woman aged 50 and above. Second, we construct a binary variable that equals one if the household also includes either a married child or child-in-law, indicating that the woman is co-residing with her married children, and zero otherwise. We intentionally exclude cases in which a woman lives only with an unmarried son or daughter, as it is common in rural China for unmarried adult children—who remain economically and socially dependent—to reside with their parents. Such arrangements do not reflect the mutual-support–based intergenerational cohabitation that this analysis aims to capture.

Table 8: Cotton and Older Women's Cohabitation with Children

Dep. Var.	Cohabitation		
	Aged 50 and Above (1)	Aged 55 and Above (2)	Aged 60 and Above (3)
Cotton Suitability	0.172***	0.182***	0.151***
	(0.047)	(0.052)	(0.059)
Control Var.	Y	Y	Y
Province FE	Y	Y	Y
Observations	175,414	134,080	98,880
Adjusted R^2	0.045	0.049	0.054
Mean of Dep. Var.	0.479	0.498	0.611

Notes: Control variables include share of healthy elderly at household level, share of Han ethnicity at prefecture level, and prefecture-level suitability indices for rice, maize, wheat, tea, and tobacco. Numbers in the parentheses are standard errors clustered at prefecture level. * $p < .10$, ** $p < .05$, *** $p < .01$.
Data source: 2005 Census.

Table 8 presents the estimation results, where the dependent variable indicates whether an older woman co-resides with her married children. The coefficient on cotton suitability is positive and statistically significant for women aged 50 and above, 55 and above, and 60 and above. These findings support the hypothesis that cotton cultivation increases the likelihood that older women co-reside with their adult children in rural China.

One reason older women may co-reside with their children is their contribution to household production, particularly when younger household members—especially daughters or daughters-in-law—are heavily engaged in labor-intensive cotton cultivation. By providing household labor, older women continue to contribute meaningfully to the family, which strengthens incentives for intergenerational co-residence. To examine this mechanism, we use data from the CFPS, which records whether co-residing older women engage in household chores on a daily basis. We construct a binary indicator equal to one if an

older woman reports doing housework every day, and zero otherwise.

Table 9 presents the results. The coefficients on cotton suitability are positive and statistically significant across all specifications. This indicates that cotton cultivation increases the likelihood that co-residing older women engage in daily household chores, supporting the view that they play a meaningful economic role in the family.

Table 9: Older Women's Domestic Work and Household Income

Dep. Var.	Engagement in Household Chores			Log(Household Monthly Income)		
	Aged 50+ (1)	Aged 55+ (2)	Aged 60+ (3)	Aged 50+ (4)	Aged 55+ (5)	Aged 60+ (6)
Cotton Suitability	0.202*** (0.023)	0.206*** (0.028)	0.208*** (0.045)			
Cohabitation				0.720*** (0.012)	0.771*** (0.014)	0.829*** (0.016)
Control Var.	Y	Y	Y	Y	Y	Y
Prefecture FE	Y	Y	Y			
Province FE				Y	Y	Y
Year FE	Y	Y	Y			
Observations	7,357	5,193	3,598	138,068	99,790	68,817
Adjusted R^2	0.170	0.184	0.199	0.232	0.235	0.233
Mean of Dep. Var.	0.932	0.912	0.887	6.208	6.164	6.132

Notes: Columns (1)–(3) examine older women's engagement in household chores using CFPS data. Control variables include a dummy for Han ethnicity, a dummy for health status, an indicator for employment, age, age squared, years of schooling, number of children, log household income, and county-level suitability indices for rice, maize, wheat, tea, and tobacco. Specifications include prefecture and year fixed effects. Standard errors are clustered at the county level.
Columns (4)–(6) examine log household monthly income using the 2005 Census. Control variables include the share of healthy elderly at the household level, the share of Han ethnicity at the prefecture level, and prefecture-level suitability indices for rice, maize, wheat, tea, and tobacco. Specifications include province fixed effects. Standard errors are clustered at the prefecture level.
* $p < .10$, ** $p < .05$, *** $p < .01$.

Using the 2005 Census data, we further show that co-residence is positively associated with household income. As shown in Table 9, households with at least one co-residing older woman have monthly incomes that are approximately 0.7–0.8 percent higher. This association aligns with the idea that co-residing older women provide economically valuable inputs to the household.

Finally, we acknowledge the potential concern of reverse causality in the above regressions. While our interpretation emphasizes that cotton cultivation improves older women's health by increasing co-residence with adult children, an alternative explanation is that

healthier older women are more likely to co-reside with their children in order to provide household support, whereas less healthy parents are more likely to live independently. Under this interpretation, the positive association between cotton cultivation and co-residence could reflect improvements in older women's health that facilitate co-residence, rather than co-residence itself being a mechanism through which cotton affects health.

We offer two responses to this concern. First, the alternative scenario is less plausible in the context of rural China, where formal eldercare services are limited and sons are traditionally expected to care for aging parents; as a result, parents in poorer health are typically more likely—not less likely—to live with their children. Second, our empirical specifications directly address this concern by controlling for parents' health status. Even after conditioning on elderly health, cotton suitability remains significantly associated with co-residence. This pattern suggests that our findings are not driven solely by health-based selection into co-residence and supports the interpretation that cotton cultivation increases co-residence, which may in turn benefit older parents.

4.3   Cotton and Older Men's Health

We argue that cotton cultivation enhances the economic value of female labor, leading to higher dowries, stronger household bargaining power for women, and a greater likelihood of co-residence with adult children. Through these channels, cotton cultivation can improve older women's health. A natural follow-up question is whether cotton cultivation generates similar health benefits for older men.

To address this question, we estimate the same difference-in-differences specification as in Table 1, using data on older men from the 1982, 1990, 2000, and 2010 Census waves. As shown in Table 10, the coefficients on the interaction between the cotton suitability index and the post-1989 price reform indicator are statistically insignificant. These results indicate that the cotton price reform did not lead to improvements in older men's general health in regions more suitable for cotton cultivation.

We further replicate the regressions from Table 2 using male samples from the 2014, 2016, 2018, and 2020 waves of the CLASS to examine whether cotton cultivation affects older men's physical and self-rated health. As shown in Table 11, we find no statistically significant effects of cotton cultivation on either outcome for older men.[17]

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[17]We also examine whether cotton cultivation affects older men's prevalence of chronic conditions, including diabetes, kidney disease, cervical spondylosis, osteoporosis, and chronic bronchitis, and find no statistically

Table 10: Cotton and Older Men's General Health: County-Year Panel

Dep. Var.	Proxy1^{men}	Proxy2^{men}	Proxy1^{men}	Proxy2^{men}
	(1)	(2)	(3)	(4)
Cotton Suitability × Post	0.828	0.066	0.674	0.108
	(0.755)	(0.680)	(0.792)	(0.702)
Socioeconomic Var.	N	N	Y	Y
Control Var.	Y	Y	Y	Y
County FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Observations	7,873	7,897	7,873	7,897
Adjusted R^2	0.227	0.255	0.239	0.265
Mean of Dep. Var.	50.606	38.111	50.606	38.111

Notes: The dependent variable is winsorized at the 5th and 95th percentiles. Cotton Suitability is the county-level cotton suitability index, and Post is a dummy variable which equals 1 for the years 1990, 2000, and 2010, and 0 for 1982. Control variables include share of Han ethnicity at county-year level, men's average years of schooling at county-year level, and interaction terms between county-level suitability indices of rice, maize, wheat, tea, and tobacco, along with their corresponding price indices. Socioeconomic variables include interaction term between county-level infant mortality rate in 1981 and year, interaction term between county-level log of distance to the provincial capital and year, share of girls aged 0-4 at county-year level, and log of GDP per capita at province-year level. Numbers in the parentheses are standard errors clustered at county level. * $p < .10$, ** $p < .05$, *** $p < .01$.
Data source: 1982, 1990, 2000, and 2010 Census.

Table 11: Cotton and Older Men's Health: Individual-level Survey

Dep. Var.	Chronic Diseases			Self-rated Health	
	Osteoporosis	Glaucoma	Chronic Bronchitis	Poorer Physical Health than Peers	Bad Health
	(1)	(2)	(3)	(4)	(5)
Cotton Suitability	−0.106	0.017	−0.184	0.106	−0.254
	(0.096)	(0.090)	(0.127)	(0.278)	(0.313)
Control Var.	Y	Y	Y	Y	Y
Prefecture FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
Observations	7,278	7,278	7,277	7,236	7,267
Adjusted R^2	0.055	0.023	0.034	0.091	0.123
Mean of Dep. Var.	0.052	0.043	0.080	0.220	0.211

Notes: Control variables include a dummy for Han ethnicity, a dummy for widowed status, an indicator for being employed, age, age squared, years of schooling, number of children, and county-level suitability indices for rice, maize, wheat, tea, and tobacco. Numbers in the parentheses are standard errors clustered at county level. * $p < .10$, ** $p < .05$, *** $p < .01$.
Data source: 2014–2020 CLASS.

We conduct several robustness checks analogous to those for the main results. The corresponding estimates are reported in Appendix Tables A.5, A.6, and A.7. Across all specifications, the coefficients for men remain small and statistically insignificant.

Taken together, we find no effect of cotton cultivation on older men's health. Given that in rural areas the household is typically the unit of production and income, husbands should also benefit financially from cotton planting. The limited health improvement observed among older men thus suggests that the pure income effect is not the sole channel through which cotton cultivation enhances older women's health.

5 Conclusion

Cotton cultivation generates millions of jobs for women globally, yet its broader impacts, particularly on the welfare of older women, remain insufficiently understood. This study is among the first to examine how engagement in a female-labor-intensive sector affects women's health later in life. We hypothesize that cotton cultivation increases women's access to relatively high-wage employment, strengthening their bargaining position within the household and generating long-lasting health benefits that persist into old age.

Using multiple waves of Chinese census data, we first implement a difference-in-differences strategy to identify the causal effect of cotton cultivation on older women's general health. We then complement this analysis with evidence from several nationally representative household surveys, showing that cotton cultivation significantly reduces the incidence of chronic diseases among older women and increases self-reported health.

We identify three mechanisms driving this effect. First, cotton cultivation increases dowries at marriage, enhancing women's long-term status within the household. Second, higher wage opportunities improve women's relative income and bargaining power, which translates into better nutrition, greater respect from husbands, and more egalitarian gender attitudes. Third, older women retain economic value to their children in cotton-growing regions by taking on household chores, especially when younger women are engaged in labor-intensive cotton work. This role increases the likelihood of co-residence with adult children, offering older women more care and companionship, which further supports their health. Finally, we find that cotton cultivation has only limited health benefits for older men. This suggests that the pure income effect alone cannot fully account for the

significant effects.

observed improvement in older women's health.

Beyond the Chinese context, our findings have broader policy relevance for developing economies where women's labor market opportunities remain constrained. They suggest that promoting female participation in sectors in which women have a comparative advantage can serve as a low-cost public health intervention with long-term benefits, particularly for older women who are often underserved by formal pension and health-care systems. By improving women's bargaining power and health over the life cycle, such policies may reduce later-life healthcare demand while simultaneously advancing gender equity. These insights are especially relevant for countries such as India and other developing economies facing pronounced gender disparities among post-reproductive populations, where expanding high-wage, female-labor-intensive industries may offer a sustainable pathway to improving women's long-term well-being.

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A Appendix

国务院关于调整棉花收购政策的通知

国发〔1989〕2号

各省、自治区、直辖市人民政府，国务院各部委、各直属机构：

棉花是关系国计民生的重要商品，随着纺织工业的发展、对外出口贸易的扩大和人民生活水平的提高，棉花消费量大幅度上升，当前供需缺口较大。为发展棉花生产，各主产省在国家规定的收购价格基础上，陆续实行了棉花生产扶持费。但由于标准高低不一，不利于维护正常的收购秩序和加强计划管理。鉴于棉花收购价格偏低，也需要作适当调整。为进一步调动棉农种棉积极性，确保明年棉花生产稳定发展，国务院决定调整棉花收购政策。现通知如下：

一、统一棉花生产扶持费。一九八八年度（一九八八年九月至一九八九年八月）各产棉省规定的棉花生产扶持费，统一按每五十公斤二十元计入供应价格。对棉农的结算价格，仍按各地原宣布的标准执行。高出二十元的部分，由地方财政负担。一九八九年度收购的棉花，统一按每五十公斤二十五元计入收购价和供应价。

二、实行棉花价外补贴。在统一的棉花生产扶持费基础上，一九八九年度再增加十元价外补贴，由中央财政和地方财政各负担一半。调出省外的棉花，地方财政负担的价外补贴款，由调入地区财政负担。

三、适当扩大棉花购销差价。鉴于银行贷款利率提高，包装材料、电力、燃料等费用提高，从一九八八年度起，棉花购销差价每五十公斤增加五元。

四、棉花生产扶持费和价外补贴，均在国家规定的价格基础上价外加价。按标准级皮辊棉计算，一九八九年度调整后的收购价格，由现行的每五十公斤一百七十六元四角二分提高到二百一十一元四角二分；产棉县棉花供应价格，由现行的一百七十二元提高到二百零二元。棉花供应价格提高的部分，工业用棉主要由工厂消化，民用絮棉价格相应提高。国家储备棉出库时按入库等级价格相应提高，升值部分补充国家特种储备资金。具体实施办法，由国家物价局、财政部、商业部制定。

五、保证农药供应。国家和地方政府要采取有效措施，增加农药资源。农药专营部门要专项安排，确保棉花用药。

六、为确保完成本年度棉花收购计划，上述调整棉花收购政策，请严格保密。何时宣布，由国家物价局、商业部另行通知。

各级人民政府要根据国家下达的合同定购计划，采取各种有力措施，切实抓好棉花生产。要进一步发掘宜棉地区的生产潜力，努力扩大棉田面积，提高单产，确保完成和超额完成棉花生产和收购任务。

国 务 院
一九八九年一月八日

Figure A.1: The Policy Document of Cotton Price Change

Table A.1: Cotton Price Reform and the Share of Cotton Area in Cultivated Land

Dep. Var.	Cotton Share	
	(1)	(2)
Cotton Suitability × Post	0.073***	0.010**
	(0.005)	(0.004)
Control Var.	N	Y
County FE	N	Y
Year FE	N	Y
Observations	82,179	82,179
Adjusted R^2	0.042	0.796
Mean of Dep. Var.	0.026	0.026

Notes: The dependent variable is share of cotton area in cultivated land at county-year level. Post is a dummy variable that equals 1 for years 1989–2000 and 0 for years 1971–1988. Control variables include county-level suitability indices for rice, maize, wheat, tea, and tobacco, along with their corresponding price indices. Numbers in the parentheses are standard errors clustered at county level. * $p < .10$, ** $p < .05$, *** $p < .01$.
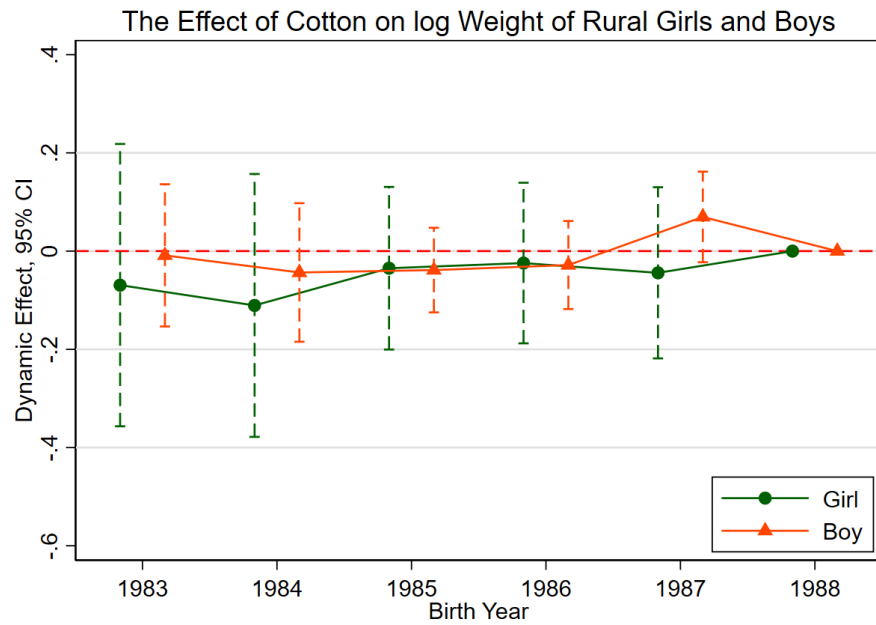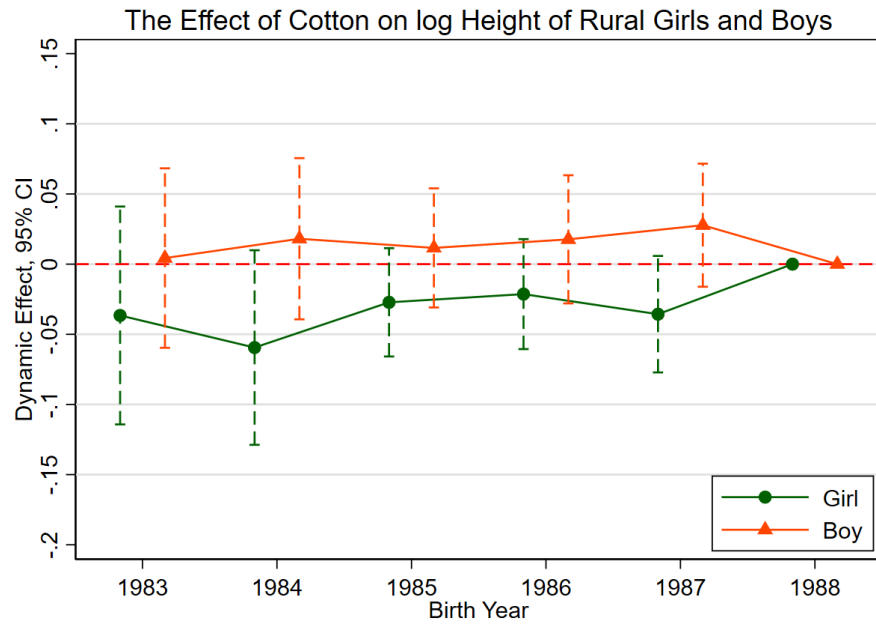
Figure A.2: Pre-trend Test

Notes: The key explanatory variables are the interaction terms between an indicator for cotton-producing provinces and birth year dummy variables. The sample period spans 1983–1988, with 1988 chosen as the base-line year. The regression controls for province fixed effects, birth-year fixed effects, province-level suitability indices for rice, maize, wheat, tea, and tobacco, along with their corresponding price indices. Standard errors are clustered at province-year level and 95% confidence intervals are reported.
Data source: 1989 CHNS.

Table A.2: Variable Definitions

Variable	Definition
General Health Conditions	
Proxy1_women	Share of women aged 60 and above in the total number of women aged 50 and above at the county–year level (%).
Proxy2_women	Share of women aged 60 and above in the total number of women aged 45 and above at the county–year level (%).
Proxy1_men	Share of men aged 60 and above in the total number of men aged 50 and above at the county–year level (%).
Proxy2_men	Share of men aged 60 and above in the total number of men aged 45 and above at the county–year level (%).
Chronic Diseases	
Osteoporosis	Whether infected by osteoporosis (yes = 1).
Glaucoma	Whether infected by glaucoma (yes = 1).
Chronic Bronchitis	Whether infected by chronic bronchitis (yes = 1).
Self-rated Health	
Poorer Physical Health than Peers	Self-rated health is worse than peers (yes = 1).
Bad Health	Self-rated health condition is not good (yes = 1).
Independent Variable	
Cotton Suitability	Cotton suitability index with irrigation as the water supply (divided by 10,000).

Table A.3: Variable Definitions (Cont.)

Variable	Definition
Women's Welfare and Bargaining Position	
Log(Dowry Value)	Value of dowry at marriage (logarithm).
Dowry	Whether a dowry was paid at marriage (yes = 1).
Fish	Whether fish was consumed in the past week (yes = 1).
Milk	Whether milk was consumed in the past week (yes = 1).
Meat	Whether meat was consumed in the past week (yes = 1).
Importance of Passing on the Family Line	Response to "How important do you think it is to carry on the family line?" (scale 1–5).
Men Prioritize Careers and Women Prioritize Families	Whether the respondent believes men prioritize careers and women prioritize families (yes = 1).
Household Chores Equally	Whether the respondent believes couples should share household chores equally (yes = 1).
Being Insulted	Frequency with which the husband has insulted the respondent (Never = 1, Occasionally = 2, Sometimes = 3, Often = 4).
Being Ignored	Frequency with which the husband has ignored the respondent for several consecutive days (Never = 1, Occasionally = 2, Sometimes = 3, Often = 4).
Being Restricted Personal Freedom	Frequency with which the husband has restricted the respondent's personal freedom (Never = 1, Occasionally = 2, Sometimes = 3, Often = 4).
Share of Wife's Income in Couple's Total Income	Share of wife's income in the combined income of wife and husband (%).
Share of Wife's Income in Total Household Income	Share of wife's income in total household income (%).
Cohabitation	Whether at least one older woman co-resides with her married children at household level (yes = 1).
Log(Household Monthly Income)	Household Monthly Income (logarithm).

Table A.4: Descriptive Statistics of Variables

Variable	Obs.	Mean	S.D.	Min	Max
Panel A: 1982, 1990, 2000, and 2010 Census					
Proxy1_women	7,891	53.697	7.299	38.636	67.417
Proxy2_women	7,917	41.037	6.842	26.786	53.846
Proxy1_men	7,873	50.606	7.299	34.615	64.925
Proxy2_men	7,897	38.111	6.535	23.529	50.000
Panel B: 2014–2020 CLASS					
Osteoporosis	13,881	0.060	0.237	0	1
Glaucoma	13,883	0.055	0.228	0	1
Chronic Bronchitis	13,885	0.076	0.265	0	1
Poorer Physical Health than Peers	13,792	0.238	0.426	0	1
Bad Health	13,853	0.240	0.427	0	1
Panel C: GAEZ v4					
Cotton Suitability	2,816	0.291	0.260	0	1
Panel D: 2010–2022 CFPS					
Log(Dowry_value)	16,566	5.104	3.633	0	13.592
Dowry	16,566	0.707	0.455	0	1
Fish	24,809	0.470	0.499	0	1
Milk	18,705	0.218	0.413	0	1
Meat	24,807	0.752	0.432	0	1
Importance of Passing on the Family Line	6,122	4.196	1.040	1	5
Household Chores	7,357	0.932	0.251	0	1
Panel E: 2010 CGSS					
Men Prioritize Careers and Women Prioritize Families	2,180	0.802	0.398	0	1
Household Chores Equally	2,176	0.741	0.438	0	1
Panel F: 2010 SSSCW					
Being Insulted	5,461	1.238	0.578	1	4
Being Ignored	5,460	1.266	0.584	1	4
Being Restricted Personal Freedom	5,462	1.026	0.205	1	4
Panel G: 2005 Census					
Share of Wife's Income in Couple's Total Income	217,645	36.215	19.418	0	100
Share of Wife's Income in Total Household Income	217,645	31.766	18.771	0	100
Cohabitation	175,414	0.479	0.500	0	1
Log(Household Monthly Income)	143,307	6.205	0.841	4.605	7.650

Table A.5: Robustness Check: High Cotton Suitability

Dep. Var.	Proxy1^{women}	Proxy2^{women}	Proxy1^{men}	Proxy2^{men}
	(1)	(2)	(3)	(4)
High Cotton Suitability $\times$ Post	1.190***	1.099***	0.166	-0.241
	(0.386)	(0.337)	(0.438)	(0.392)
Socioeconomic Var.	Y	Y	Y	Y
Control Var.	Y	Y	Y	Y
County FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Observations	7,891	7,917	7,873	7,897
Adjusted R^2	0.317	0.382	0.239	0.265
Mean of Dep. Var.	53.697	41.037	50.606	38.111

Notes: High Cotton Suitability is a dummy variable which equals one for counties with above-average suitability. Control variables include share of Han ethnicity at county-year level, women's or men's average years of schooling at county-year level, and interaction terms between county-level suitability indices of rice, maize, wheat, tea, and tobacco, along with their corresponding price indices. Socioeconomic variables include interaction term between county-level infant mortality rate in 1981 and year, interaction term between county-level log of distance to the provincial capital and year, share of girls aged 0-4 at county-year level, and log of GDP per capita at province-year level. Numbers in the parentheses are standard errors clustered at county level. * $p < .10$, ** $p < .05$, *** $p < .01$.
Data source: 1982, 1990, 2000, and 2010 Census.

Table A.6: Robustness Check: Other Age Thresholds for *Proxy*

Dep. Var.	Proxy3$^{\text{women}}$ (1)	Proxy4$^{\text{women}}$ (2)	Proxy3$^{\text{men}}$ (3)	Proxy4$^{\text{men}}$ (4)
Cotton Suitability × Post	2.268***	1.990***	1.162	0.726
	(0.670)	(0.534)	(0.744)	(0.618)
Socioeconomic Var.	Y	Y	Y	Y
Control Var.	Y	Y	Y	Y
County FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Observations	7,891	7,917	7,873	7,897
Adjusted R^2	0.402	0.435	0.326	0.323
Mean of Dep. Var.	36.074	27.562	32.250	24.261

Notes: Proxy3$^{\text{women}}$ is share of women aged 65 and above in the total number of women aged 50 and above at county-year level, and Proxy4$^{\text{women}}$ is share of women aged 65 and above in the total number of women aged 45 and above at county-year level. Proxy3$^{\text{men}}$ and Proxy4$^{\text{men}}$ are defined analogously. Control variables include share of Han ethnicity at county-year level, women's or men's average years of schooling at county-year level, and interaction terms between county-level suitability indices of rice, maize, wheat, tea, and tobacco, along with their corresponding price indices. Socioeconomic variables include interaction term between county-level infant mortality rate in 1981 and year, interaction term between county-level log of distance to the provincial capital and year, share of girls aged 0-4 at county-year level, and log of GDP per capita at province-year level. Numbers in the parentheses are standard errors clustered at county level. * $p < .10$, ** $p < .05$, *** $p < .01$. Data source: 1982, 1990, 2000, and 2010 Census.

Table A.7: Robustness Check: SE Clustered at Prefecture Level

| Dep. Var. | Proxy1^{women} | Proxy2^{women} | Proxy1^{men} | Proxy2^{men} |
	(1)	(2)	(3)	(4)
Cotton Suitability × Post	2.490**	2.201**	0.674	0.108
	(1.023)	(0.962)	(1.139)	(1.025)
Socioeconomic Var.	Y	Y	Y	Y
Control Var.	Y	Y	Y	Y
County FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Observations	7,891	7,917	7,873	7,897
Adjusted R^2	0.317	0.383	0.239	0.265
Mean of Dep. Var.	53.697	41.037	50.606	38.111

Notes: Control variables include share of Han ethnicity at county-year level, women's or men's average years of schooling at county-year level, and interaction terms between county-level suitability indices of rice, maize, wheat, tea, and tobacco, along with their corresponding price indices. Socioeconomic variables include interaction term between county-level infant mortality rate in 1981 and year, interaction term between county-level log of distance to the provincial capital and year, share of girls aged 0-4 at county-year level, and log of GDP per capita at province-year level. Numbers in the parentheses are standard errors clustered at prefecture level. * p < .10, ** p < .05, *** p < .01.
Data source: 1982, 1990, 2000, and 2010 Census.

Table A.8: Cotton and Older Women's Health: Individual-level (Probit Model)

| Dep. Var. | Chronic Diseases | | | Self-rated Health | |
| | Osteoporosis | Glaucoma | Chronic Bronchitis | Poorer Physical Health than Peers | Bad Health |
	(1)	(2)	(3)	(4)	(5)
Cotton Suitability	−0.493***	−0.425***	−0.422***	−0.574***	−0.575*
	(0.107)	(0.132)	(0.152)	(0.176)	(0.337)
Control Var.	Y	Y	Y	Y	Y
Prefecture FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
Observations	6,217	6,480	6,186	6,488	6,527
Pseudo R^2	0.120	0.097	0.091	0.116	0.136
Mean of Dep. Var.	0.073	0.070	0.076	0.260	0.275

Notes: Coefficients are marginal effects from Probit models. Control variables include a dummy for Han ethnicity, a dummy for widowed status, an indicator for being employed, age, age squared, years of schooling, number of children, and county-level suitability indices for rice, maize, wheat, tea, and tobacco. Numbers in the parentheses are standard errors clustered at county level. * p < .10, ** p < .05, *** p < .01.
Data source: 2014–2020 CLASS.

Table A.9: Cotton and Older Women's Health: Individual-level (Logit Model)

Dep. Var.	Chronic Diseases			Self-rated Health	
	Osteoporosis	Glaucoma	Chronic Bronchitis	Poorer Physical Health than Peers	Bad Health
	(1)	(2)	(3)	(4)	(5)
Cotton Suitability	−0.513***	−0.427***	−0.426***	−0.562***	−0.601*
	(0.121)	(0.155)	(0.151)	(0.174)	(0.332)
Control Var.	Y	Y	Y	Y	Y
Prefecture FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
Observations	6,217	6,480	6,186	6,488	6,527
Pseudo R^2	0.120	0.097	0.091	0.114	0.135
Mean of Dep. Var.	0.073	0.070	0.076	0.260	0.275

Notes: Coefficients are marginal effects from Logit models. Control variables include a dummy for Han ethnicity, a dummy for widowed status, an indicator for being employed, age, age squared, years of schooling, number of children, and county-level suitability indices for rice, maize, wheat, tea, and tobacco. Numbers in the parentheses are standard errors clustered at county level. * $p < .10$, ** $p < .05$, *** $p < .01$.
Data source: 2014–2020 CLASS.

Table A.10: Cotton and Older Women's Health: Individual-level (SE Clustered at Prefecture Level)

Dep. Var.	Chronic Diseases			Self-rated Health	
	Osteoporosis	Glaucoma	Chronic Bronchitis	Poorer Physical Health than Peers	Bad Health
	(1)	(2)	(3)	(4)	(5)
Cotton Suitability	−0.387***	−0.251**	−0.388***	−0.620***	−0.624**
	(0.076)	(0.124)	(0.146)	(0.181)	(0.276)
Control Var.	Y	Y	Y	Y	Y
Prefecture FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
Observations	6,603	6,605	6,608	6,556	6,586
Adjusted R^2	0.062	0.040	0.041	0.119	0.141
Mean of Dep. Var.	0.069	0.068	0.071	0.259	0.273

Notes: Control variables include a dummy for Han ethnicity, a dummy for widowed status, an indicator for being employed, age, age squared, years of schooling, number of children, and county-level suitability indices for rice, maize, wheat, tea, and tobacco. Numbers in the parentheses are standard errors clustered at prefecture level. * $p < .10$, ** $p < .05$, *** $p < .01$.
Data source: 2014–2020 CLASS.

Table A.11: Additional Analysis of Dowry and Women's Self-Rated Health

Dep. Var.	Self-rated Health					
	Married Before 1989		Married at or After 1989		Married at or After 1989, Age $\geq$ 50	
	(1)	(2)	(3)	(4)	(5)	(6)
log(Dowry Value)	0.009***		0.006***		0.012*	
	(0.003)		(0.002)		(0.007)	
Dowry		0.030*		0.043**		0.062
		(0.017)		(0.019)		(0.050)
Control Var.	Y	Y	Y	Y	Y	Y
County FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Marriage Year FE	Y	Y	Y	Y	Y	Y
Observations	5,951	5,951	6,692	6,692	784	784
Adjusted R^2	0.090	0.089	0.115	0.114	0.076	0.074
Mean of Dep. Var.	0.516	0.516	0.743	0.743	0.593	0.593

Notes: Control variables include a dummy for Han ethnicity, a dummy for widowed status, an indicator for being employed, age, age squared, years of schooling, number of children, log household income, and county-level suitability indices for rice, maize, wheat, tea, and tobacco, along with their corresponding price indices. Numbers in the parentheses are standard errors clustered at county level. * $p < .10$, ** $p < .05$, *** $p < .01$. Data source: 2014–2022 CFPS.

Table A.12: Cotton and Attitudes to Gender Roles

Dep. Var.	Importance of Continuing the Family Line (1)	Men Prioritize Careers and Women Prioritize Families (2)	Couples Should Share Household Chores Equally (3)
Panel A: Ever-Married Women			
Cotton Suitability	−1.060***	−0.375***	1.259***
	(0.215)	(0.109)	(0.297)
Observations	6,122	2,180	2,176
Adjusted R^2	0.087	0.073	0.078
Panel B: Ever-Married Women Aged 50 and Above			
Cotton Suitability	−0.983***	−0.786***	2.077***
	(0.240)	(0.293)	(0.230)
Observations	2,530	882	880
Adjusted R^2	0.107	0.062	0.110
Panel C: Ever-Married Women Aged 60 and Above			
Cotton Suitability	−0.304	−0.939**	3.313***
	(0.349)	(0.387)	(0.340)
Observations	1,284	453	452
Adjusted R^2	0.092	0.059	0.147
Control Var.	Y	Y	Y
Prefecture FE	Y	Y	Y

Notes: The 2010 CFPS asks, "Do you think it's important to carry on the family line?" Responses are scored on a scale from 1 to 5, with higher values indicating stronger belief in the importance of patrilineal continuity. The 2010 CGSS asks, "Do you agree that men should prioritize their careers and women should prioritize their families?" and "Do you agree that couples should share household chores equally?" Responses to these two questions are coded as 1 if the respondent agrees and 0 otherwise. Control variables include a dummy for Han ethnicity, an indicator for being employed, age, age squared, years of schooling, number of children, log household income, and county-level suitability indices for rice, maize, wheat, tea, and tobacco. Numbers in the parentheses are standard errors clustered at county level. * p < .10, ** p < .05, *** p < .01.
Data source: 2010 CFPS and 2010 CGSS.

Table A.13: Average Input of Standard Labor Day per Mu: Cereals versus Cotton

Year	Cereals	Cotton
1965	18.5	44.5
1975	24.2	58.8
1976	28.0	59.4
1977	25.9	59.3
1978	28.6	60.5
1979	22.7	53.9
1980	22.9	52.5
1981	20.3	50.2

Notes: This table reports the average labor input measured in standard labor days per mu for cereal crops and cotton.
Data source: *Agricultural Economic Data: 1949–1983* (*Nongye Jingji Ziliao: 1949–1983*), compiled by the Planning Department of the Ministry of Agriculture, Animal Husbandry, and Fisheries (1983).