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How Does Matching Uncertainty Affect Marital Surplus? Theory and Evidence from China

Li Han, Xinzheng Shi and Ming-ang Zhang

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HKUST Center for Economic Policy
The Hong Kong University of Science and Technology
Clear Water Bay, Kowloon, Hong Kong
T: 3469 3007 E:cep@ust.hk W: cep.hkust.edu.hk

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Authors' contact information

Li Han

Hong Kong University of Science and Technology, Hong Kong
Email: lihan@ust.hk

Xinzheng Shi

Tsinghua University, China
Email: shixzh@sem.tsinghua.edu.cn

Ming-ang Zhang

Central University of Finance and Economics, China
Email: zhangmingang@cufe.edu.cn

How Does Matching Uncertainty Affect Marital Surplus? Theory and Evidence from China *

Li Han[a], Xinzheng Shi[b], and Ming-ang Zhang[c]

[a] *Hong Kong University of Science and Technology, Hong Kong. E-mail: lihan@ust.hk*

[b] *Tsinghua University, China. E-mail: shixzh@sem.tsinghua.edu.cn*

[c] *Central University of Finance and Economics, China. E-mail: zhangmingang@cufe.edu.cn*

Abstract

Information quality affects matching and marital outcomes. We show in a simple two-dimensional matching model that a noisier cue for one trait leads to a shift in sorting tradeoff toward the other, lowers average welfare but the impact is asymmetric. To test the predictions, we explore the repeal of mandatory premarital health examinations in China. The repeal, increasing health cue noise, is found to have reduced postmarital subjective well-being mainly through a reduction in child health associated with decreased sorting by health. The deterioration was particularly strong for women and the poor, suggesting entrenched inequality by gender and wealth.

Keywords: Premarital Health Examination; Subjective Well-being; Assortative Matching; Sorting Tradeoff; Inequality.

JEL codes: J12; J13; I18.

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1 Introduction

Is ignorance in matching bliss for one's marital life? People in search of a mate often encounter information friction or noise, which reduces their ability to correctly evaluate prospective spouses and distorts their matching outcomes. Given that the production and division of marital surplus depend on the characteristics of spouses, the effect of such noise may be carried over to marriage, a practice that, in the words of Becker (1973), "is followed in some form by practically all adults in every recorded society." How does matching noise affect the overall level and distribution of welfare? The answer to this question is not straightforward, especially as the effect of noise on a particular individual characteristic can ripple through the entire market via changes in matching patterns. Understanding the welfare implications of matching noise is important in various contexts, particularly for matching in terms of health.

Health of both spouses typically complements each other in the production of marital surplus, of which the health of prospective children is a critical component. Health status is sometimes unobservable, especially in the presence of widespread infectious diseases, such as AIDS and viral hepatitis, in the developing world.[1] Thus, information cues related to health are valuable in the marriage market. This situation is the probable reason why premarital health tests featuring a variety of examination items are common in many African and Middle Eastern countries (Rennie and Mupenda, 2008).[2] Afflicted with prevalent infectious diseases, such as hepatitis B, China gradually adopted mandatory premarital health examinations (PHEs) in the mid-1980s.[3] However, concerns arose that disclosure of health information

[1]According to statistics from the American Foundation for AIDS Research, in 2019, 1.7 million people were newly infected with HIV, and 690,000 people died from AIDS-related causes; new HIV infections are increasing in countries in Central Asia, the Middle East and North Africa (see https://www.amfar.org/About-HIV-and-AIDS/Facts-and-Stats/Statistics--Worldwide/). According to a report from the World Health Organization (WHO), viral hepatitis caused 1.34 million deaths in 2015, and mortality is still increasing (WHO, 2017).

[2]See https://www.opensocietyfoundations.org/uploads/f531df52-0c99-46af-8968-8e25ab34c951/mandatory-premarital-hiv-testing-20100513.pdf.

[3]The WHO estimates that 87 million people in China (approximately 6% of the total population) are

placed people with relatively poor health at a disadvantage in mate searches and amplified inequalities in well-being. The compulsory PHE was eventually repealed in 2003, leading to increased noise in matching. However, the ensuing increase in birth defects has aroused concerns among scholars and policy-makers, prompting calls for studies to determine how this policy-induced increase in matching uncertainty affects social welfare.[4] Our paper addresses this issue theoretically and empirically.

First, we construct a simple two-dimensional transferable utility (TU) matching model in which individuals of both genders are characterized by two traits: health and socioeconomic status (SES). A sorting tradeoff is observed: a noisier health cue reduces positive sorting on health but has the opposite effect on SES. Given that parental health is complementary in producing child health, the expected health of prospective children decreases due to reduced sorting by health, and the average expected marital output declines. Moreover, the distribution of welfare loss is not balanced. The welfare deterioration effect is particularly strong in healthy people not only because expected health given a healthy cue is low but also because sorting on health decreases. Interestingly, even in cases in which health and SES are orthogonal to each other, poor people (those with lower SES) suffer more than wealthy people because increased sorting on SES is favorable to wealthy people. Another interesting prediction is that women usually suffer more from a noisier health cue than men. Notably, this prediction does not arise from asymmetric gender roles in child care. As marital payoffs in our model are assumed to be symmetric between genders, this prediction arises from the assumption of a sex-ratio imbalance. Assumed to be on the long side of the market, men receive a marital payoff that is pinned down through competition for brides, and thus, the marginal increase goes mainly to women. Therefore, women bear a larger decrease in their expected marital payoff when the expected marital surplus decreases. If women are assumed

infected with hepatitis B virus (HBV), which can cause severe liver damage (see https://www.who.int/China/health-topics/hepatitis).

[4]For example, a Chinese news report (https://www.thepaper.cn/newsDetail_forward_1527556) states that the newborn defect rate doubled within the decade after 2003, and an academician in medical science of the Chinese Academy of Sciences, Junbo Ge, urged a change in the PHE policy.

to play a primary role in child care, the welfare deterioration is even more salient for women than for men.

We test model predictions by exploiting the repeal of the compulsory PHE in China as a natural experiment. We adopt a difference-in-differences (DID) design and exploit the fact that the PHE adoption rate varied considerably among provinces before the repeal. Given that provinces with high initial adoption rates showed large drops in their PHE rates, we expect a larger effect on the marriage market in areas with higher PHE rates ex ante.

Our primary data source is drawn from the China Family Panel Survey (CFPS),[5] which contains important measures of marital utility—namely, subjective well-being (SWB) measures. SWB itself is one ultimate goal of economic development (Frey and Stutzer, 2002), and a growing economics literature uses self-reported SWB as a proxy for individual utility (Aghion et al., 2016; Allcott et al., 2020).[6] Our DID estimation shows that the repeal of mandatory PHEs resulted in a significant decrease in self-reported SWB. Specifically, a one standard deviation increase in the prereform PHE ratio results in a 5.6% decrease in self-reported life satisfaction, a 4.6% decrease in self-reported family satisfaction, and a 10.5% decrease in self-reported happiness. The significant effects are supported by a battery of tests, including the parallel trend test, consideration of confounding shocks, and a permutation test.

We then explore potential mechanisms underlying the baseline results. Consistent with our theoretical predictions, the removal of PHE significantly widened the health gap and narrowed the SES gap between couples, suggesting decreased sorting by health and increased sorting by SES. In association with changes in the sorting pattern, a deterioration in average child health is observed.

We further examine the inequality implications of the model by conducting a heterogeneity analysis of the policy effects. The SWB deterioration is found to be more salient

[5]The CFPS can be considered the Chinese analogue of the Panel Study of Income Dynamics in the US.

[6]The sufficient statistics approach is another way to measure welfare gain or loss. For example, Huang and Zhou (2015) use the sufficient statistics approach to calculate the welfare loss caused by China's one-child policy–induced marriage distortions.

among individuals with better health and lower SES and is particularly strong among women, supporting the model predictions.

Overall, our findings corroborate the theoretical analysis on the sorting tradeoff. As information noise increases, matching efficiency, reflected in overall SWB, likely decreases. At the same time, equity may not be achieved. The policy change, despite its aims to protect the less healthy group, may exacerbate inequality across different SESs. A particularly concerning finding is that a major channel for the decline in SWB is a decline in child health associated with decreased sorting by health. As the health of subsequent generations has important demographic and economic implications, this finding merits more attention of academia and policy-makers.

Related literature. This paper contributes to three strands of literature. The first is the literature on marriage matching. Following the pioneering work of Becker (1973), numerous theoretical and empirical studies examine the determinants and patterns of marriage matching. The recent development regarding multidimensional matching enables scholars to explore the relationship between positive assortative matching (PAM) and inequality (Greenwood et al., 2014; Hryshko et al., 2017; Chiappori et al., 2020b). Our paper adds to this strand of literature by modeling and providing evidence of the sorting tradeoff between health and SES. In particular, we incorporate the role of information in the analysis. Becker (1981) points out that information asymmetry can be a hurdle in marriage matching, but empirical studies on this topic remain scant (Jung and Sim, 2020). One exception is Angelucci and Bennett (2021), who show that high-frequency "opt-out" HIV testing interventions increase marriage and pregnancy probabilities by reducing information asymmetry. Our study adds to this line of literature by examining not only the matching pattern but also postmarital welfare measures.

Our paper also contributes to the literature on the role of health and health tests in the marriage market. Despite rich evidence of PAM on age, education, parental background, religion, and race,[7] sorting by health is no less important but has been less studied. Chiappori

[7]To provide an incomplete list, we mention the studies investigating PAM on age (Qian and Preston, 1993), education (Schwartz and Mare, 2005; Breen and Salazar, 2011; Greenwood et al., 2014), parental

et al. (2020a) find that spouses sort positively on health-related behaviors and attitudes. Buckles et al. (2011) find that the repeal of the premarital blood test requirement in the US has increased marriage rates and interpret the result as a response to the changed cost of marriage. In developing countries, most discussions focus on the impacts of health tests on individual behaviors and disease prevention (e.g., Petersen and White, 1990; Thornton, 2008; Ganczak, 2010; Delavande and Kohler, 2012; Wilson et al., 2014; Gong, 2015; Saffi and Howard, 2015). Only a few studies explore marriage and fertility behavior (Baird et al., 2014; Beegle et al., 2015; Angelucci and Bennett, 2021). Moreover, research on impacts on marriage matching by health is scarce despite its important implications for the health of subsequent generations. Our paper sheds light on this issue.

Finally, our findings add to evidence of the effects of public policy on SWB. SWB measures have been increasingly used as proxies for utility in evaluating public policy and events.[8] We extend this literature to policies concerning the marriage market.

The remaining part of this paper is organized as follows. Section 2 provides background information on the PHE. Section 3 describes the theoretical model. Sections 4 and 5 describe the data and empirical strategy, respectively. Section 6 presents the results, including baseline results and those from robustness checks. Section 7 explores underlying channels for the main findings, Section 8 tests for the inequality implications, and Section 9 concludes.

2 Background

The PHE in China dates back to the middle of the 1980s. A regulation called the *Method for Marriage Registration* was issued on March 15, 1986, by the Ministry of Civil Affairs (MCA) to forbid marriages of individuals with uncured leprosy or venerism and of proximity

background (Charles et al., 2013; Sun and Zhang, 2020), religion, and race (Wong, 2003; Blackwell and Lichter, 2004).

[8]For example, tax policy (Gruber and Mullainathan, 2005), political institutions (Frey and Stutzer, 2000), the Moving to Opportunity program in the US (Ludwig et al., 2012), and public events (Dolan et al., 2019; Clark et al., 2020).

of blood.[9] The requirement for the implementation was specified in the *Notice on Issues about Premarital Health Examination* issued on September 1, 1986, which delegated the responsibility to provincial governments but allowed certain autonomy on the start time.[10]

The 1985 regulation was replaced by the *Regulation on Marriage Registration* issued on February 1, 1994.[11] This regulation explicitly stipulated that eligible medical examination results were required for marriage registration after PHE implementation (see Article 9) and restated that marriage was forbidden for individuals with "diseases not suitable for marriage" (see Article 13), referring to the *Marriage Law of the People's Republic of China* issued in 1981 (Article 6).[12] Nonmarriageable diseases, specified later in the *Guidance for Premarital Health Examination*,[13] included severe genetic diseases, infectious diseases such as HIV, clap, leprosy and others affecting fertility, neuropathy, and diseases of vital organs.[14]

The PHE became compulsory nationwide in 1995, mandated in the *Law on Maternal and Infant Health Care*.[15] A standard PHE checklist starts with doctor inquiries about hereditary illness and problems that might jeopardize parenting abilities, such as learning disorders and psychiatric problems, and proceeds with not only routine examinations on height, weight, and blood pressure but also fairly comprehensive blood and laboratory tests. The blood tests usually include a full blood count, liver function tests, and testing for hepatitis B surface antigen. Laboratory examinations are carried out for gonococcus and sometimes trichomonads and chlamydia. Chest radiography is sometimes obtained, and abdominal ultrasonography is performed. Then, couples receive hour-long premarital health instructions. Upon receiving the examination results, couples meeting the requirements are issued a certificate of health for marriage. In other instances, marriage must be postponed to allow for some form of treatment or counseling. Couples with severe psychiatric diseases

[9] The file (in Chinese) can be found at http://www.law-lib.com/law/law_view.asp?id=47231.

[10] The file (in Chinese) can be found at https://China.findlaw.cn/fagui/p_1/109794.html.

[11] The file (in Chinese) can be found at http://www.law-lib.com/law/law_view.asp?id=10181.

[12] The file (in Chinese) can be found at http://www.law-lib.com/law/law_view.asp?id=44312.

[13] The guidance was issued by the Ministry of Health on July 31, 1997.

[14] The file (in Chinese) can be found at http://www.law-lib.com/law/law_view.asp?id=13410.

[15] It was enacted on June 1, 1995, by the China State Council. The file (in Chinese) can be found at http://www.law-lib.com/law/law_view.asp?id=547.

or with low intelligence must agree to receive permanent contraception. Some people, even those who receive certificates, may opt not to marry after learning more about each other's health status.

The PHE was unappealing to many couples because of its associated cost. Apart from the cost of undergoing examinations, the PHE involves nontrivial time and transportation costs.[16] Approximately 54.2% of respondents in a survey conducted in Beijing cited the associated hassle as their reason for not taking the PHE.[17] The psychological cost weighs heavily on people unwilling to have their illness revealed (Sun, 2006; Buckles et al., 2011).[18] More than half of respondents in a survey conducted in Shanghai reported that they would refuse a PHE for fear of being discovered to be sick.[19]

More importantly, the compulsory and comprehensive nature of the PHE stirred ethical concerns. There were criticisms that the PHE weakened the protection of the basic rights of less healthy people and entrenched their disadvantage. In response, the State Council lifted the requirement of qualified medical examination results for marriage registration in a new version of the *Regulation on Marriage Registration*, which was enacted on October 1, 2003.[20] As shown in Figure 1, the PHE rate plummeted from 68% in 2002 to a mere 2.7% in 2004 and remained low until approximately 2008. An upswing in birth defects after the repeal caught the attention of the media and aroused concerns that the repeal of the compulsory PHE conflicted with the spirit of the *Law on Maternal and Infant Health Care*.[21] Some local

[16] The PHE fee differs in different places. According to reports in 2006 and 2007, it usually cost a couple 200 to 400 RMB yuan (approximately 30 to 50 USD) to complete the PHE. This cost is nontrivial given that the monthly household income per capita was approximately 100 USD in 2005. See https://www.cctv.com/law/20060221/100657.shtml,http://www.hainan.gov.cn/zxtadata-2006.html and http://idg.timedg.com/p/7267.html.

[17] See http://news.sina.com.cn/o/2005-03-05/08175272366s.shtml.

[18] See http://www.xinhuanet.com/mrdx/2016-09/17/c_135692125.htm and http://www.cpwnews.com/content-26-3141-1.html.

[19] See http://news.sina.com.cn/s/2004-09-30/01473805427s.shtml.

[20] The file (in Chinese) can be found at http://www.law-lib.com/law/law_view.asp?id=79072.

[21] Some evidence from the media shows that the annual growth in the ratio of infants with defects grew from 0.04 percentage points between 1996 and 2002 to 0.08 percentage points between 2003 and 2007 (see the article (in Chinese) at http://zqb.cyol.com/html/2014-09/30/nw.D110000zgqnb_20140930_3-07.htm).

governments started to provide incentives for new couples to take the PHE in 2008, which may explain the modest increase in the PHE rate after 2008 (Zhou et al., 2015).

The impact of the PHE repeal varied widely among provinces because the pre-2003 PHE adoption rates differed greatly. Our data show that in 2002, PHE rates were above 90% in Beijing and Shanghai and below 50% in poor provinces such as Qinghai, Henan, and Shanxi.[22] Zhou et al. (2015) show that the average PHE rates between 1995 and 2002 in the east, middle, west and northeast of China were 72.6%, 42.9%, 58% and 77%, respectively. Figure 2 plots the provincial reduction in PHE rates between the 2004-2007 average and 2002 against the rates in 2002. Except for the dot corresponding to Tibet, most of the dots lie around the 45-degree line, showing that provinces with PHE rates one percentage point higher before 2003 show reductions of almost the same magnitude after the repeal.

3 A TU Model of the Marriage Market

In this section, we first set up a basic model and then analyze how a change in the life of the compulsory PHE affects the equilibrium outcome.

3.1 Model Setup

Our TU model characterizes a marriage market in which an individual has two observable traits: a health marker s and socioeconomic status (SES). There are two health marker groups denoted by $s \in \{0, 1\}$, where $s = 0$ and $s = 1$ denote the low and high groups, respectively. Observable health markers signal cues of one's true health status h, i.e., $s = h$ with probability θ, $\frac{1}{2} \leq \theta \leq 1$; $h = 1$ if one is healthy, and $h = 0$ if not. Note that the health marker is uninformative when $\theta = \frac{1}{2}$ and fully informative when $\theta = 1$. The higher θ is, the more precise the health marker s is in measuring health. In our empirical context, a PHE can reveal information on one's health. The θ value is thus higher before the repeal of the PHE requirement, all else equal.

[22] The only available data that we have on provincial-level PHE rates start from 2002.

For simplicity of illustration, we deal with the case where each gender is evenly divided into two marker groups and two SES groups and assume that the health marker is independent of SES. The number of men with a high marker ($s = 1$) and men with a low marker ($s = 0$) is normalized to 1, and the number of women with a high marker ($s = 1$) and those with a low marker ($s = 0$) is μ, where $\mu < 1$ due to the sex imbalance. Notably, the female-to-male ratio μ is set to be identical for the two marker groups. Each gender marker group is evenly divided into two SES subgroups (denoted r and p), where r denotes the rich subgroup and p denotes the poor subgroup. We denote as m^i and f^j the SES of type i men and type j women, respectively, where $i, j \in \{r, p\}$; $m^r > m^p > 0$; $f^r > f^p > 0$. Our setup is generalizable to the more complicated case where people are classified into more groups according to their percentiles in the distribution of traits. Nevertheless, the intuition is the same.

Given the setup described above, each gender can be classified into four types based on the observable marker s and SES: the high-rich type ($1r$), the high-poor type ($1p$), the low-rich type ($0r$), and the low-poor type ($0p$). We make the following technical assumptions:

ASSUMPTION 1. $\frac{3}{4} < \mu < 1$.

This technical assumption is adopted to help us specify the equilibrium matching and marital output allocation schemes. $\mu < 1$ ensures that women are in short supply in the marriage market. $\mu > \frac{3}{4}$ ensures that there are sufficiently numerous women; that is, three types of men combined are not enough to marry all the women.[23]

The assumption $\mu < 1$ is motivated by the empirical finding that fecund women are in relative scarcity in the marriage market, although the sex ratio at birth is more balanced. Siow (1998) discusses the implication of the fact that women's fertile period is shorter than men's. That is, in monogamous societies with divorce and remarriage, fecund women are relatively scarce. Moreover, most developing countries suffer from the "missing women"

[23]The number of men is two and is divided evenly into four groups. The number of women is 2μ and divided into four groups as well. Therefore, $\frac{1}{2} + \frac{1}{2} + \frac{1}{2} < 2\mu$, which means $\mu > \frac{3}{4}$. This ensures that three types of men are not enough to marry all the women.

problem. Technically, our main results still hold even if we relax the assumption of $\mu < 1$.

Marital matching is performed based on observable characteristics, marker s and SES. An individual potentially derives his or her utility from two aspects of marital output: his or her child's health status and nonhealth marital output. A child's health status is determined by the husband's and the wife's health. We use superscripts τ and x to label Mr. i's health and SES, respectively, and use κ and y to label Ms. j's health and SES, respectively. If Mr. i marries Ms. j, their utility can be written as follows.

$$\begin{aligned} u^{i,j} &= q(h^\tau, h^\kappa) g^{xy} \\ v^{i,j} &= q(h^\tau, h^\kappa) b^{xy} \end{aligned}$$

where the prospective child's health status $q(h^\tau, h^\kappa)$ is a public good in the marriage between Mr. i and Ms. j. g^{xy} and b^{xy} denote the share of nonchild marital output allocated to the groom, Mr. i, and the bride, Ms. j, respectively, with

$$g^{xy} + b^{xy} = t(m^x, f^y) \tag{1}$$

where $t(\cdot, \cdot)$ is the nonchild marital output produced from the SES of the couple. Following Chiappori et al. (2012), we adopt the multiplicatively separable form of the marital output function so that equilibrium exists.

In our notation, a single person is written as being matched with ϕ, the empty set. In the absence of out-of-wedlock birth or adoption, a single man i or a single woman j only derives utility $t(m^x, f^\phi)$ or $t(m^\phi, f^y)$, respectively. We normalize the utility of the remaining single person to 0, that is, $t(m^\phi, .) = 0$ and $t(., f^\phi) = 0$.

ASSUMPTION 2. For any $x, y \in \{r, p, \phi\}$, $t(m^x, f^y)$ is increasing in both m^x and f^y. For any $x, x', y, y' \in \{r, p, \phi\}$ with $m^x > m^{x'}, f^y > f^{y'}$, $t(m^x, f^y) + t(m^{x'}, f^{y'}) > t(m^x, f^{y'}) + t(m^{x'}, f^y)$ and $[t(m^r, f^r) - t(m^r, f^p)]/t(m^r, f^p) > [t(m^r, f^p)) - t(m^p, t^p)]/t(m^p, f^p))$.

It is conventional to assume that both men and women can be ranked by SES, which is complementary (or supermodular) in producing marital output. The complementarity property can be rationalized by increasing returns in the household production function or household public goods (e.g., Weiss, 1997; Lam, 1988; Iyigun and Walsh, 2007; Chiappori et al., 2009; Banerjee et al., 2013; Weiss et al., 2018).

ASSUMPTION 3. For any $\tau, \kappa \in \{0, 1\}$, $q(h^\tau, h^\kappa)$ is increasing in both h^τ and h^κ. For any $\tau, \tau', \kappa, \kappa' \in \{0, 1\}$ with $h^\tau > h^{\tau'}, h^\kappa > h^{\kappa'}$, $q(h^\tau, h^\kappa) + q(h^{\tau'}, h^{\kappa'}) > q(h^\tau, h^{\kappa'}) + q(h^{\tau'}, h^\kappa)$.

For the ease of calculation, we assume without loss of generality that $q(h^\tau, h^\kappa) = h^\tau h^\kappa$. Note that health status h is unobservable. Men and women match on the observable marker s and SES ω and derive their expected utility $Eu^{i,j}$ and $Ev^{i,j}$ from the matching.

3.2 Equilibria

DEFINITION 1. Suppose man i receives expected payoff Eu_i^* and woman j receives payoff Ev_j^* from a match and that F_{ij}^* (G_{ij}^*) is the measure of type i men (type j women) who are married to type j women (type i men). It is a marriage market equilibrium (core) if the following three conditions are satisfied for all i and j:

1. $Eu_i^* \geq t(m^i, f^\phi)$ and $Ev_j^* \geq t(m^\phi, f^j)$.
2. $Eu_i^* + Ev_j^* \geq Eu^{i,j} + Ev^{i,j}$, for any i, j.
3. $F_{i,j}^* = G_{i,j}^*$, for any $i, j \in \{1r, 1p, 0r, 0p\}$.

The first condition requires that everyone cannot be worse off than they would be from remaining single. The second condition requires that the equilibrium cannot be blocked by a deviating individual (couple); that is, the equilibrium must be stable. The third condition requires that the measure of married men and women be equal in each marriage category, implying that the market clears.

Lemma 1. *In each marker–SES–gender group, all individuals have the same expected utility in equilibrium.*

Proof. See the proof in Appendix A.1. □

If there are two identical individuals obtaining different equilibrium expected utilities, the one receiving the higher expected utility must be married. The one who receives the lower expected utility can always outbid the individual who receives higher expected utility by slightly increasing the transfer to the high-utility person's spouse without making himself (or herself) worse off. Therefore, we can simplify our analysis by focusing on the types of individuals instead of on the individuals themselves.

Lemma 2. *In equilibrium, the set of single persons must include some low-poor men but must never include a woman or a high-rich man.*

Proof. See the proof in Appendix A.1. □

Because the female-to-male ratio $\mu < 1$, some men must be single in equilibrium. The complementarity in nonchild marital output production ensures that all women and all high-rich men (type $1r$) are married in any equilibrium. Given our assumption that type 0 men are sufficiently numerous, in any equilibrium, at least some of the low-poor men (type $0p$) must remain single.

We first define the total expected marital output (or utility) matrix: $\mathbf{U} = [EU_{i,j}]$, where $EU_{i,j} = Eu^{i,j} + Ev^{i,j}$ represents the total marital output of a couple consisting of a groom of type i and a bride of type j, with i and $j \in \{1r, 1p, 0r, 0p\}$. Given lemmas 1 and 2, in any equilibrium, all low-poor men obtain $t(m^p, f^\phi)$—their reservation utility from remaining single. Given condition 2 of Definition 1 and Lemma 1, all brides of type j must receive an expected equilibrium payoff of no less than $EU_{0p,j} - t(m^p, f^\phi)$, which is higher than their reservation utility from remaining single given the complementarity assumption. Because women are on the short side of the market, their effective reservation utility is associated not with remaining single but with marrying low-poor men.

Given assumptions 1 to 3, our lemmas indicate that any equilibrium outcome systematically favors women. Specifically, low-poor men receive their reservation utility in any equilibrium. Given assumption 1 and lemma 1, some low-poor men marry, and hence, low-poor men specify the equilibrium utility for all men. The following propositions show how the expected utility, expected health of children and the marriage matching pattern in equilibrium respond to changes in the precision of health markers θ.

Our Proposition 1 compares how this equilibrium matching pattern responds to changes in the health marker precision θ.

PROPOSITION 1. *If the health marker sends a noisier cue of the health status, that is, if θ decreases, there tends to be more marital sorting based on SES and less sorting on the health marker.*

Proof. See the proof in Appendix A.2. □

Changes in the matching pattern are illustrated in Figure 3, with Φ_1 and Φ_2 denoting two thresholds for θ, where $\frac{\Phi_1}{1-\Phi_1} = \frac{t(m^r,f^r)-t(m^r,f^p)}{t(m^r,f^p)-t(m^p,f^p)}$ and $\frac{\Phi_2}{1-\Phi_2} = \frac{t(m^r,f^p)}{t(m^p,f^p)}$. When $\theta > \Phi_1$, the marginal contribution of a type $1p$ spouse to the marriage with a type $1r$ individual outweighs that of a type $0r$ spouse. Positive sorting on the health marker dominates sorting on SES. For all types, the ranking of preferences over a potential spouse's type is $1r > 1p > 0r > 0p$. In the case of $\Phi_2 < \theta \leq \Phi_1$, the health marker is noisier. For a type $1r$ individual, the marginal contribution of a type $1p$ spouse is outweighed by that of a type $0r$ spouse, whereas for a type $1p$ individual, the marginal contribution of a type $1p$ spouse still outweighs that of a type $0r$ spouse.

When θ is extremely small, that is, $\theta < \Phi_2$, the health cue is too noisy to be used for marital sorting. Sorting on SES dominates sorting on the health marker. The two-dimensional matching effectively reduces to matching on SES. Consequently, the range of matching across the health marker is fairly large.

PROPOSITION 2. *If the health marker sends a noisier cue of the health status, that is, if θ decreases, the expected health status of the child decreases.*

Proof. See the proof in Appendix A.2. □

The relationship between the precision of the health marker θ and the expected child health $Eq*$ can be illustrated in Figure 4. The intuition of Proposition 2 is straightforward.

First, the noisier the health cue is (the smaller θ is), the worse the expected child health is for type 1–type 1 couples. While the expected child health of mixed-marker couples would be higher, the complementarity of parental health in producing child health dictates that the average expected child health would decrease. Second, when θ decreases to a level below Φ_1, sorting on the health marker decreases, as shown in Figure 3. A decrease in the size of same-maker matching leads to a discrete drop in the average expected child health.

As θ decreases, matching efficiency decreases, and the overall expected utility of married couples decreases. When θ is sufficiently large, sorting on the health marker dominates sorting on SES, while a lower θ reduces average child health and the expected utility of couples. As θ further decreases, sorting on the health marker further decreases, as does the expected utility of couples. The pattern of average marital output is illustrated in Figure 5.

PROPOSITION 3. *When the precision of the health marker θ decreases, the expected equilibrium marital output generally decreases.*

Proof. See the proof in Appendix A.2. □

As θ decreases, the overall expected utility decreases, but the impacts are asymmetric between types and genders. We have the following proposition on inequality.

PROPOSITION 4. *When the precision of the health marker θ decreases, (1) the expected utility gap between type 1 and type 0 individuals shrinks, (2) the expected utility gap between the rich and the poor likely widens, and (3) women's expected utility on average decreases more than men's.*

Proof. See the proof in Appendix A.2. □

Proposition 4(1) is intuitive. As the health cue becomes noisier, individuals with high health markers lose their advantage in the marriage market, and their expected utility decreases to a higher degree than that of their counterparts with low health markers. Therefore, the expected utility gap shrinks.

The prediction in Proposition 4(2) arises when the sorting tradeoff shifts toward sorting on SES. As positive sorting on SES increases, the poor are less likely to marry the rich. The utility gap between the rich and poor is likely entrenched.

Proposition 4(3) holds even if we assume that males and females have symmetric roles in producing child health and monetary marital output. This result arises from the sex imbalance and assortative matching. Given the assumption of the sex ratio imbalance and lemmas 1 and 2, women tend to marry up or within the same type. The share of marital surplus obtained by women can be considered the "price" bid by men. As θ decreases, the "price" bid for type 0 women is higher than the share that remains with men, whereas the bid for type 1 women is lower. Owing to complementarity, overall, the male–female expected utility gap becomes narrower.

In our empirical context, the initial state in the presence of the mandatory PHE is likely to be the same as that in cases 1 or 2 in our model ($\theta > \Phi_1$ or $\theta > \Phi_2$). The removal of the PHE reduces θ. The decrease is particularly large in areas where PHEs have been widely adopted. Thus, according to the propositions above, we would expect to see larger changes in well-being, children's health and matching patterns in those areas than in areas with a low level of prior PHE intensity. Therefore, we can test the following hypotheses.

Hypothesis 1. *Married individuals would on average experience a larger decrease in SWB after the removal of the PHE in areas with more prevalent PHE use ex ante than those in areas where the PHE was less used.*

We also test channels through which utility decreases. Propositions 1 and 2 lead to the following corresponding hypotheses.

Hypothesis 2. *Child health on average tends to decline more after the removal of the PHE in areas with a higher ex ante PHE prevalence than in areas where the PHE was less prevalent.*

Hypothesis 3. *Areas with high prior prevalence of the PHE see more marital sorting on SES and less sorting on the health marker after the removal of the PHE than areas where the PHE was less prevalent.*

Proposition 4 generates the following predictions on inequality.

Hypothesis 4. *The decrease in subjective well-being is larger for the relatively healthy than for the relatively unhealthy, for the poor than for the rich and for women than for men.*

4 Data

To test the aforementioned hypotheses, we combine individual- with provincial-level data from China.

We obtain the individual-level data from the China Family Panel Survey (CFPS)—a biennial panel survey launched in 2010 by the Institute of Social Science Survey at Peking University. Using an implicitly stratified multistage sampling method, the CFPS covers 25 out of 31 provinces in China.[24] It contains rich information on individual economic and noneconomic conditions. The baseline survey included 33,600 adults and 8,990 children from 14,960 families. The follow-up surveys not only traced the baseline respondents but also included newly formed families in the sample.[25] We use data mainly from the 2014 wave because more comprehensive information on individual SWB was collected in this wave than in other waves. In addition, we use the information from waves 2010 and 2012 to impute missing data on time-invariant individual characteristics in the 2014 wave.

We focus our main analysis on the rural sample. The reason is that PHEs likely play a more important role in rural areas, where infectious diseases and birth defects are more prevalent than in urban areas.[26] We define rural residents as those whose *hukou* (household

[24] Ningxia, Inner Mongolia, Qinghai, Hainan, Xinjiang and Tibet are not covered. Since Tibet is not covered in the sample, we do not need to worry about this outlier, as shown in Figure 2.

[25] See http://www.isss.pku.edu.cn/cfps/en/index.htm for more information on the CFPS.

[26] Wang et al. (2019) document that the prevalence rates of HBV are 3.29% and 5.86% among urban and rural people, respectively. Besides, data from National Disease Surveillance Points show that the average rate of birth malformation was higher in rural areas (1.24%) than in urban areas (0.79%) from 1991 to 1995. In addition, the Report on China Birth Defect Prevention (2012) shows that the infant mortality rate due to birth defects was 4.3‰ in rural areas but 3‰ in urban areas in 2000. In the same year, maternal mortality was 0.7‰ in rural areas and 0.3‰ in urban areas, and the mortality rate of children under age 5 was 45.7‰ in rural areas and 13.8‰ in urban areas (*China Health Statistic Yearbook*, 2001).

registration) status is rural at the survey time and at age 12 to mitigate concerns regarding sample selection due to *hukou* changes. We keep individuals who registered for marriage between 1995 and 2007, including those who divorced during this period. As the repeal of the mandatory PHE occurred in October 2003, it is difficult to determine whether couples who married in 2003 were affected. Thus, we exclude these couples from our sample. Given that we have no information on provinces where individuals registered for marriage, we keep only individuals who had never migrated across provinces after age 12.[27] We end up with 2,777 individuals as our main analysis sample. We further construct an urban sample based on the same criterion to use in our robustness checks.

The CFPS contains information that can be used to construct three measures of SWB. The first one is *life satisfaction*, constructed from the question "How satisfied are you with your life?" The answer has a value ranging from 1 (very unsatisfied) to 5 (very satisfied). The second one is *satisfaction with family*, constructed from the survey question that "How satisfied are you with your family?" This answer also takes a value from 1 (very unsatisfied) to 5 (very satisfied). The third one is *happiness*, constructed from the question "How happy do you think you are?" The self-rating scores range from 0 (lowest level of happiness) to 10 (highest level of happiness). We directly use the answers to the three questions to construct the SWB measures.[28]

We draw provincial-level information from various sources. First, the PHE rate, defined as the share of PHE takers among newly married individuals in 2002, is taken from the *China Health Statistical Yearbook* (2003). We use the PHE rate to measure preabolition exposure to PHE in each province. We collect other provincial-level economic and demographic characteristics in 2002 from the *China Statistical Yearbook* (2003), including GDP per capita,

[27]Only 164 individuals had cross-province migration experience (accounting for approximately 5.6% of the sample).

[28]One concern is that self-reported SWB scores are not comparable across individuals, as self-reported measures are affected by other idiosyncratic factors such as the interpretation of the response categories (Kahneman and Krueger, 2006). However, as Kahneman (1999) points out, this issue is less problematic in a practical sense when we compare two groups consisting of many individuals, in which case the reporting bias is likely to be trivial (Di Tella and MacCulloch, 2005; Kahneman and Krueger, 2006).

consumption per capita, fiscal revenue, share of the primary and secondary industries in GDP, sex ratio, population, number of doctors per 10,000 people, and number of health institutes per 10,000 people.

We present the summary statistics of major variables in our paper in Table 1, in which Panel A contains the details for the individual-level variables and Panel B those for the province-level variables. We do not describe the details of Table 1 here because of space limitations.

5 Empirical Strategy

We exploit the DID strategy to estimate the causal effect of the repeal of the mandatory PHE on SWB. We combine two dimensions of variation. The first is the change between the pre- and post-PHE repeal periods. Specifically, we compare individuals who married before 2003 with those who married after 2003 (we drop individuals who married in 2003 to avoid the mixture of effects). The second source of variation comes from the different provincial PHE rates measured in 2002, one year before the policy change. The higher the PHE rate in 2002, the greater is the reduction in the precision of information cues, and hence, the more salient the impact is expected to be. To this end, we estimate the following equation:

$$y_{ipt} = \beta \times PheRate_{p,2002} \times Post2003_t + \psi_{p,2002} \times Post2003_t + \delta_p + \phi_t + \epsilon_{ipt}. \quad (2)$$

In Equation (2), i denotes the individual, p the province, and t the year of marriage. y_{ipt} is a set of outcome variables, including *life satisfaction*, *satisfaction with family*, and *happiness*. $PheRate_{p,2002}$ is the PHE rate in 2002 in province p. $Post2003_t$ is a dummy variable, where a value of 1 indicates individuals who married after 2003 and 0 those who married before 2003. δ_p and ϕ_t are province and marriage-year fixed effects, respectively, with which we control for province-specific time-invariant variables and time-specific variables. We do not separately include $PheRate_{p,2002}$ and $Post2003_t$ because they are absorbed by δ_p and ϕ_t, respectively. Note that the marriage-year fixed effects also absorb the marriage-duration fixed effect since our sample is cross-sectional data from 2014. $\psi_{p,2002}$ is a set of province-level variables measured in 2002. As $\psi_{p,2002}$ is time invariant, we therefore include $\psi_{p,2002} \times Post2003_t$ in the regression. The rationale for doing so is discussed in detail below. β is the parameter of the most interest and captures the DID effects of the repeal of the PHE requirement on SWB. To deal with heteroskedasticity and serial correlation within provinces and across provinces within a marriage year, we calculate the standard errors by two-way clustering over province and marriage year. We calculate standard errors using different clustering methods as a robustness check (see Section 6.2).

There are several concerns about the validity of our DID strategy. First, the PHE rate in 2002 was not randomly distributed across provinces. Thus, it could have been correlated with other provincial variables in 2002. If these variables drove changes in our outcome variables between the pre- and post-PHE repeal periods, our estimates could be biased. To address this issue, we control for a set of predetermined province-level variables measured in 2002, $\psi_{p,2002}$ (interacted with $Post2003_t$). These variables include GDP per capita, consumption per capita, fiscal revenue, total population (the variables above are all in the logarithm form), share of the primary and secondary industries in GDP, sex ratio, number of doctors per 10,000 people, and number of health institutes per 10,000 people.

Second, the assumption on which any valid DID is predicated is that there would have been no differential time trends in the outcome variables for provinces with different PHE rates in 2002 in the absence of the policy change. We test whether this assumption holds in Section 6.2.

A third concern lies in the selection issue. The PHE repeal might have induced individuals who would not have married before the policy change to marry. If these individuals initially tended to have higher (lower) SWB, our estimates would be downward (upward) biased. To address this issue, we first investigate the impact of the PHE repeal on the provincial marriage rate. The results are shown in Table 2, from which we can see that there was not a significant effect of the repeal of the PHE on marriage rate. Then, in the spirit of the balance test used in regression discontinuity designs (Lee and Lemieux, 2010), we check whether individual-level predetermined characteristics show systematic differences between the pre- and postreform periods across provinces. Specifically, we estimate Equation (2) but replace the outcome variable with individuals' predetermined characteristics, including the individual's parents' education and own education, the number of siblings, a minority dummy, and the logarithm of the number of weeks not living with parents before age 12. The results are shown in Table 3. No coefficients are significant, providing evidence that individuals' predetermined characteristics showed no systematic differences before and after the policy change and among provinces. [29]

Fourth, some concurrent events occurring in the same period could be correlated with the PHE and affect the change in SWB. Three events—China's WTO entry in 2001, a college enrollment expansion after 1999 and the SARS outbreak in 2003—stand out. In Section 6.2, we show that our estimates are not driven by these three events.

In addition, we conduct other robustness checks, such as permutation tests, using different specifications and different samples to reinforce our main findings (see Section 6.2).

6 Main Results

6.1 Baseline Results: Deteriorating SWB

In Table 4, we report the baseline results. In all columns, we include controls for provincial variables at their 2002 values (interacted with the post dummy) and province and marriage-year fixed effects. The dependent variables in Columns (1) to (3) are *life satisfaction*, *family satisfaction*, and *happiness*, respectively. They are defined in Section 4.

The coefficient of $PheRate_{p,2002} \times Post2003_t$ is statistically significant in all three columns at a 1% significance level. It is equal to -1.160 for *life satisfaction* (Column (1)), -0.986 for *family satisfaction* (Column (2)), and -4.318 for *happiness* (Column (3)). Regarding the

[29]To supplement these results, we use the 2005 population minicensus data to conduct a similar test. The 2005 population minicensus was conducted by China's National Bureau of Statistics, covering 1% of the total population. We have access to a 20% subsample of these survey data. The results in Appendix Table A1 show that the individuals' characteristics are balanced in the larger sample as well. Owing to the data limitations, we can check only the individual's own education, number of siblings, and minority status when the population census data are used.

magnitude, in comparison with the average values of the outcome variables (approximately 3.753 for *life satisfaction*, 3.851 for *family satisfaction*, and 7.434 for *happiness*), a one-standard-deviation increase (approximately 0.18) in the PHE ratio in 2002 results in a 5.6% decrease in *life satisfaction* (the product of 0.18 and -1.160, divided by 3.753), a 4.6% decrease in *family satisfaction* (the product of 0.18 and -0.986, divided by 3.851), and a 10.5% decrease in *happiness* (the product of 0.18 and -4.318, divided by 7.434).

In summary, the repeal of the mandatory PHE significantly lowered the SWB of affected individuals. It is consistent with Hypothesis 1 that individuals experienced a larger decrease in mental utility after the removal of the PHE in areas with higher use of the PHE before the policy change.

6.2 Robustness Checks

In this section, we conduct a battery of robustness checks to justify our main findings.

Existence of Parallel Trends. The assumption that must hold for the DID strategy to be valid is that the time trends of the outcome variables should be the same across provinces in the absence of the policy change. To test this assumption, we estimate the following equation:

$$y_{ipt} = \sum_{t=1995}^{2007} \beta_t \times PheRate_{p,2002} \times Year_t + \psi_{p,2002} \times Post2003_t + \delta_p + \phi_t + \epsilon_{ipt} \qquad (3)$$

where $Year_t$ is a dummy variable equal to 1 for marriage year t. The other variables remain the same as in Equation (2). We set the cohort married in 2002 as the benchmark, and therefore, β_t captures the difference in outcomes in marriage cohort t in comparison with those of marriage cohort 2002 across provinces. We report the regression results in Table 5. For all three outcome variables, except for one coefficient (which is marginally significant at the 10% level), all other coefficients of the interaction term $PheRate_{p,2002} \times Year_t$ are insignificant before 2002, and the magnitudes are also small, confirming the existence of parallel trends.

Confounding Events. Another condition for the validity of DID is that no other concurrent events are correlated with the PHE in 2002 and affect the outcome variables at the same time. Three events occurring during this period, i.e., China's entry into the WTO in 2001, the college admission expansion after 1999 and the SARS outbreak in 2002, stand out. Furthermore, some other time-varying shocks beyond the province level may have affected the PHE and the outcome variables at the same time. We investigate whether these events drive our main results.

First, after China entered the WTO in 2001, the domestic market faced more competition from the inflow of foreign products because of reduced import tariffs (Brandt et al., 2017). Provinces with lower PHE rates in 2002 could be less economically developed and therefore more likely to be impacted by an increase in foreign competition. If more competition reduces individuals' SWB, China's entry into the WTO could lead to downward bias in our estimates. Second, starting in 1999, China expanded college enrollment; therefore, the number of college graduates increased dramatically in 2002 (college takes at least three years), and the increase in college graduates in the labor market might have driven down wages (Li et al., 2017). Moreover, college admission could expand more in provinces with higher PHE rates. If lower wages are linked to a lower SWB, then our estimates would be upward biased. Finally, SARS broke out in China in 2002, and provinces with higher PHE rates may have suffered less. If SARS lowered individuals' SWB, then our estimates could be underestimated.

To determine whether these three events drive our main results, we include in the regression the logarithm of total trade value (i.e., exports plus imports), logarithm of the number of college graduates, and logarithm of the number of SARS-infected persons[30] of each province in 2002 (interacted with a post-2003 dummy).[31] The estimation results are reported in Panel A of Table 6. We can see that the main results remain robust.

Furthermore, there might also exist some time-varying shocks happening beyond the province level that were correlated with the effect of the PHE in 2002 and affected the change in outcome variables. To address this concern, we divide provinces into different regions

[30]The data are obtained from Fan and Ying (2005).

[31]The total trade value and the number of college graduates are obtained from the *China Statistical Yearbook* (2003), and the number of SARS-infected persons is from Fan and Ying (2005).

according to conventional criteria, that is, eastern, central, and western China.[32] Then, we include in the regression interactions between the region dummies and the marriage-year dummies. The results are shown in Panel B of Table 6, and we can see that they remain robust.

Migration Issue. In the main analysis, we drop individuals who migrated to different provinces after age 12. However, if cross-province migration decisions were affected by the repeal of PHE policy, the estimates above could be biased because of a sample selection problem. For example, if the repeal of the mandatory PHE resulted in more out-migration of individuals with lower SWB levels in provinces with lower PHE rates in 2002, dropping migrants would generate a downward bias. Considering this issue, we estimate how the reform affects cross-province migration during age 12 and the survey year. The regression results in Panel C of Table 6 confirm that the reform has no significant effect on the cross-province migration status.

Permutation Test. Given that our sample comprises only 25 provinces, to check whether the variation in the PHE rate across provinces is sufficient to allow causal inference, a permutation test is conducted. To do so, we randomly assign prereform PHE ratios to provinces and estimate the effect of the "fake" treatment status on SWB. We repeat this exercise 500 times. We plot the distribution of these coefficients in Figure 6. Less than 5% of the estimates are more negative than our estimates in Table 4, confirming that our main results are not driven by random factors.

Inclusion of Predetermined Individual Characteristics. We show in Table 3 and Appendix Table A1 that predetermined individual characteristics are balanced across provinces and in the pre- and postrepeal periods. Lee and Lemieux (2010) suggest that if the distribution of these predetermined characteristics across provinces around the policy shock is balanced, the inclusion of these controls should have little effect on the baseline estimates.

[32] Eastern China includes Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan provinces. Central China includes Shanxi, Anhui, Jiangxi, Henan, Hubei, Hunan, Heilongjiang, and Jilin provinces. Western China includes Inner Menggu, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang provinces.

Results to the contrary may suggest that our research design is invalid. As a robustness check, we include these individual-level predetermined variables in the baseline regression. The estimation results are reported in Panel A of Table 7. Our key estimates remain robust in both magnitude and statistical significance.

Inclusion of Individuals Married in 2003. In the main analysis, we drop individuals married in 2003 to ensure clear identification of the treatment and control groups. To investigate how the inclusion of individuals married in 2003 changes the estimates, we include them in the sample and define their treatment status according to their reported month of marriage. Individuals are classed in the policy affected group if their marriage month is after October 2003 and in the unaffected group otherwise. Given that individuals registering for marriage right after October might have already conducted the PHE due to the time gap between the PHE and the marriage registration, including individuals married in 2003 could cause a downward bias. The results in Panel B of Table 7 show that the coefficients are smaller than the baseline results, thereby confirming our conjecture.

Emotional Well-Being. While the evaluative well-being measure is a powerful indicator of an individual's overall utility and is widely used in the literature studying SWB, emotional well-being captures the actual experience in a recent period (Kahneman and Deaton, 2010; Stone and Mackie, 2013). We therefore use emotional well-being as a complement to measure SWB. We obtain three specific measures from the CFPS survey: the frequencies of feeling depressed, feeling nervous, and feeling restless. Their value ranges from 1 (corresponding to never in the last month) to 5 (almost every day in the last month). The regression results in Panel C of Table 7 show that the PHE repeal resulted in a significant increase in the frequency of depression and restlessness. This confirms that our conclusion holds when different measurements of SWB are used.

Use of an Urban Sample. In the main analysis, we focus on individuals with a rural *hukou*. As a comparison, we investigate the impact of the PHE repeal on individuals with an urban *hukou*. The empirical results are shown in Panel A of Table 8. No coefficients are significant, showing that the repeal of the PHE had no significant impacts on SWB for urban people. One possible reason is that the prevalence of infectious disease in urban areas is lower than that in rural areas (Wang et al., 2019). Compared with rural people, urban people have better access to prenatal care, which may serve as a substitute for the role of the PHE for healthy childbearing.[33]

Different Ways of Calculating Standard Errors. We determine whether the baseline statistical inference is robust to the choice of methods to calculate standard errors. We experiment with two alternative clustering methods. One is to calculate the standard errors by clustering over provinces, allowing the error terms to be correlated across individuals in the same province. Considering the small number of clustering units, 25 in this case, we implement the wild bootstrap procedure (Camron et al., 2008). The other practice is to calculate standard errors by clustering over counties, allowing the error terms to be correlated within the same county.[34] The results shown in Panel B of Table 8 are robust.

7 Channels: Sorting and Child Health

Hypothesis 2 and Hypothesis 3 predict that the repeal of the mandatory PHE reduced sorting on health (the health marker), which resulted in a decline in the expected health of the child, and increased sorting on SES. In this section, we investigate these channels.

7.1 Sorting by Health

To check the change in assortative matching on health, we estimate the effect of a repeal of the mandatory PHE on the health gap between spouses.[35] Unfortunately, the CFPS does not contain information on health status before marriage, except for a small proportion who reported their birth weight. Thus, we have to rely mainly on the health measurement at the time of the survey, including self-reported health status, whether the respondent felt sick in the previous two weeks, and whether he or she had been hospitalized in the past year. By

[33]Due to *hukou* restrictions, the marriage markets in rural and urban areas are segmented (Han and Shi, 2019).

[34]There are 187 counties in our sample.

[35]Similarly, Han et al. (2015) use the education gap and age gap between spouses to measure assortative matching on education and age, respectively.

doing so, we implicitly assume that current health status is correlated with past health. This may lead to a downward bias in the measurement of the spousal gap in health given that spousal health habits and status tend to evolve in a similar way (Venters et al., 1984; Falba and Sindelar, 2008; Meyler et al., 2007; Pai et al., 2010). The results are reported in Table 9. Albeit underestimated, the estimates show that the husband–wife gap in birth weight and self-reported health increased significantly after the abolition of mandatory PHE, supporting the model prediction that the repeal of mandatory PHE reduced PAM on health. [36]

To provide further evidence on sorting by premarital health status, we resort to the China Health and Nutrition Survey (CHNS hereafter).[37] Unlike the CFPS, the CHNS is a panel survey focusing mostly on the health and nutrition of individuals and families and tracing the sample individuals from 1989 onward. Thus, it enables us to analyze premarital health status. The survey contains four relevant health measures, namely, self-reported health, being sick in the last three months, being sick in the last four weeks, and having high blood pressure. We use two approaches: keeping only those health indicators surveyed before marriage and keeping the health indicators surveyed before marriage or within three years after marriage (by doing so, we assume that the respondent's health remains stable at least over a short period after marriage). We examine the effect of PHE repeal on couples' gaps on these health measures. The results are reported in Table 10. In both exercises, a larger gap in couples' health confirms that the PHE repeal led to reduced mating on health.

7.2 Child Health

As spousal health is complementary in producing a healthy child, a decrease in sorting on health likely reduces the probability of having a child and the health of the child.

We first examine the effect of the repeal of mandatory PHE on fertility probability by using the fertility dummy as the dependent variable in the regressions. The results in Column (1) in Table 11 show that the repeal of PHE reduced the fertility rate, but the estimate is

[36] Note that the survey did not cover each individual within a couple, which means that some observations corresponding to respondents whose partner was not in the survey are not included in the regression.

[37] Details of the CHNS can be found at https://www.cpc.unc.edu/projects/China.

statistically insignificant.

We further investigate how the PHE repeal affected child health for those having children,[38] by applying the DID model to estimate the effect on birth weight, height-for-age z score, weight-for-age z score, frequency of being sick in the last month, and frequency of seeing a doctor in the last month.[39] The regression results are reported in Columns (2) to (6) of Table 11. The results consistently show that the PHE repeal tended to worsen child health. In provinces where the PHE rates were previously high, the decrease in children's height and weight for their age and the increase in the likelihood of falling sick was larger than that in provinces where the PHE rates were low. The effects are statistically significant.

7.3 Matching on SES

As Hypothesis 3 predicts, the sorting tradeoff is likely to shift toward sorting on SES as the health cue becomes noisier. To test for this prediction, we first use the respondent's own education as a proxy for SES and then turn to the fathers' and mothers' own education following Sun and Zhang (2020). We find no significant effect of repealing the PHE on matching by education (Column (1) of Table 12). Interestingly, the spousal gap in father's education years decreased more in provinces with higher ex ante PHE rates after the repeal, suggesting that the repeal increased sorting on father's education (Column (2) of Table 12). Sun and Zhang (2020) argue that fathers' education is a better proxy for one's family SES than one's own education in contemporary China. Our finding is consistent with our model prediction.

[38]We can match approximately 89% adults in the baseline sample with their child's information in the survey.

[39]We resort to the 2010 and 2012 waves to fill in the missing values on birth weight in wave 2014. We obtain the standard for calculating the height-for-age z score under age 19 and weight-for-age z score under age 10 from the WHO. Height- and weight-for-age z scores are extensively used in the literature as measures for child health (see Thomas et al., 1991, Strauss and Thomas, 1998, and Chen and Li, 2009, for example).

8 Testing Inequality Implications

Our model predicts that the repeal of the PHE is more likely to hurt the healthy, the poor and women (Hypothesis 4). We test these implications for inequality in this section.

8.1 By Health Status

We first examine the heterogeneity in the treatment effect by health status. Given that spousal health complements each other in marital production, the healthy people would suffer more as the repeal of the PHE reduced marital sorting by health.

Since we have no information on premarital health, we use self-reported health at the time of the survey as a proxy.[40] By doing so, we assume that the respondent's health remains stable for a certain period. In Table 13, we find statistically significant effects for the healthy subsample, while the estimates for the unhealthy subsample are statistically insignificant and smaller in magnitude. The results show that healthy people suffered more loss of SWB from the PHE repeal, consistent with our model prediction. This result is in spirit similar to the finding in Angelucci and Bennett (2021), who find that frequent HIV testing significantly increases the probabilities of marriage and pregnancy for people not at risk while decreasing them for people who are more at risk.

8.2 By SES

We examine the heterogeneity in the policy effect by SES in this section. We divide the sample into low-SES and high-SES groups based on the respondent's (or his or her father's) education attainment—individuals (or their fathers) with a junior high school diploma and below are classified into the low-SES group, and the rest belongs to the high-SES group. We examine the policy effect on life satisfaction, family satisfaction, and happiness for the two

[40] Fewer than 30% of the individuals in our sample reported birth weights, so birth weight is not a suitable metric for dividing subsamples. People whose self-reported health status is fairly healthy or above are defined as healthy, and those whose self-reported health status is not good or below are defined as unhealthy.

groups. The results are reported in Table 14. Panel A uses the respondent's own education to divide the subsample, and Panel B uses the father's education to divide the subsample. Across the three measures of SWB, the deterioration effects are consistently salient only for the low-SES group, supporting our model prediction.

Notably, our model naively assumes that health status and SES are orthogonal to each other. Even so, on average, those with low SES were hurt more by the repeal of the PHE due to the rise in sorting on SES. In reality, SES and health are likely to be positively correlated. However, the empirical finding suggests that the benefit to less healthy people from the PHE repeal cannot offset the negative effect on other people in the low-SES group.

8.3 By Gender

We investigate whether the effects are different between men and women. Our model predicts that women on average will be worse off as the health cue becomes noisier in the absence of an assumption of asymmetric gender roles in providing care to family members. In reality, mothers are usually found to be the main caregivers, especially for children (e.g., Han and Shi, 2019). Thus, a deterioration in child health tends to have a greater negative impact on females. We estimate the impact on SWB for male and female respondents separately. The results in Table 15 confirm that the negative effect of PHE repeal on SWB is more salient for women.

9 Conclusion

Becker (1981) points out that information frictions on partner traits give rise to search costs in the marriage market and influences sorting patterns. This paper builds on this notion and takes a step further by examining the impacts of information noise on marital matching and postmarital well-being both theoretically and empirically. We take advantage of the repeal of mandatory PHE in China, which increased noise in the health cue, as a natural experiment to examine how noise in matching affects SWB in marital life by distorting matching patterns. Using a DID strategy, we find that the removal of the mandatory PHE resulted in a significant drop in SWB after marriage by reducing positive assortative mating on health and increasing positive assortative mating on SES. A change in the matching pattern leads to poor child health, which is likely a major channel for the deterioration of SWB. In particular, the healthy, the poor and women tended to suffer more in their marriage payoffs from the repeal of the PHE.

Despite the associated ethical controversy, the mandatory PHE has been strongly advocated by professionals from the WHO (Rennie and Mupenda, 2008). The findings of this paper provide supportive evidence of the positive impact of the PHE on marital utility and especially child health. In addition, our analysis suggests that given the complementarity of spousal traits in producing marital surplus, making health information less transparent would reduce overall welfare. A possible policy direction to protect the underprivileged is to reduce complementarity by reducing the impact of parental health on child health or reducing the health burden on families rather than suppressing information.

Our findings also have important implications for inequality policies. A tendency in attempts to address inequality in college admissions and marriage and labor markets is to suppress information to avoid competition based on explicit measures. One recent example is that the University of California system extended its policy of test-free admissions in 2021 to resolve a 2019 lawsuit charging that the SAT and ACT are biased against poor, Black and Hispanic students. Such measures are not rare in health care and labor markets. However, our analysis shows that this type of attempt may have the risk of exacerbating inequality along different dimensions even when matching efficiency is compromised. In particular, concealing information cues on some dimensions tends to shift the sorting tradeoff toward wealth, which is often at odds with the policy intention.

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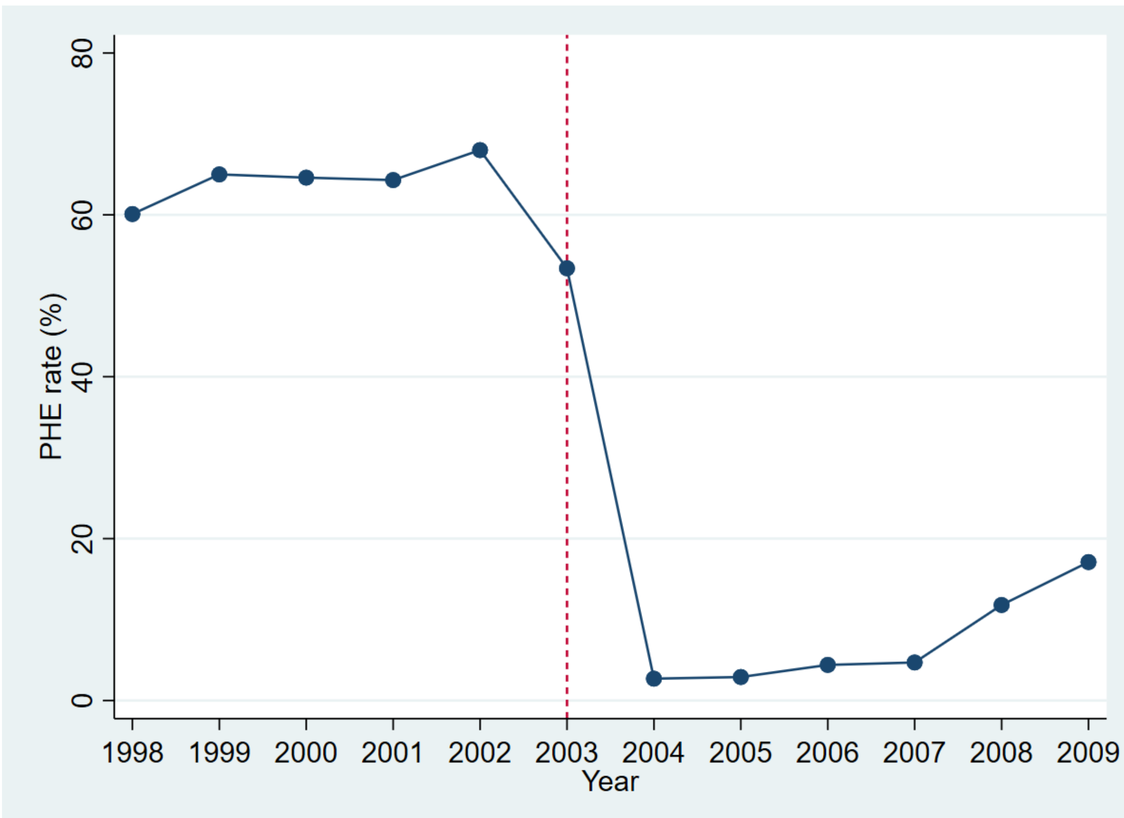
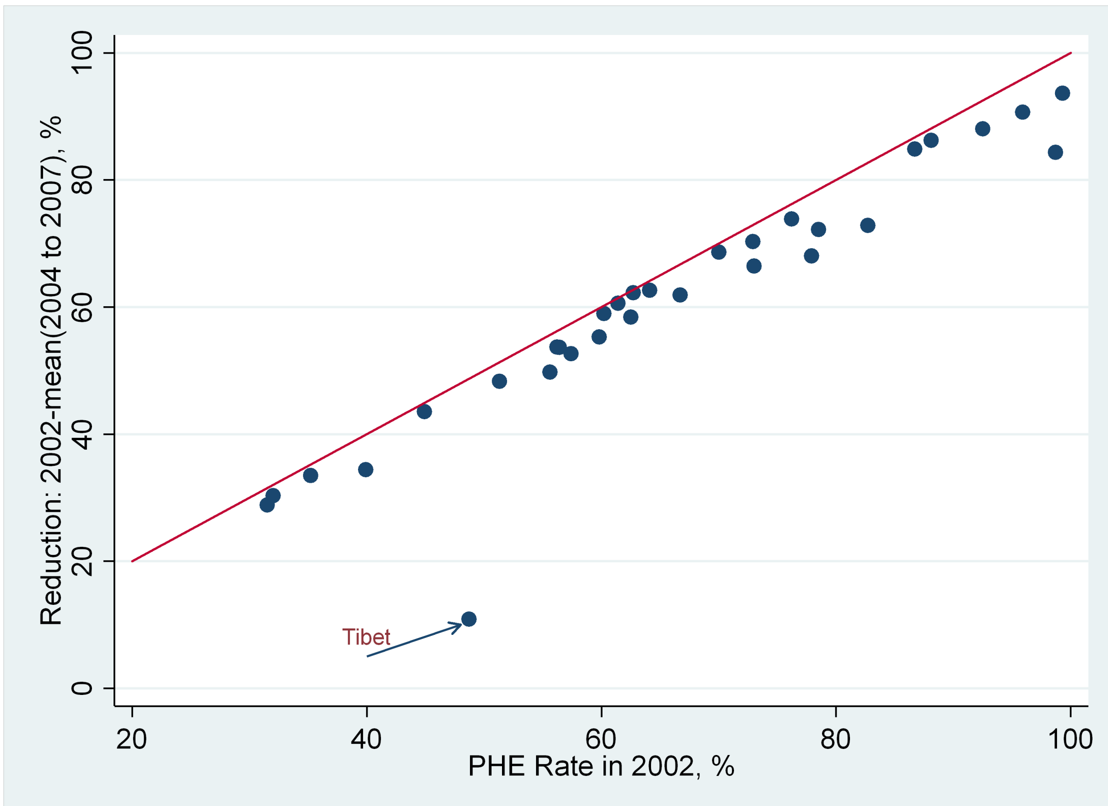
Figure 1. PHE Rate between 1998 and 2009



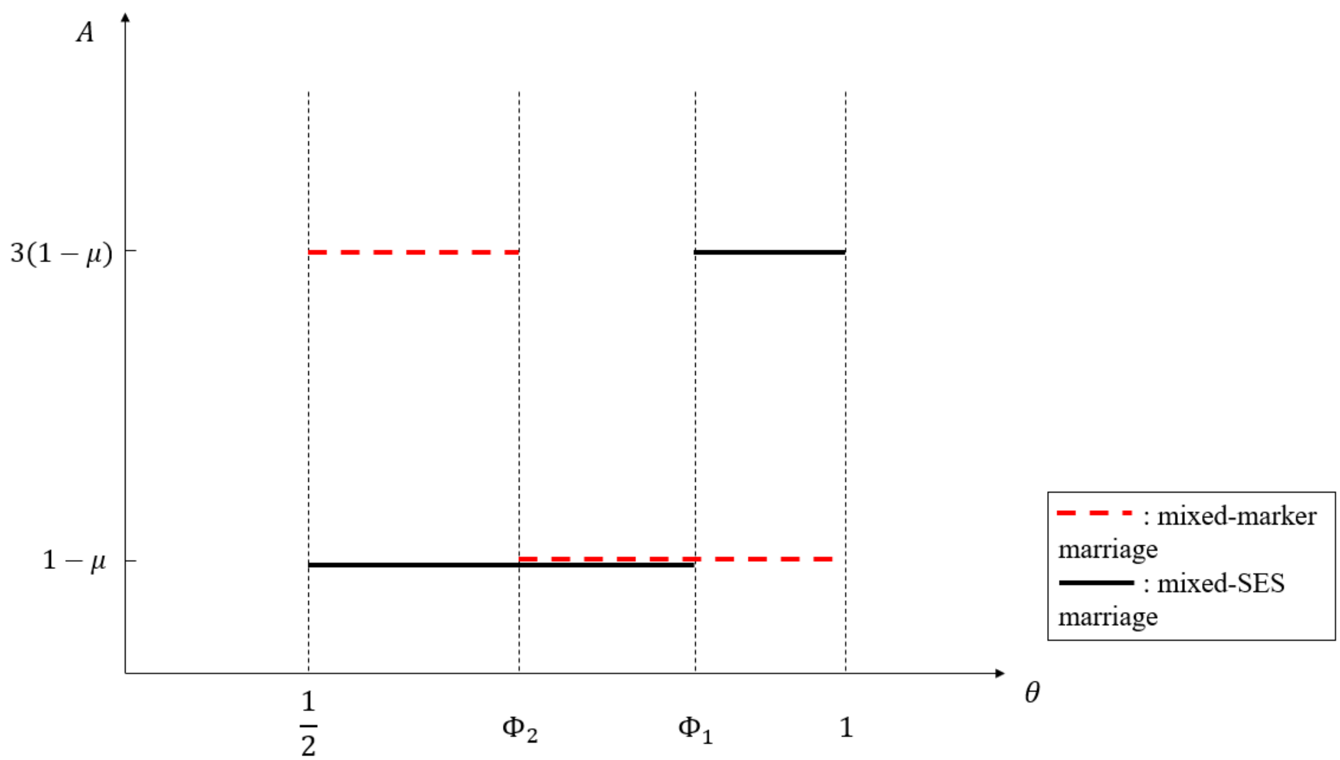
Notes: The dots represent the national average PHE rate in China from 1998 to 2009. The data are from the *China Health Statistical Yearbook*.

Figure 2. Relationship between Reductions in the PHE Rate after 2003 and the Initial Level in 2002



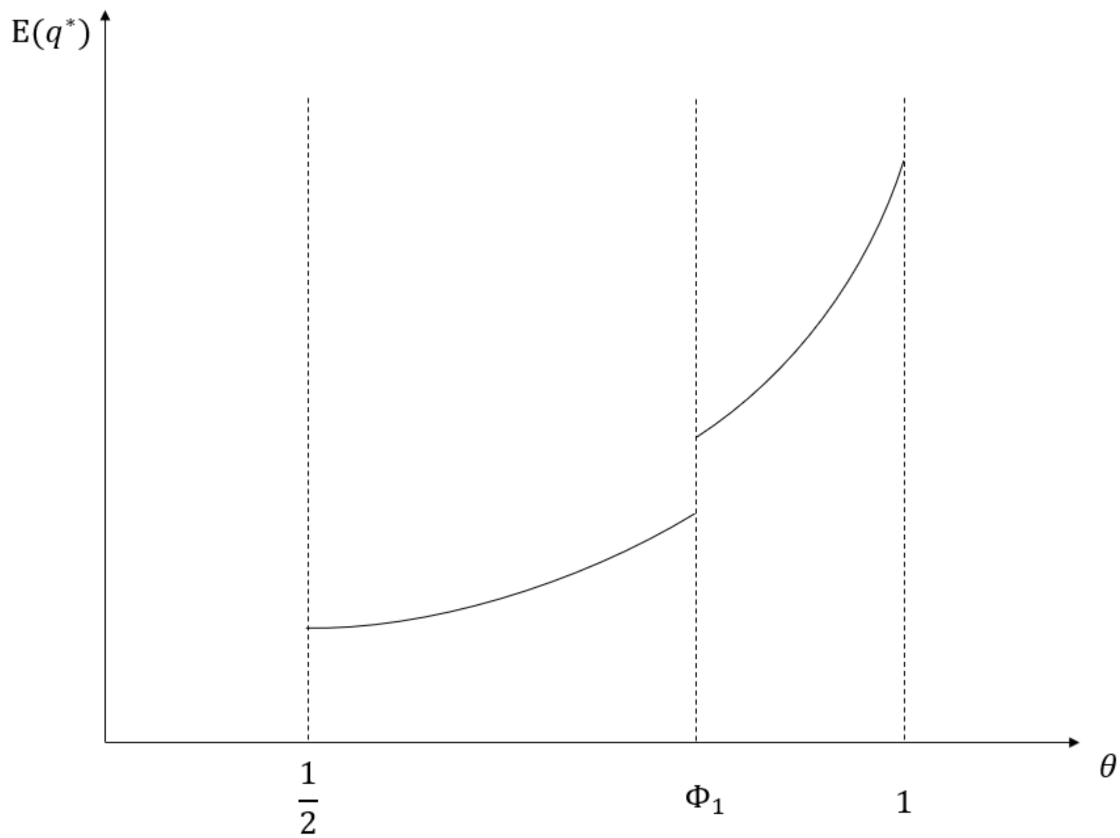
Notes: The dots represent the observations for each province. The line is the 45-degree line. The data are obtained from the *China Health Statistical Yearbook*.

Figure 3. Pattern of Marriage Matching



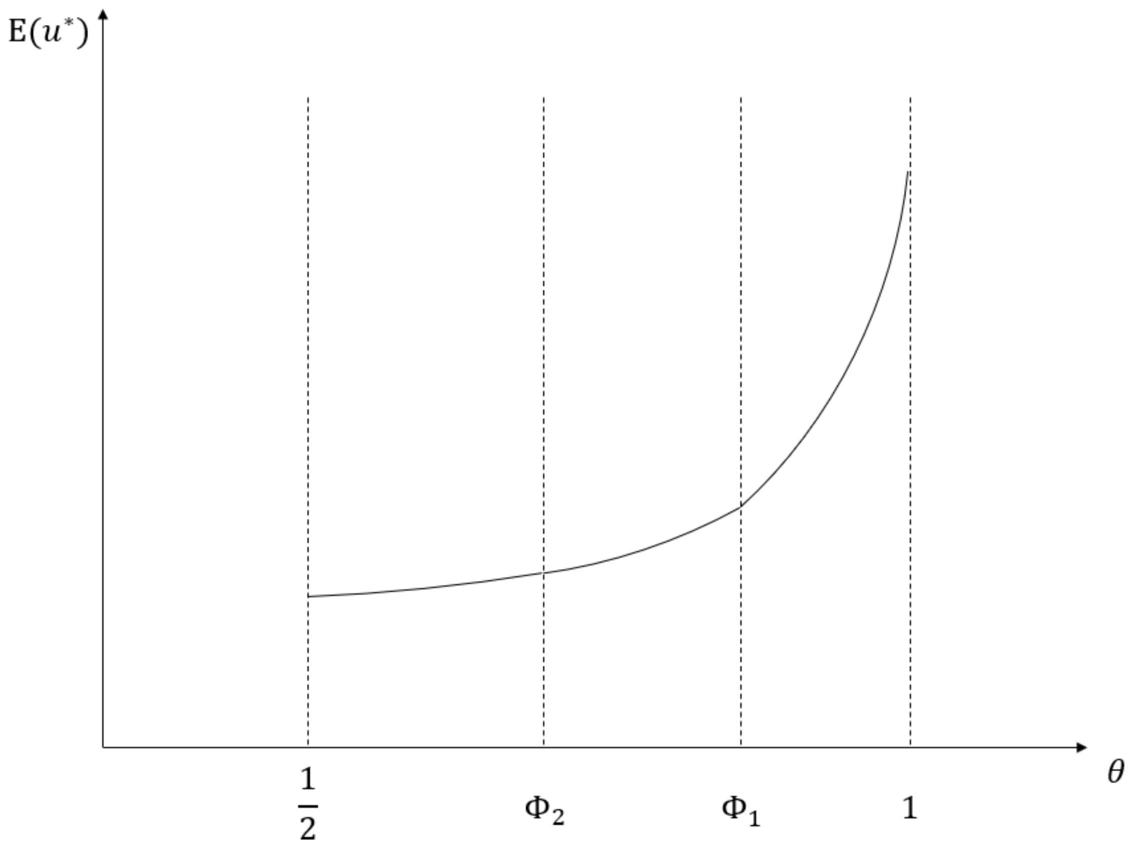
Notes: The x-axis is the probability of the health marker signaling cues of the true health status. The y-axis is the proportion of mixed-type marriages (denoted as A). The dashed line represents the proportion of mixed health marker marriages, and the solid line represents the proportion of mixed SES marriages.

Figure 4. Expected Child Health



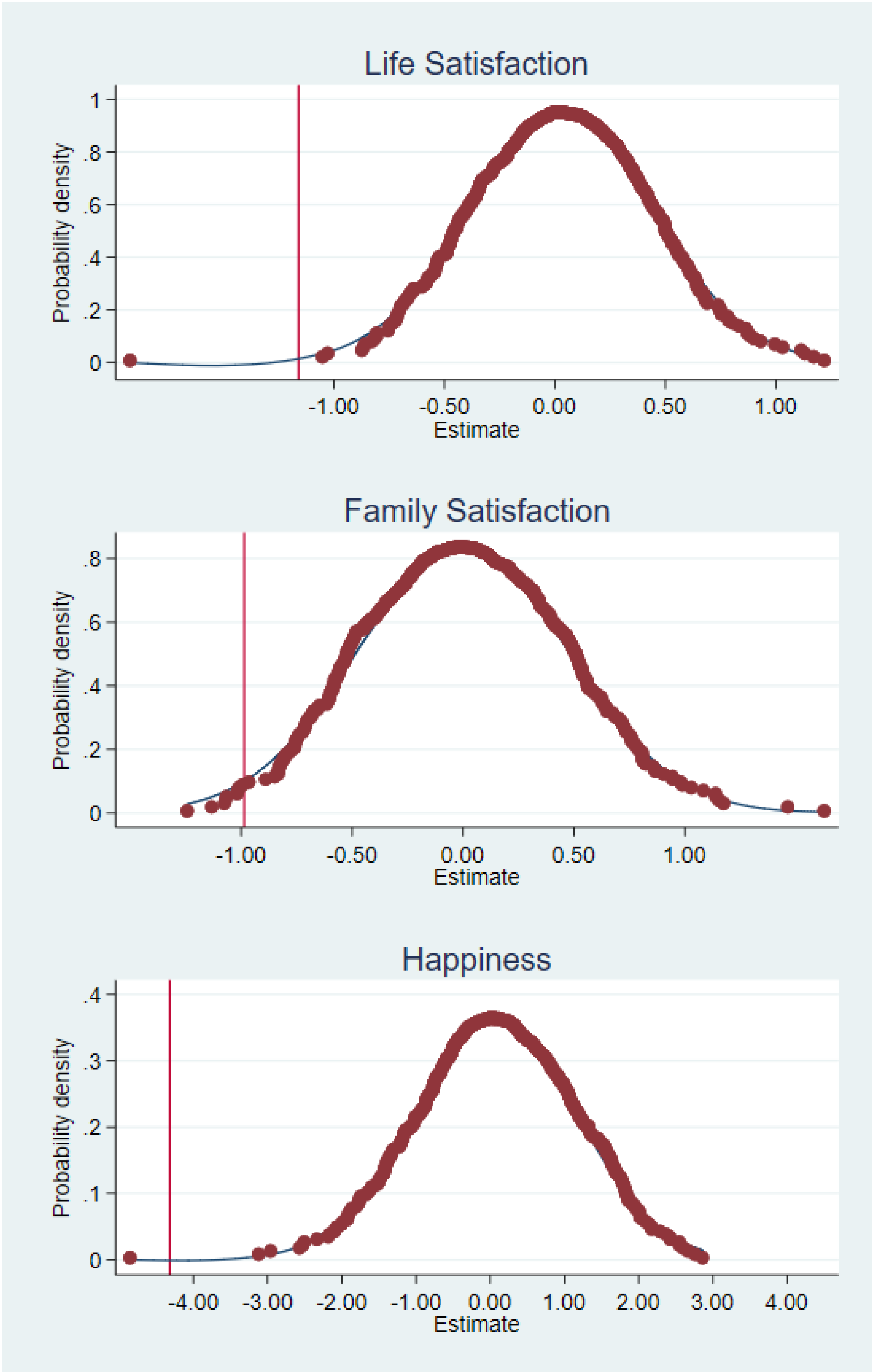
Notes: The x-axis is the probability of the health marker signaling cues of the true health status. The y-axis is expected child health.

Figure 5. Average Expected Utility



Notes: The x-axis is the probability of the health marker signaling cues of the true health status. The y-axis is the expected utility from marriage.

Figure 6. Distribution of Estimates of Permutation Test



Notes: The figures show the probability distribution density of the coefficients of the permutation test, which randomly assigns the treatment intensity to the provinces 500 times. The outcome variables correspond to life satisfaction, family satisfaction and happiness. The vertical lines represent the baseline coefficients in Table 4.

Table 1. Summary Statistics

Variable	Mean	SD	N
Panel A: Individual-level variables			
Life satisfaction	3.753	1.030	2,777
Family satisfaction	3.851	1.009	2,777
Happiness	7.434	2.240	2,777
Ethnic minority	0.122	0.327	2,777
Gender	0.465	0.499	2,777
Age	37.838	6.623	2,777
Number of siblings	2.505	1.566	2,618
Education level	2.359	0.977	2,777
Father's education level	1.972	0.961	2,558
Mother's education level	1.453	0.738	2,604
Log(weeks not living with father before age 12+1)	0.447	1.215	2,530
Log(weeks not living with mother before age 12+1)	0.227	0.925	2,578
Panel B: Province-level variables in 2002			
PHE rate	0.689	0.180	25
Log(GDP per capita)	9.115	0.617	25
Log(consumption per capita)	8.209	0.499	25
Log(fiscal revenue)	5.557	0.675	25
Share of primary industry in GDP	0.148	0.065	25
Share of secondary industry in GDP	0.457	0.055	25
Log(total population)	8.342	0.579	25
Sex ratio	1.045	0.034	25
Health institutes per 10,000 people	2.494	0.889	25
Doctors per 10,000 people	15.499	7.551	25

Table 2. Marriage Rate at the Province Level

	(1)
Variable	Marriage rate (%)
PHE rate×Post2003	0.107
	(0.272)
Observations	347
R-squared	0.727
Province control	Yes
Province FE	Yes
Year-of-Marriage FE	Yes

Notes: The regression function is $Marriage\_rate_{pt} = \beta \times PheRate_p \times Post2003_t + \psi_p \times Post2003_t + \delta_p + \delta_t + \epsilon_{pt}$, in which t denotes the calendar year rather than the year of marriage. Data on the marriage rate are obtained from the China Civic Affairs Statistical Yearbook. The standard errors are reported in parentheses, two-way clustered by province and year of marriage.

Table 3. Balance Test of Predetermined Individual Characteristics

Variables	(1) Father's education	(2) Mother's education	(3) Education	(4) Number of siblings	(5) Ethnic minority	(6) Log(weeks not living with father before age 12+1)	(7) Log(weeks not living with mother before age 12+1)
PHE rate×Post2003	0.027	-0.259	-0.059	-0.731	0.089	0.418	0.348
	(0.606)	(0.438)	(0.602)	(1.080)	(0.181)	(0.992)	(0.746)
Observations	2,558	2,604	2,777	2,618	2,777	2,530	2,578
R-squared	0.114	0.106	0.164	0.160	0.316	0.029	0.040
Province control	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-of-Marriage FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The standard errors are reported in parentheses, two-way clustered by province and year of marriage.

Table 4. Baseline Results

VARIABLES	(1) Life satisfaction	(2) Family satisfaction	(3) Happiness
PHE rate×Post2003	-1.160***	-0.986***	-4.318***
	(0.328)	(0.225)	(0.546)
Observations	2,777	2,777	2,777
R-squared	0.037	0.036	0.069
Province control	Yes	Yes	Yes
Province FE	Yes	Yes	Yes
Year-of-Marriage FE	Yes	Yes	Yes

Notes: The standard errors are reported in parentheses, two-way clustered by province and year of marriage. ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively.

Table 5. Test for the Existence of Parallel Trends

Variables	(1) Life satisfaction	(2) Family satisfaction	(3) Happiness
PHE rate×Year(-7)	0.125	-0.049	-1.092
	(0.170)	(0.134)	(0.750)
PHE rate×Year(-6)	0.270	0.075	-0.836
	(0.565)	(0.491)	(1.504)
PHE rate×Year(-5)	-0.409	0.173	-0.211
	(0.243)	(0.202)	(0.355)
PHE rate×Year(-4)	-0.162	-0.150	-1.258
	(0.453)	(0.417)	(1.065)
PHE rate×Year(-3)	-0.381	-0.468	0.343
	(0.411)	(0.381)	(0.668)
PHE rate×Year(-2)	-0.669	-0.877*	0.071
	(0.411)	(0.436)	(0.690)
PHE rate×Year(-1)	-1.003	-0.734	-0.787
	(0.612)	(0.560)	(1.152)
PHE rate×Year(+1)	-1.385**	-1.334**	-4.541***
	(0.454)	(0.445)	(0.870)
PHE rate×Year(+2)	-1.461***	-1.171***	-5.801***
	(0.360)	(0.273)	(0.735)
PHE rate×Year(+3)	-1.348***	-1.144***	-5.218***
	(0.418)	(0.357)	(0.561)
PHE rate×Year(+4)	-1.431***	-1.220***	-3.582***
	(0.323)	(0.239)	(0.500)
Observations	2,777	2,777	2,777
R-squared	0.039	0.038	0.072

Notes: We include provincial controls and provincial and year-of-marriage fixed effects in all columns. The benchmark for year of marriage is 2002. Year(-1) refers to year of marriage 2001, that is, one year before the benchmark, and year(+1) refers to year of marriage 2004 because the sample does not include individuals married in 2003. The standard errors are reported in parentheses, two-way clustered by province and year of marriage. ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively.

Table 6. Robustness Check I

	(1) Life Satisfaction	(2) Family Satisfaction	(3) Happiness
Panel A: Inclusion of confounding shocks			
PHE rate×Post2003	-1.137***	-1.156***	-4.051***
	(0.261)	(0.343)	(0.603)
Observations	2,777	2,777	2,777
R-squared	0.037	0.036	0.070
Confounding Shocks	Yes	Yes	Yes
Panel B: Inclusion of region×year-of-marriage fixed effect			
PHE rate×Post2003	-1.260***	-1.073***	-4.661***
	(0.333)	(0.247)	(0.397)
Observations	2,777	2,777	2,777
R-squared	0.044	0.042	0.078
Region×year-of-marriage FE	Yes	Yes	Yes
Panel C: Nonmigration as outcome variable			
	Nonmigration		
PHE rate×Post2003	-0.004		
	(0.105)		
Observations	2,949		
R-squared	0.209		

Notes: We include provincial controls and province and year-of-marriage fixed effects in all regressions. The standard errors are reported in parentheses, two-way clustered by province and year of marriage. ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively. Confounding shocks include trade value, number of college graduates and SARS-infected person in each province in 2002, interacted with a post-2003 dummy. Nonmigration is defined as living in the same province between age 12 and the survey year.

Table 7. Robustness Check II

	(1) Life Satisfaction	(2) Family Satisfaction	(3) Happiness
Panel A: Inclusion of predetermined personal characteristics			
PHE rate×Post2003	-1.284**	-1.073***	-4.934***
	(0.427)	(0.300)	(0.776)
Observations	2,323	2,323	2,323
R-squared	0.042	0.045	0.083
Predetermined controls	Yes	Yes	Yes
Panel B: Inclusion of individuals married in 2003			
PHE rate×Post2003	-0.944***	-0.880***	-4.013***
	(0.195)	(0.173)	(0.400)
Observations	2,974	2,974	2,974
R-squared	0.037	0.035	0.066
Panel C: Emotional well-being as outcome variable			
	Depression	Nervousness	Restlessness
PHE rate×Post2003	1.129***	0.341	0.940***
	(0.232)	(0.355)	(0.275)
Observations	2,775	2,776	2,776
R-squared	0.037	0.036	0.044

Notes: We include provincial controls and provincial and year-of-marriage fixed effects in all regressions. The standard errors are reported in parentheses, two-way clustered by province and year of marriage. ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively. Predetermined controls include the respondent's father's education, mother's education, own education, number of siblings, ethnic minority, and weeks not living with parents before age 12 (taking logarithm).

Table 8. Robustness Check III

	(1) Life Satisfaction	(2) Family Satisfaction	(3) Happiness
Panel A: Urban Sample			
PHE rate×Post2003	0.302	0.071	0.627
	(0.630)	(0.398)	(1.230)
Observations	1,387	1,387	1,387
R-squared	0.050	0.055	0.059
Panel B: Different Ways of Clustering			
PHE rate×Post2003	-1.160	-0.986	-4.318
	(0.328)***	(0.225)***	(0.546)***
	[0.528] **	[0.668]	[1.499]***
	{0.587}**	{0.527}*	{1.041}***
Observations	2,777	2,777	2,777
R-squared	0.037	0.036	0.069

Notes: We include provincial controls and provincial and year-of-marriage fixed effects in all columns. The standard errors two-way clustered by province and year of marriage are reported in parentheses, those clustered by province using the wild bootstrap procedure are reported in square brackets, and those clustered by county are reported in curly brackets, respectively. ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively.

Table 9. Channel: Assortative Matching of Health

	(1)	(2)	(3)	(4)
	Gap in birth weight	Gap in self-reported health status	Gap in recent illness	Gap in hospitalization
PHE rate×Post2003	4.695**	2.160**	0.504	0.224
	(1.958)	(0.764)	(0.314)	(0.358)
Observations	167	910	910	910
R-squared	0.228	0.044	0.054	0.072

Notes: We include provincial controls and provincial and year-of-marriage fixed effects in all columns. The standard errors are reported in parentheses, two-way clustered by province and year of marriage. ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively.

Table 10. Channel: Assortative Matching on Health Using the CHNS

	(1) Gap in self-reported health	(2) Gap in being sick in the last 3 months	(3) Gap in being sick in the last 4 weeks	(4) Gap in having high blood pressure
Panel A: Health indicators surveyed premarriage				
PHE rate×Post2003	0.896***	0.104	0.622***	-0.056
	(0.000)	(0.247)	(0.210)	(0.098)
Observations	104	105	110	106
R-squared	0.324	0.218	0.162	0.119
Panel B: Premarriage or postmarriage (within 3 years) health indicators				
PHE rate×Post2003	0.825***	0.177*	0.191	-0.014
	(0.286)	(0.097)	(0.135)	(0.013)
Observations	549	540	641	640
R-squared	0.092	0.049	0.072	0.044

Notes: We include provincial controls and provincial and year-of-marriage fixed effects in all columns. The standard errors are reported in parentheses, two-way clustered by province and year of marriage. ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively. Waves between 1991 and 2011 are used. The regression sample is restricted to rural *hukou* respondents married between 1995 and 2007, and the 2003 marriage cohort is excluded. Panel A further restricts the sample to those surveyed before marriage to ensure that we have indicators of premarital health, whereas Panel B restricts the sample to those surveyed before marriage or within three years after marriage to ensure that we have indicators of premarital and recent postmarital health (we argue that health should remain stable for a few years after marriage).

Table 11. Channel: Fertility and Child Health

	(1)	(2)	(3)	(4)	(5)	(6)
	Fertility	Birth weight	Height-for-age Z score	Weight-for-age Z score	Frequency of sickness in the last month	Frequency of seeing a doctor in the last month
PHE rate×Post2003	-0.117	-0.649	-3.125*	-1.463**	1.040**	0.584
	(0.088)	(0.511)	(1.531)	(0.642)	(0.365)	(0.328)
Observations	2,777	2,254	2,541	1,643	2,637	2,640
R-squared	0.031	0.079	0.138	0.092	0.032	0.032

Notes: We include provincial controls and provincial and year-of-marriage fixed effects in all columns. The standard errors are reported in parentheses, two-way clustered by province and year of marriage. ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively.

Table 12. Channel: Assortative Matching on SES

	(1)	(2)	(3)
	Gap in education years	Gap in father's education years	Gap in mother's education years
PHE rate×Post2003	-0.839	-6.413***	-1.893
	(0.513)	(1.449)	(3.007)
Observations	910	794	818
R-squared	0.047	0.078	0.097

Notes: We include provincial controls and provincial and year-of-marriage fixed effects in all columns. The standard errors are reported in parentheses, two-way clustered by province and year of marriage. ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively.

Table 13. Heterogeneity Test by Health Status

	(1)	(2)	(3)	(4)	(5)	(6)
	Life Satisfaction		Family Satisfaction		Happiness	
	Unhealthy	Healthy	Unhealthy	Healthy	Unhealthy	Healthy
PHE rate×Post2003	-0.113	-1.077*	0.537	-1.079**	-3.027	-3.539***
	(1.011)	(0.517)	(1.039)	(0.456)	(2.520)	(0.801)
Observations	667	2,110	667	2,110	667	2,110
R-squared	0.086	0.037	0.076	0.045	0.129	0.064

Notes: People whose self-reported health status is fairly healthy or above are defined as healthy, and those whose self-reported health status is not good or below are defined as unhealthy. We include provincial controls and provincial and year-of-marriage fixed effects in all columns. The standard errors are reported in parentheses, two-way clustered by province and year of marriage. ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively.

Table 14. Heterogeneity Test by SES

	(1)	(2)	(3)	(4)	(5)	(6)
	Life Satisfaction		Family Satisfaction		Happiness	
Panel A: Own Education	Low	High	Low	High	Low	High
PHE rate×Post2003	-2.281***	0.448	-1.568***	-0.010	-6.685***	-0.862
	(0.291)	(0.722)	(0.469)	(0.671)	(1.353)	(1.714)
Observations	1,481	1,296	1,481	1,296	1,481	1,296
R-squared	0.047	0.071	0.047	0.070	0.078	0.078
Panel B: Father's Education	Low	High	Low	High	Low	High
PHE rate×Post2003	-1.513**	0.198	-0.854**	-0.220	-5.384***	-0.594
	(0.526)	(1.100)	(0.315)	(1.187)	(1.329)	(1.981)
Observations	1,897	878	1,897	878	1,897	878
R-squared	0.037	0.089	0.035	0.080	0.068	0.112

Notes: We include provincial controls and provincial and year-of-marriage fixed effects in all columns. The standard errors are reported in parentheses, two-way clustered by province and year of marriage. ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively.

Table 15. Heterogeneity Test by Gender

	(1)	(2)	(3)	(4)	(5)	(6)
	Life Satisfaction		Family Satisfaction		Happiness	
	Female	Male	Female	Male	Female	Male
PHE rate×Post2003	-1.873***	-0.494	-1.494***	-0.561	-4.956***	-3.694**
	(0.241)	(1.151)	(0.304)	(0.901)	(0.924)	(1.267)
Observations	1,487	1,289	1,487	1,289	1,487	1,289
R-squared	0.050	0.057	0.044	0.055	0.085	0.073

Notes: We include provincial controls and provincial and year-of-marriage fixed effects in all columns. The standard errors are reported in parentheses, two-way clustered by province and year of marriage. ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively.

Appendix Table A1. Balance Test Using 2005 Population Census

	(1)	(2)	(3)
	Education	Number of siblings	Ethnic minority
PHE rate×Post2003	0.102	-0.223	-0.015
	(0.051)	(0.121)	(0.015)
Observations	68,745	68,745	68,745
R-squared	0.111	0.087	0.338

Notes: We include provincial controls and provincial and year-of-marriage fixed effects in all columns. The standard errors are reported in parentheses, two-way clustered by province and year of marriage; cohorts married within two years before/after the policy shock are used.

APPENDICES (Not for Publication)

A Proofs

A.1 Proof of Lemma

Proof of Lemma 1:

Proof. Suppose that i and i' both belong to the same marker-SES-gender group, with $u_i^* > u_{i'}^*$ in an equilibrium. Because of the first condition in Definition 1, i must be matched to a spouse j. Suppose j obtains u_j^* in the equilibrium. We must have $u^{i,j} + v^{i,j} = u_i^* + v_j^*$. Because $u^{i,j} + v^{i,j} = u^{i',j} + v^{i',j}$, we have $u^{i',j} + v^{i',j} > u_{i'}^* + v_j^*$, which contradicts the second condition in Definition 1. □

Proof of Lemma 2:

Proof. Because there are more men than women, for any equilibrium there always exists a man i who remains single. Suppose there is also a woman j remaining single in the equilibrium. Because of complementarity (Assumption 3), $t(m^x, f^y) = t(m^x, f^y) + t(m^\phi, f^\phi) > t(m^x, f^\phi) + t(m^\phi, f^y)$. So i and j as a deviating couple can get at least $t(m^x, f^y)$, violating condition 2 of Definition 1. So all women should be married in any equilibrium.

Suppose there is a type 1r man who remains single in an equilibrium and receives $t(m^r, f^\phi)$. Because $\mu > 3/4$ and all women are married in equilibrium, at least one man $i \in \{1p, 0r, 0p\}$ is married to a woman $j \in \{1p, 0r, 0p\}$. Suppose in equilibrium i (j) gets Eu_i^* (Ev_j^*) respectively. Because of Definition 1, we must have $Ev_j^* = Eq(s^\tau, s^\kappa)t(m^x, f^y) - Eu_i^* \leq Eq(s^\tau, s^\kappa)t(m^x, f^y) - t(m^x, f^\phi)$. Because of Assumption 3, $t(m^x, f^y) - t(m^x, f^\phi) \leq t(m^r, f^y) - t(m^r, f^\phi)$. Because of Assumption 4, we also have $Eq(s^0, s^\kappa) < Eq(s^1, s^\kappa)$. So $Ev_j^* < Eq(s^1, s^\kappa)t(m^r, f^y) - t(m^r, f^\phi)$. Re-arranging terms, we have $Ev_j^* + t(m^r, f^\phi) < Eq(s^1, s^\kappa)t(m^r, f^y)$, which contradicts condition 2 of Definition 1. So all high-rich men should be married in any equilibrium.

Similarly we can show that men of types $1p$ and $0r$ are also married in the equilibrium

Given the above results and Assumption 2, some low-poor men (type $0p$) have to remain single. □

A.2 Proof of Propositions

Proof. We first show that there is an equilibrium. The expected total marital output matrix can be written as

$$\mathbf{E}(\mathbf{U}) = \left[\begin{array}{c|cccc} & 1r & 1p & 0r & 0p \\ \hline 1r & \theta^2 t^{rr} & \theta^2 t^{rp} & \theta(1-\theta)t^{rr} & \theta(1-\theta)t^{rp} \\ 1p & \theta^2 t^{pr} & \theta^2 t^{pp} & \theta(1-\theta)t^{pr} & \theta(1-\theta)t^{pp} \\ 0r & \theta(1-\theta)t^{rr} & \theta(1-\theta)t^{rp} & (1-\theta)^2 t^{rr} & (1-\theta)^2 t^{rp} \\ 0p & \theta(1-\theta)t^{pr} & \theta(1-\theta)t^{pp} & (1-\theta)^2 t^{pr} & (1-\theta)^2 t^{pp} \end{array}\right] \tag{1}$$

where t^{xy} denotes $t(m^x, f^y)$, $x \in \{r, p\}$.

Given Assumptions 1-3, Equation (1) shows that, for any given type of men (women), marrying type $1r$ women (men) generates the maximum marital output and marrying type $0p$ women (men) generates the minimum marital output. The relative ranking of spouses of type $1p$ and $0r$ depends on the value of θ.

Given lemma 2, some low-poor men (type $0p$) have to remain single. According to lemma 1, all type $0p$ men will have the reservation utility of remaining single in the equilibrium, i.e., $Eu^*_{0p} = t^{p\phi}$, which is normalized to 0. Thus type j women who marry type $0p$ men can obtain the marital surplus $E\tilde{v_{0p,j}} = EU_{0p,j}$.

If other types of men get married in the equilibrium, their spouses of type j should be able to get at least $Ev^*_{0p,j}$ in the marriage. Otherwise women would be better off to marry type $0p$ men, which violates condition 2 of Definition 1. The matrix below shows the best possible offer that men can get by marrying different types of women and offering them marital output $Ev_{0p,j}$.

$$\mathbf{D} = \left[\begin{array}{c|cccc} & 1r & 1p & 0r & 0p \\ \hline 1r & \theta^2 t^{rr} - \theta(1-\theta)t^{pr} & \theta^2 t^{rp} - \theta(1-\theta)t^{pp} & \theta(1-\theta)t^{rr} - (1-\theta)^2 t^{pr} & \theta(1-\theta)t^{rp} - (1-\theta)^2 t^{pp} \\ 1p & \theta_1 t^{pr} & \theta_1 t^{pp} & \theta_2 t^{pr} & \theta_2 t^{pp} \\ 0r & \theta(1-\theta)\Delta t^{rr}_{pr} & \theta(1-\theta)\Delta t^{rp}_{pp} & \theta(1-\theta)\Delta t^{rr}_{pr} & \theta(1-\theta)\Delta t^{rp}_{pp} \\ 0p & 0 & 0 & 0 & 0 \end{array}\right]$$

where $\theta_1 = \theta(2\theta - 1)$, $\theta_2 = (1-\theta)(2\theta-1)$; $\Delta t^{ij}_{i'j'} = t(m^i, f^j) - t(m^{i'}, f^{j'})$, for any $i, j, i', j' \in \{r, p\}$.

Given Assumptions 1 and 3, we can verify that $Eu^*_j = t^{p\phi} < d_{i,j}$, for any $i \in \{1r, 1p, 0r\}$ and $j \in \{1r, 1p, 0r, 0p\}$. That is, all other types of men can outbid type $0p$ men for type $0p$ women. Given lemma 1, all other type men should be married in the equilibrium. Otherwise condition 2 of Definition 1 will be be violated.

<u>Case 1</u>: $\frac{\theta}{1-\theta} \geq \frac{\Delta t^{rr}_{pr}}{\Delta t^{rp}_{pp}}$

Let $\tilde{\theta}_1$ be the cutoff value of θ so that $\frac{\tilde{\theta}_1}{1-\tilde{\theta}_1} = \frac{\Delta t^{rr}_{pr}}{\Delta t^{rp}_{pp}}$. This case is straightforward. If $\theta > \tilde{\theta}_1$, the marginal contribution of type $1p$ spouse to the marriage with type $1r$ is greater than that of type $0r$ spouse. Therefore, for any $i, j \in \{1r, 1p, 0r, 0p\}$, the expected total marital output follows $E(U_{1r,j}) > E(U_{1p,j}) > E(U_{0r,j}) > E(U_{0p,j})$ and $E(U_{i,1r}) > E(U_{i,1p}) > E(U_{i,0r}) > E(U_{i,0p})$. Both men and women have the same order of preferences over the spouse's type. This case is similar the one-dimension matching problem. The highest price offered to a groom of type i from all types below is from the type with expected marital output just below. Given lemma 1, it is never worthwhile for higher-type brides to marry a lower-type groom.

The equilibrium marriage assignment is summarized in the following matrix:

$$\mathbf{A} = \left[\begin{array}{c|ccccc} & 1r & 1p & 0r & 0p & \phi \\ \hline 1r & \frac{\mu}{2} & \frac{1}{2}-\frac{\mu}{2} & & & \\ 1p & & \mu-\frac{1}{2} & 1-\mu & & \\ 0r & & & \frac{3}{2}\mu-1 & \frac{3}{2}(1-\mu) & \\ 0p & & & & 2\mu-\frac{3}{2} & 2(1-\mu) \\ \phi & & & & & \end{array}\right] \tag{2}$$

where $a_{i,j}$ equals to the size of type-i men who are matched with type-j women. The equilibrium expected payoffs of men (u_i^*) and of women (v_j^*) are summarized below.

$$Eu_i^* = \begin{cases} \theta^2\Delta t_{pp}^{rp} + \theta(1-\theta)t^{pr} - (1-\theta)^2(\Delta t_{rp}^{rr} + t^{pp}) & \text{if } i = 1r \\ \theta(1-\theta)t^{pr} - (1-\theta)^2(\Delta t_{rp}^{rr} + t^{pp}) & \text{if } i = 1p \\ (1-\theta)^2\Delta t_{pp}^{rp} & \text{if } i = 0r \\ 0 & \text{if } i = 0p \end{cases}$$

$$Ev_j^* = \begin{cases} \theta^2(\Delta t_{rp}^{rr} + t^{pp}) - \theta(1-\theta)t^{pr} + (1-\theta)^2(\Delta t_{rp}^{rr} + t^{pp}) & \text{if } j = 1r \\ \theta^2 t^{pp} - \theta(1-\theta)t^{pr} + (1-\theta)^2(\Delta t_{rp}^{rr} + t^{pp}) & \text{if } j = 1p \\ (1-\theta)^2(\Delta t_{rp}^{rr} + t^{pp}) & \text{if } j = 0r \\ (1-\theta)^2 t^{pp} & \text{if } j = 0p \end{cases}$$

It is straightforward that the above assignments and payoffs satisfy conditions 1 and 2 of Definition 1 (the definition of the market equilibrium). Next we show that condition 2 of the equilibrium is also satisfied, $Eu_i^* + Ev_j^* \geq Eu^{i,j} + Ev^{i,j}$, for any i, j. That is, the equilibrium cannot be blocked by a deviating individual (couple).

1. $i = 1r,\ j = 0r$

$$\begin{aligned} Eu_i^* + Ev_j^* - EU_{i,j} &= \theta^2\Delta t_{pp}^{rp} + \theta(1-\theta)t^{pr} - \theta(1-\theta)t^{rr} \\ &= \theta[\theta\Delta t_{pp}^{rp} - (1-\theta)\Delta t_{pr}^{rr}] \geq 0 \end{aligned}$$

as $\theta \geq \tilde{\theta}_1$, i.e., $\frac{\theta}{1-\theta} \geq \frac{\Delta t_{pr}^{rr}}{\Delta t_{pp}^{rp}}$.

2. $i = 1p,\ j = 1r$

$$\begin{aligned} Eu_i^* + Ev_j^* - EU_{i,j} &= \theta^2(\Delta t_{rp}^{rr} + t^{pp}) - \theta^2 t^{pr} \\ &= \theta^2(\Delta t_{rp}^{rr} - \Delta t_{pp}^{pr}) > 0 \end{aligned}$$

3. $i = 1p,\ j = 0p$

$$\begin{aligned} Eu_i^* + Ev_j^* - EU_{i,j} &= \theta(1-\theta)t^{pr} - (1-\theta)^2\Delta t_{rp}^{rr} - \theta(1-\theta)t^{pp} \\ &= (1-\theta)[\theta\Delta t_{pp}^{rp} - (1-\theta)\Delta t_{pr}^{rr}] \geq 0 \quad for\ \theta \geq \tilde{\theta}_1 \end{aligned}$$

4. $i = 0r,\ j = 1r$

$$\begin{aligned} Eu_i^* + Ev_j^* - EU_{i,j} &= (1-\theta)^2\Delta t_{pp}^{rp} + \theta^2(\Delta t_{rp}^{rr} + t^{pp}) - \theta(1-\theta)t^{pr} \\ &+ (1-\theta)^2(\Delta t_{rp}^{rr} + t^{pp}) - \theta(1-\theta)t^{rr} \\ &= (1-\theta)^2 t^{rr} + \theta^2\Delta t_{rp}^{rr} + \theta^2 t^{pp} - \theta(1-\theta)t^{pr} - \theta(1-\theta)t^{rr} \\ &= \theta\Delta t_{rp}^{rr} + \theta^2 t^{pp} + [\theta^2 - 2\theta(1-\theta) + (1-\theta)^2]t^{rr} - \theta^2 t^{rr} \\ &= \theta\Delta t_{rp}^{rr} + \theta^2 t^{pp} + (1-\theta^2)t^{rr} > 0 \end{aligned}$$

5. $i = 0r,\ j = 1p$

$$\begin{aligned} Eu_i^* + Ev_j^* - EU_{i,j} &= (1-\theta)^2\Delta t_{pp}^{rp} + \theta^2 t^{pp} - \theta(1-\theta)t^{pr} + (1-\theta)^2(\Delta t_{rp}^{rr} + t^{pp}) - \theta(1-\theta)t^{rp} \\ &= (1-\theta)^2 t^{rr} + \theta^2 t^{pp} - 2\theta(1-\theta)t^{rp} > 0 \end{aligned}$$

under the assumption $\frac{t^{rp}}{t^{pp}} < \frac{\Delta t_{rp}^{rr}}{\Delta t_{pp}^{rp}}$, i.e., $t^{rr}t^{pp} > (t^{rp})^2$.

6. For $i = 0p$ or, $j = 0p$, the way that the equilibrium payoff is derived guarantees that

$$Eu_i^* + Ev_j^* - EU_{i,j} \geq 0$$

Note that the measure of mixed marriages across the wealth status is

$$A(mixed\ wealth) = A_{1r,1p} + A_{1p,0r} + A_{0r,0p} = 3(1-\mu) \tag{3}$$

The measure of mixed marriages across the health marker is

$$A(mixed\ marker) = A_{1p,0r} = 1 - \mu \tag{4}$$

The expected health of children

$$Eq^* = \theta^2\mu + \theta(1-\theta)(1-\mu) + (1-\theta)^2(2\mu - 1) \tag{5}$$

<u>Case 2</u>: $\frac{t^{rp}}{t^{pp}} \leq \frac{\theta}{1-\theta} < \frac{\Delta t^{rr}_{pr}}{\Delta t^{rp}_{pp}}$

Let $\tilde{\theta_2}$ be the cutoff value of θ so that $\frac{\tilde{\theta_2}}{1-\tilde{\theta_2}} = \frac{t^{rp}}{t^{pp}}$. In the case where $\tilde{\theta_2} \leq \theta < \tilde{\theta_1}$, not all the types have the same preferences over the type of spouses. The matching pattern is different from that of a nontransferable utility model. For type $1r$ and type $0r$ men, the marginal contribution of type $0r$ women to marital surplus is greater than that of type $1p$ women. For type $1p$ men, the marginal contribution of type $1p$ women still outweighs that of type $0r$ women.

The equilibrium marriage distribution is summarized in the following matrix:

$$\mathbf{A} = \left[\begin{array}{c|ccccc} & 1r & 1p & 0r & 0p & \phi \\ \hline 1r & \frac{\mu}{2} & & \frac{1}{2} - \frac{\mu}{2} & & \\ 1p & & \frac{\mu}{2} & & \frac{1}{2} - \frac{\mu}{2} & \\ 0r & & & \mu - \frac{1}{2} & 1 - \mu & \\ 0p & & & & 2\mu - \frac{3}{2} & 2(1-\mu) \\ \phi & & & & & \end{array}\right] \tag{6}$$

$$Eu_i^* = \begin{cases} \theta(1-\theta)t^{rr} - (1-\theta)^2\Delta t^{rr}_{rp} - (1-\theta)^2 t^{pp} & \text{if } i = 1r \\ \theta_2 t^{pp} & \text{if } i = 1p \\ (1-\theta)^2\Delta t^{rp}_{pp} & \text{if } i = 0r \\ 0 & \text{if } i = 0p \end{cases}$$

$$Ev_j^* = \begin{cases} \theta^2 t^{rr} - \theta(1-\theta)t^{rr} + (1-\theta)^2\Delta t^{rr}_{rp} + (1-\theta)^2 t^{pp} & \text{if } j = 1r \\ (\theta^2 - \theta_2)t^{pp} & \text{if } j = 1p \\ (1-\theta)^2(\Delta t^{rr}_{rp} + t^{pp}) & \text{if } j = 0r \\ (1-\theta)^2 t^{pp} & \text{if } j = 0p \end{cases}$$

It is straightforward that the above assignments and payoffs satisfy conditions 1 and 2 of Definition 1 (the definition of the market equilibrium). Next we show that condition 2 of the equilibrium is also satisfied, $Eu_i^* + Ev_j^* \geq Eu^{i,j} + Ev^{i,j}$, for any i, j. That is, the equilibrium cannot be blocked by a deviating individual (couple).

1. $i = 1r,\ j = 1p$

$$\begin{aligned} Eu_i^* + Ev_j^* - EU_{i,j} &= \theta(1-\theta)t^{rr} - (1-\theta)^2\Delta t^{rr}_{rp} - (1-\theta)^2 t^{pp} + (\theta^2 - \theta_2)t^{pp} - \theta^2 t^{rp} \\ &= (2\theta - 1)[(1-\theta)t^{rr} - t^{rp} + \theta t^{pp}] \\ &= (2\theta - 1)[(1-\theta)\Delta t^{rr}_{rp} - \theta t^{rp}_{pp}] \end{aligned}$$

as $\theta < \tilde{\theta}_1$, i.e., $\frac{\theta}{1-\theta} < \frac{\Delta t^{rr}_{pr}}{\Delta t^{rp}_{pp}}$.

2. $i = 1p,\ j = 1r$

$$\begin{aligned} Eu_i^* + Ev_j^* - EU_{i,j} &= \theta_2 t^{pp} + \theta^2 t^{rr} - \theta(1-\theta)t^{rr} + (1-\theta)^2(\Delta t^{rr}_{rp} + t^{pp}) - \theta^2 t^{pr} \\ &= (1-\theta)\theta t^{pp} - [(1-\theta)^2 + \theta^2]t^{pr} + [\theta^2 - (1-\theta)\theta + (1-\theta)^2]t^{rr} \\ &= (1-\theta)\theta(t^{pp} + t^{rr} - 2t^{rp}) - [(1-\theta) - \theta]^2 t^{rp} + [(1-\theta) - \theta]^2 t^{rr} \\ &= (1-\theta)\theta(t^{pp} + t^{rr} - 2t^{rp}) + (1-2\theta)^2\Delta t^{rr}_{rp} > 0 \end{aligned}$$

3. $i = 1p,\ j = 0r$

$$\begin{aligned} Eu_i^* + Ev_j^* - EU_{i,j} &= \theta_2 t^{pp} + (1-\theta)^2(\Delta t^{rr}_{rp} + t^{pp}) - \theta(1-\theta)t^{pr} \\ &= (1-\theta)^2 t^{rr} - (1-\theta)^2 t^{rp} + \theta(1-\theta)t^{pp} - \theta(1-\theta)t^{pr} \\ &= (1-\theta)[(1-\theta)\Delta t^{rr}_{rp} - \theta\Delta t^{rp}_{pp}] > 0 \end{aligned}$$

for $\theta < \tilde{\theta}_1$.

4. $i = 0r,\ j = 1r$

$$\begin{aligned} Eu_i^* + Ev_j^* - EU_{i,j} &= (1-\theta)^2\Delta t^{rp}_{pp} + \theta^2 t^{rr} - \theta(1-\theta)t^{rp} + (1-\theta)^2(\Delta t^{rr}_{rp} + t^{pp}) - \theta(1-\theta)t^{pr} \\ &= (1-\theta)^2 t^{rr} + \theta^2\Delta t^{rr}_{rp} + \theta^2 t^{pp} - \theta(1-\theta)t^{pr} - \theta(1-\theta)t^{rr} \\ &= [\theta^2 + (1-\theta)^2]t^{rr} > 0 \end{aligned}$$

5. $i = 0r,\ j = 1p$

$$\begin{aligned} Eu_i^* + Ev_j^* - EU_{i,j} &= (1-\theta)^2 \Delta t_{pp}^{rp} + (\theta^2 - \theta_2) t^{pp} - \theta(1-\theta) t^{pr} \\ &= (2\theta - 1)[\theta t^{pp} - (1-\theta) t^{rp}] > 0 \end{aligned}$$

for $\theta > \tilde{\theta}_2$.

6. For $i = 0p$ or, $j = 0p$, the way that the equilibrium payoff is derived guarantees that

$$Eu_i^* + Ev_j^* - EU_{i,j} \geq 0$$

The measure of mixed marriages across the wealth status is

$$A(mixed\ wealth) = A_{0r,0p} = 1 - \mu \tag{7}$$

The measure of mixed marriages across the health marker is

$$A(mixed\ marker) = A_{1r,0r} + A_{1p,0p} = 1 - \mu \tag{8}$$

The expected health of children

$$Eq^* = \theta^2 \mu + \theta(1-\theta)(1-\mu) + (1-\theta)^2(2\mu - 1) \tag{9}$$

Case 3: $\frac{1}{2} < \frac{\theta}{1-\theta} < \frac{t^{rp}}{t^{pp}}$

This case is straightforward too. When $\frac{1}{2} < \theta < \tilde{\theta}_2$, for any $i, j \in \{1r, 1p, 0r, 0p\}$, the marginal contribution of type $0r$ to marital surplus outweigh that of type $1p$. Both men and women have the same order of preferences over the spouse's type: $1r > 0r > 1p > 0p$. This case is similar the one-dimension matching problem. The highest price offered to a groom of type i from all types below is from the type with expected marital output just below. Given lemma 1, it is never worthwhile for higher-type brides to marry down.

The equilibrium marriage distribution is summarized in the following matrix:

$$\mathbf{A} = \left[\begin{array}{c|ccccc} & 1r & 1p & 0r & 0p & \phi \\ \hline 1r & \frac{\mu}{2} & & \frac{1}{2}-\frac{\mu}{2} & & \\ 1p & & \frac{3}{2}\mu-1 & & \frac{3}{2}(1-\mu) & \\ 0r & & 1-\mu & \mu-\frac{1}{2} & & \\ 0p & & & & 2\mu-\frac{3}{2} & 2(1-\mu) \\ \phi & & & & & \end{array}\right] \tag{10}$$

where $a_{i,j}$ equals to the size of type-i men who are matched with type-j women.

The equilibrium expected payoffs of men (u_i^*) and of women (v_j^*) are summarized as below.

$$Eu_i^* = \begin{cases} \theta_2 t^{rr} + \theta(1-\theta)t^{rp} - (\theta^2-\theta_2)t^{pp} & \text{if } i = 1r \\ \theta_2 t^{pp} & \text{if } i = 1p \\ \theta(1-\theta)t^{rp} - (\theta^2-\theta_2)t^{pp} & \text{if } i = 0r \\ 0 & \text{if } i = 0p \end{cases}$$

$$Ev_j^* = \begin{cases} (\theta^2-\theta_2)t^{rr} - \theta(1-\theta)t^{rp} + (\theta^2-\theta_2)t^{pp} & \text{if } j = 1r \\ (\theta^2-\theta_2)t^{pp} & \text{if } j = 1p \\ (1-\theta)^2 t^{rr} - \theta(1-\theta)t^{rp} + (\theta^2-\theta_2)t^{pp} & \text{if } j = 0r \\ (1-\theta)^2 t^{pp} & \text{if } j = 0p \end{cases}$$

The measure of mixed marriages across the wealth status is

$$A(mixed\ wealth) = A_{0r,1p} = 1-\mu \tag{11}$$

It is straightforward that the above assignments and payoffs satisfy conditions 1 and 2 of Definition 1 (the definition of the market equilibrium). Next we show that condition 2 of the equilibrium is also satisfied, $Eu_i^* + Ev_j^* \geq Eu^{i,j} + Ev^{i,j}$, for any i, j. That is, the equilibrium cannot be blocked by a deviating individual (couple).

1. $i = 1r,\ j = 1p$

$$\begin{aligned} Eu_i^* + Ev_j^* - EU_{i,j} &= \theta_2 t^{rr} + \theta(1-\theta)t^{rp} - \theta^2 t^{rp} = (2\theta-1)[(1-\theta)t^{rr} - \theta t^{rp}] \\ &= (2\theta-1)\{[(1-\theta)\Delta t_{rp}^{rr} - \theta\Delta t_{pp}^{rp}] + [(1-\theta)t^{rp} - \theta t_{pp}]\} > 0 \end{aligned}$$

as $\theta \leq \tilde{\theta}_2$, i.e., $\frac{\theta}{1-\theta} \leq \frac{t^{rp}}{t^{pp}} < \frac{\Delta t^{rr}_{pr}}{\Delta t^{rp}_{pp}}$.

2. $i = 1p,\ j = 1r$

$$\begin{aligned} Eu_i^* + Ev_j^* - EU_{i,j} &= \theta_2 t^{pp} + (\theta^2 - \theta_2)t^{rr} - \theta(1-\theta)t^{rp} + (\theta^2 - \theta_2)t_{rp} - \theta^2 t^{pr} \\ &= (\theta^2 - \theta_2)t^{rr} - \theta t^{rp} + \theta^2 t^{pp} \\ &= (2\theta - 1)^2 t^{rr} + \theta(1-\theta)t^{rr} + \theta^2 t^{pp} - \theta[(1-\theta) + \theta]t^{rp} \\ &= (2\theta - 1)^2 t^{rr} + \theta[(1-\theta)\Delta t^{rr}_{rp} - \theta \Delta t^{rp}_{pp}] > 0 \end{aligned}$$

for $\theta \leq \tilde{\theta}_2 < \tilde{\theta}_1$.

3. $i = 1p,\ j = 0r$

$$\begin{aligned} Eu_i^* + Ev_j^* - EU_{i,j} &= \theta_2 t_{pp} + (1-\theta)^2 t^{rr} - \theta(1-\theta)t^{rp} + (\theta^2 - \theta_2)t^{pp}) - \theta(1-\theta)t^{pr} \\ &= (1-\theta)^2 t^{rr} + \theta^2 t^{pp} - 2\theta(1-\theta)t^{rp} > 0 \end{aligned}$$

under the assumption $\frac{t^{rp}}{t^{pp}} < \frac{\Delta t^{rr}_{rp}}{\Delta t^{rp}_{pp}}$, i.e., $t^{rr}t^{pp} > (t^{rp})^2$.

4. $i = 0r,\ j = 1r$

$$\begin{aligned} Eu_i^* + Ev_j^* - EU_{i,j} &= \theta(1-\theta)t^{rp} - (\theta^2 - \theta_2)t^{pp} + (\theta^2 - \theta_2)t^{rr} - \theta(1-\theta)t^{rp} \\ &+ (\theta^2 - \theta_2)t^{pp} - \theta(1-\theta)t^{rr} \\ &= [(\theta)^2 - (1-\theta)(2\theta - 1) - \theta(1-\theta)]t^{rr} \\ &= (2\theta - 1)^2 t^{rr} \geq 0 \end{aligned}$$

5. For $i = 0p$ or, $j = 0p$, the way that the equilibrium payoff is derived guarantees that

$$Eu_i^* + Ev_j^* - EU_{i,j} \geq 0$$

The measure of mixed marriages across the health marker is

$$A(mixed\ marker) = A_{1r,0r} + A_{1p,0p} + A_{0r,1p} = 3(1-\mu) \tag{12}$$

The expected health of children

$$Eq^* = \theta^2[2\mu - 1] + \theta(1-\theta)3(1-\mu) + (1-\theta)^2(3\mu - 2) \tag{13}$$

Our equilibrium construction ensures that all conditions of the Definition 1 are satisfied. We have also checked one by one all the conditions. So $\{\mathbf{A}, u_i^*, u_j^*\}$ defined above constitutes a marriage equilibrium for part (i). For brevity we will omit the above statement for all the other equilibria constructed in this paper.

$\square$

Proof of Proposition 1: Given the equilibrium solution, it is easy to show that Proposition 1 holds.

As θ decreases, the marriage matching pattern changes from case 1 to case 3. The measures for mixed-wealth marriages and mixed-marker marriages can be respectively illustrated as below.

$$A(mixed\ wealth) = \begin{cases} 3(1-\mu) & \text{if } \theta > \tilde{\theta}_1. \text{ (case 1)} \\ 1-\mu & \text{if } \tilde{\theta}_2 \leq \theta \leq \tilde{\theta}_1. \text{ (case 2)} \\ 1-\mu & \text{if } \theta < \tilde{\theta}_1. \text{ (case 3)} \end{cases}$$

$$A(mixed\ marker) = \begin{cases} 1-\mu & \text{if } \theta > \tilde{\theta}_1. \text{ (case 1)} \\ 1-\mu & \text{if } \tilde{\theta}_2 \leq \theta \leq \tilde{\theta}_1. \text{ (case 2)} \\ 3(1-\mu) & \text{if } \theta < \tilde{\theta}_1. \text{ (case 3)} \end{cases}$$

It is obvious that the measure of mixed-SES marriages decreases and the measure of mixed-marker marriages increases while θ decreases. In other words, the sorting on wealth increases and the sorting on health marker decreases as the health signal becomes more imprecise. E.O.P.

Proof of Proposition 2: Expected health of children declines as the health marker becomes more noisy.

Proof: Let's denote $Eq^{(c)*}$ as the expected child health in case c. The core solution shows that

$$Eq^{(c)*} = \begin{cases} \theta^2\mu + \theta(1-\theta)(1-\mu) + (1-\theta)^2(2\mu-1) & \text{if } \theta \geq \tilde{\theta}_2. \text{ (cases 1, 2)} \\ \theta^2(2\mu-1) + \theta(1-\theta)3(1-\mu) + (1-\theta)^2(3\mu-2) & \text{if } \theta < \tilde{\theta}_2. \text{ (case 3)} \end{cases}$$

We first show that $Eq^{(1)*} = Eq^{(2)*} > Eq^{(3)*}$, for $\frac{1}{2} \leq \theta \leq 1$ and $\mu < 1$.

$$\begin{aligned} Eq^{(3)*} - Eq^{(1)*} &= -\theta^2(1-\mu) + \theta(1-\theta)2(1-\mu) - (1-\theta)^2(1-\mu) \\ &= -(2\theta-1)^2(1-\mu) \leq 0 \end{aligned}$$

where equality only holds when $\theta = \frac{1}{2}$.

Next we show that $Eq^{(1)*}$ increases in θ.

$$\begin{aligned} \frac{\partial Eq^{(1)*}}{\partial \theta} &= 8\theta\mu - 4\theta - 5\mu + 3 \\ \frac{\partial^2 Eq^{(1)*}}{\partial \theta^2} &= 8\mu - 4 > 0 \end{aligned} \tag{14}$$

Since $\frac{\partial Eq^{(1)*}}{\partial \theta}|_{\theta=\frac{1}{2}} = 1 - \mu > 0$, given $\frac{\partial^2 Eq^{(1)*}}{\partial \theta^2} > 0$ and $\theta \geq \frac{1}{2}$, we have $\frac{\partial Eq^{(1)*}}{\partial \theta} > 0$ for $\frac{1}{2} \leq \theta \leq 1$. So $Eq^{(1)*}$ increases in θ.

Similarly we can show that $Eq^{(3)*}$ increases in θ.

Therefore, as θ deceases, the expected health of children decreases. E.O.P.

Proof of Proposition 3: When the precision of the health marker θ decreases, the average expected marital output generally decreases.

Let's denote $EU^{(c)*}$ as the average equilibrium expected marital output in case c. We first show that $EU^{(c)*}$ increases in θ, for $c \in \{1, 2, 3\}$.

Given the equilibrium matching and expected marital output for each type of couples, the average expected marital output in case 1 is as follows.

$$\begin{aligned} EU^{(1)*} &= \frac{1}{2\mu}\{\frac{\mu}{2}\theta^2 t^{rr} + (\frac{1}{2} - \frac{\mu}{2})\theta^2 t^{rp} + (\mu - \frac{1}{2})\theta^2 t^{pp} + (1-\mu)\theta(1-\theta)t^{pr} \\ &+ (\frac{3\mu}{2} - 1)(1-\theta)^2 t^{rr} + \frac{3}{2}(1-\mu)[(1-\theta)^2 t^{rp} + (2\mu - \frac{3}{2})(1-\theta)^2 t^{pp}\} \end{aligned} \tag{15}$$

Thus

$$\begin{aligned}\frac{\partial EU^{(1)*}}{\partial\theta} &= \mu\theta t^{rr} - \mu(1-\theta)t^{rr} + 2(1-\mu)(1-\theta)t^{rr} - 2(1-\mu)(1-\theta)t^{rp} \\ &+ (2\mu-1)\theta t^{pp} - (2\mu-1)(1-\theta)t^{pp} - (2\mu-2)(1-\theta)t^{pp} \\ &= \mu t^{rr}(2\theta-1) + 2(1-\mu)(1-\theta)t^{rr} - 2(1-\mu)(1-\theta)t^{rp} \\ &+ (2\mu-1)(2\theta-1)t^{pp} + 2(1-\mu)(1-\theta)t^{pp} \qquad (16)\end{aligned}$$

Therefore, $EU^{(1)*}$ increases in θ.

The average expected marital output in case 2 is as follows.

$$\begin{aligned}EU^{(2)*} &= \frac{1}{2\mu}\{\frac{\mu}{2}\theta^2 t^{rr} + (\frac{1}{2}-\frac{\mu}{2})\theta(1-\theta)t^{rr} + \frac{\mu}{2}\theta^2 t^{pp} + (\frac{1}{2}-\frac{\mu}{2})\theta(1-\theta)t^{pp} \\ &+ (\mu-\frac{1}{2})(1-\theta)^2 t^{rr} + (1-\mu)(1-\theta)^2 t^{rp} + (2\mu-\frac{3}{2})(1-\theta)^2 t^{pp}\}\end{aligned}$$

Similar to case 1,

$$\begin{aligned}\frac{\partial EU^{(2)*}}{\partial\theta} &= \mu\theta t^{rr} + \frac{1}{2}(1-\mu)(1-2\theta)t^{rr} + \mu\theta t^{pp} + \frac{1}{2}(1-\mu)(1-2\theta)t^{pp} \\ &- 2(\mu-\frac{1}{2})(1-\theta)t^{rr} - 2(1-\mu)(1-\theta)t^{rp} - (4\mu-3)(1-\theta)t^{pp}\end{aligned}$$

Note that $\frac{\partial^2 EU^{(2)*}}{\partial\theta^2} = 2(2\mu-1)t^{rr} + 2(1-\mu)t^{rp} + 2(3\mu-2)t^{pp} > 0$, so $\frac{\partial EU^{(2)*}}{\partial\theta}$ increases in θ. And

$$\frac{\partial EU^{(2)*}}{\partial\theta}|_{\theta=1/2} = \frac{1}{2}(1-\mu)(t^{rr} + 3t^{pp} - 2t^{rp}) > 0$$

Therefore, $EU^{(2)*}$ increases in θ as $\theta \geq \frac{1}{2}$.

The average expected marital output in case 3 is as follows.

$$\begin{aligned}EU^{(3)*} &= \frac{1}{2\mu}\{\frac{\mu}{2}\theta^2 t^{rr} + (\frac{1}{2}-\frac{\mu}{2})\theta(1-\theta)t^{rr} + (\frac{3\mu}{2}-1)\theta^2 t^{pp} + \frac{3}{2}(1-\mu)\theta(1-\theta)t^{pp} \\ &+ (1-\mu)\theta(1-\theta)t^{rp} + (\mu-\frac{1}{2})(1-\theta)^2 t^{rr} + (2\mu-\frac{3}{2})(1-\theta)^2 t^{pp}\}\end{aligned}$$

Thus

$$\begin{aligned}\frac{\partial EU^{(3)*}}{\partial\theta} &\propto \mu\theta t^{rr} + \frac{1}{2}(1-\mu)(1-2\theta)t^{rr} + (3\mu-2)\theta t^{pp} + (1-\mu)(1-2\theta)t^{rp} \\ &- (2\mu-1)(1-\theta)t^{rr} - 2(2\mu-\frac{3}{2})(1-\theta)t^{pp}\end{aligned}$$

We can also get

$$\frac{\partial^2 EU^{(3)*}}{\partial\theta^2} \propto (2\mu-1)t^{rr}+(5\mu-4)t^{pp}-(1-\mu)t^{rp} \quad (17)$$

$$= (2\mu-1)t^{rr}+(4\mu-2)t^{pp}-(1-\mu)t^{pp}-(1-\mu)t^{rp} \quad (18)$$

$$> (2\mu-1)t^{rr}+(4\mu-2)t^{pp}-2(1-\mu)t^{rr}=(4\mu-3)t^{rr}+(4\mu-2)t^{pp}>0$$

And $\frac{\partial EU^{(3)*}}{\partial\theta}|_{\theta=1/2}=\frac{1}{2}(1-\mu)(t^{rr}+t^{pp})>0$, so $\frac{\partial EU^{(3)*}}{\partial\theta}>0$. Therefore $EU^{(3)*}$ increases in θ.

In addition, for given any $\theta\in(\frac{1}{2},1]$

$$EU^{(2)*}-EU^{(3)*} = (1-\mu)(2\theta-1)[\theta t^{pp}-(1-\theta)t^{rp}]$$

$$EU^{(1)*}-EU^{(2)*} = \frac{1}{2}(1-\mu)[\theta\Delta r^{rp}_{pp}-(1-\theta)\Delta t^{rr}_{rp}]$$

Therefore, as illustrated in Figure 5 in the text, except for the small jump at Φ_2, average expected marital output increases in θ.

Proof of Proposition 4:

Proof of 4(1):

Let $\zeta_g^{(c)*}$ denote the difference in average expected utility between type 1 and type 0 individuals of gender g in case c, where$g\in\{W,M\};c\in\{1,2,3\}$. It is easy to show that, for gender g, $g\in\{W,M\}$, $\zeta_g^{(1)*}\geq\zeta_g^{(2)*}\geq\zeta_g^{(3)*}$.

$$\begin{aligned}
\zeta_W^{(1)*} &= \frac{1}{2}[Ev_{1r}^{(1)*}+Ev_{1p}^{(1)*}-Ev_{0r}^{(1)*}-Ev_{0p}^{(1)*}] \\
&= \theta^2(\Delta t^{rr}_{rp}+t^{pp})-2\theta(1-\theta)t^{pr}+(1-\theta)^2(\Delta t^{rr}_{r}p+t^{pp})+\theta^2t^{pp}-(1-\theta)^2t^{pp} \\
&= [\theta^2+(1-\theta)^2]\Delta t^{rr}_{rp}+2\theta[\theta t^{pp}-(1-\theta)t^{pr}] \\
&= t^{rr}-t^{rp}-\theta t^{rr}+\theta t^{pp} \\
\zeta_W^{(2)*} &= \theta^2t^{rr}-\theta(1-\theta)t^{rr}+(1-\theta)^2\Delta t^{rr}_{rp}+(\theta^2-\theta_2)t^{pp}-(1-\theta)^2(\Delta t^{rr}_{rp}+t^{pp})-(1-\theta)^2t^{pp} \\
&= \theta(2\theta-1)(t^{rr}+t^{pp}) \\
\zeta_W^{(3)*} &= (\theta^2-\theta_2)(t^{rr}+t^{pp})-\theta(1-\theta)t^{rp}+(\theta^2-\theta_2)t^{pp}-(1-\theta)^2t^{rr} \\
&+ \theta(1-\theta)t^{rp}-(\theta^2-\theta_2)t^{pp}-(1-\theta)^2t^{pp} \\
&= \theta(2\theta-1)(t^{rr}+t^{pp}) \\
\zeta_W^{(1)*}-\zeta_W^{(2)*} &= (1-\theta)t^{rr}+\theta t^{pp}+(2\theta-1)t^{pr}>0 \quad (19)
\end{aligned}$$

Therefore, $\zeta_W^{(1)*} > \zeta_W^{(2)*} = \zeta_W^{(3)*}$ for any $\theta > \frac{1}{2}$. It is also easy to show that $\zeta_W^{(1)*}, \zeta_W^{(2)*}, \zeta_W^{(3)*}$ increases in θ when $\theta \geq 1/2$.

Similarly,

$$\begin{aligned}
\zeta_M^{(1)*} &= \theta^2 \Delta t_{pp}^{rp} + 2\theta(1-\theta)t^{rp} - 2(1-\theta)^2(\Delta t_{rp}^{rr} + t^{pp}) - (1-\theta)^2 \Delta t_{pp}^{rp} \\
&= t^{rp} + [\theta^2 + (1-\theta)^2]t^{pp} - 2(1-\theta)^2 t^{rr} \\
\frac{\partial \zeta_M^{(2)}}{\partial \theta} &= 2(2\theta - 1)t^{pp} + 4(1-\theta)t^{rr} > 0 \\
\zeta_M^{(2)*} &= \theta(1-\theta)t^{rr} - (1-\theta)^2(\Delta t_{rp}^{rr} + t^{pp}) + \theta_2 t^{pp} - (1-\theta)^2 \Delta t_{pp}^{rp} \\
&= (1-\theta)(2\theta - 1)(t^{rr} + t^{pp}) \\
\zeta_M^{(3)*} &= (1-\theta)(2\theta - 1)(t^{rr} + t^{pp})
\end{aligned}$$

Therefore, $\zeta_M^{(1)*} > \zeta_M^{(2)*} = \zeta_M^{(3)*}$ for any $\theta > \frac{1}{2}$.

Proof of Prop 4(2):

Let $\xi_g^{(c)*}$ denote the difference in average expected utility between type r and type p individuals of gender g in case c, where$g \in \{W, M\}; c \in \{1, 2, 3\}$. It is easy to show that, for gender g, $g \in \{W, M\}$, $\zeta_g^{(1)*} \geq \zeta_g^{(2)*} \geq \zeta_g^{(3)*}$.

$$
\begin{aligned}
\xi_M^{(1)*} &= \theta^2 \Delta t^{rp} + \theta(1-\theta)t^{pr} - (1-\theta)^2(\Delta t_{rp}^{rr} + t^{pp}) + (1-\theta)^2 \Delta t_{pp}^{rp} \\
&- \theta(1-\theta)t^{pr} + (1-\theta)^2(\Delta t_{rp}^{rr} + t^{pp}) \\
&= [\theta^2 + (1-\theta^2)]\Delta t_{pp}^{rp} \\
\xi_M^{(2)*} &= \theta(1-\theta)t^{rr} - (1-\theta)^2 \Delta t_{rp}^{rr} - (1-\theta)^2 t^{pp} + (1-\theta)^2 \Delta t_{pp}^{rp} - (1-\theta)(2\theta-1)t^{pp} \\
&= (1-\theta)(2\theta-1)(t^{rr} - t^{pp}) + 2(1-\theta)^2 \Delta t_{pp}^{rp} \\
\xi_M^{(3)*} &= \theta_2(t^{rr} - t^{pp}) + 2\theta(1-\theta)t^{rp} - 2(\theta^2 - \theta_2)t^{pp} \\
\xi_W^{(1)*} &= [\theta^2 + (1-\theta)^2]\Delta t_{rp}^{rr} \\
\xi_W^{(2)*} &= \theta(2\theta-1)t^{rr} + 2(1-\theta)^2 \Delta t_{rp}^{rr} - \theta(2\theta-1)t^{pp} \\
\xi_W^{(3)*} &= [\theta^2 - \theta_2 + (1-\theta^2)]t^{rr} - 2\theta(1-\theta)t^{rp} + \theta(2\theta-1)t^{pp} \\
\xi^{(1)*} - \xi^{(2)*} &= \xi_M^{(1)*} + \mu\xi_W^{(1)*} - \xi_M^{(1)*} - \mu\xi_W^{(2)*} \\
&= (\xi_M^{(1)*} - \xi_M^{(2)*}) + \mu(\xi_W^{(1)*} - \xi_W^{(2)*}) \\
&= (1-\mu)(2\theta-1)[\theta\Delta t_{pp}^{rp} - (1-\theta)\Delta t_{rp}^{rr}] < 0 \;\; if \quad \tilde{\theta}_2 < \theta < \tilde{\theta}_1 \\
\xi^{(2)*} - \xi^{(3)*} &= \xi_M^{(2)*} + \mu\xi_W^{(2)*} - \xi_M^{(3)*} - \mu\xi_W^{(3)*} \\
&= (\xi_M^{(2)*} - \xi_M^{(3)*}) + \mu(\xi_W^{(2)*} - \xi_W^{(3)*}) \\
&= (1-\mu)(2\theta-1)[\theta t^{pp} - (1-\theta)t^{rp}] < 0 \;\; if \;\; \theta < \tilde{\theta}_2
\end{aligned}
$$

Note that as in case 1 where $\theta > \tilde{\theta}_1$, both $\xi_M^{(1)*}$ and $\xi_W^{(1)*}$ are increasing in θ. That is, the more precise the information cue is, the wider the utility gap between the rich and the poor is. However, if θ is lower, $\tilde{\theta}_2 < \theta < t\tilde{h}eta_1$, the sorting on health cue decreases. Compared to case 1, the utility gap between the rich and the poor is wider for males in case 1 while that for females is smaller. The average utility gap between the rich and the poor increases. In case 3, sorting on SES further increases compared to that in case 2. Overall utility gap between the rich and the poor is further entrenched.

Proof of 4(3):

Let $\eta^{(c)*}$ denote the difference in the average expected utility between women and men in case c, i.e., $\eta^{(c)*} = Ev^{(c)*} - Eu^{(c)*}$.

We first show $\eta^{(1)*} > \eta^{(2)*} > \eta^{(3)*}$ for any given θ.

$$\begin{aligned}
\eta^{(1)*} - \eta^{(2)*} &= (Ev^{(1)*} - Eu^{(1)*}) - (Ev^{(2)*} - Eu^{(2)*}) \\
&= (Ev^{(1)*} - Ev^{(2)*}) - (Eu^{(1)*} - Eu^{(2)*}) \\
&= (1-\theta^2)t^{rr} + \theta t^{pp} - [(1-\theta)^2 + \theta(1-\theta)]t^{rp} \\
&= (1-\theta^2)\Delta t^{rr}_{rp} + \theta[\theta t^{pp} - (1-\theta)t^{rp}]
\end{aligned}$$

Note that in cases (1) and (2), $\theta > \tilde{\theta}_1 = \frac{t^{rp}}{t^{pp}}$, so $\eta^{(1)*} - \eta^{(2)*} > 0$.

Similarly

$$\begin{aligned}
\eta^{(2)*} - \eta^{(3)*} &= (Ev^{(2)*} - Eu^{(2)*}) - (Ev^{(3)*} - Eu^{(3)*}) \\
&= 4(1-\theta)(2\theta-1)t^{rp} + 4[\theta^2 - (1-\theta)(2\theta-1) + (1-\theta)^2]t^{pp} \\
&= 4(1-\theta)(2\theta-1)\Delta t^{rp}_{pp} + 4[\theta^2 + (1-\theta)^2]t^{pp} > 0
\end{aligned}$$

Note that as θ decreases, the average utility for type 0 women increases and that for type 1 women decreases. However, overall the average utility of women decreases more than that of men.