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ABSTRACT

One-Child Policy, Marriage Distortion, and Welfare Loss*

Using plausibly exogenous variations in the ethnicity-specific assigned birth quotas and different fertility penalties across Chinese provinces over time, we provide new evidence for the transferable utility model by showing how China's One-Child Policy induced a significantly higher unmarried rate among the population and more interethnic marriages in China. We further develop the model and find that a policy-induced welfare loss originates from not only restricted fertility but also from marriage distortion, and both depend solely on the corresponding reduced-form elasticities. Our calculations suggest that the total welfare loss is around 4.9 percent of yearly household income, with marriage distortion contributing 17 percent of this welfare loss. These findings highlight the importance of taking into consideration the unintended behavioral responses to public policies and the corresponding social consequences.

JEL Classification: H20, I31, J12, J13, J18

Keywords: One-Child Policy, marriage distortion, welfare loss

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"No union is more profound than marriage, for it embodies the highest ideals of love, fidelity, devotion, sacrifice, and family. In forming a marital union, two people become something greater than once they were."

——*Justice Anthony Kennedy.*

I. Introduction

Marriage is an important source of happiness and plays an important role in generating and redistributing welfare among individuals (e.g. Stutzer and Frey, 2006; Zimmermann and Easterlin, 2006; Dupuy and Galichon, 2014). Since Becker (1973, 1974) built up the original transferable utility model for the marriage market over 40 years ago, an established strand of literature has used and applied the model and its wide-ranging implications (Rao, 1993; Edlund, 2000; Angrist, 2002; Chiappori, Fortin, and Lacroix, 2002; Botticini and Siow, 2003). One recent paper (Choo and Siow, 2006) further developed the model to derive a reduced-form testable formula explicitly linking unobserved marriage gains to the observed marriage outcomes and then use it to estimate the loss of marriage gains due to the national legalization of abortion in the US in 1973.

However, there is little empirical evidence for the cornerstone of the transferable utility model, i.e., that individual marriage behavior and market equilibrium are shaped by potential marriage gains. The major difficulty is the rareness of exogenous variations in marriage gain since there is almost no such event or policy that assigns different gains to various types of marriages.

This paper first sheds some light on this by estimating the effects of China's One-Child Policy (OCP) on the corresponding marriage equilibrium outcomes. Since children can be sources of joy or future supporters, compulsory fertility restrictions might reduce potential marriage gains and thus the marriage equilibrium outcomes should be altered due to the distorted incentives.[1] Some unique features of the OCP implementation make it a natu-

[1]China has the largest marriage market in the world because of its huge population. The OCP was

ral setting in which to investigate the questions about the possible effects of distortions caused by the disincentives to having children on marriage. Unlike birth control policies in other nations, the OCP *directly* and *compulsorily* assigned limited birth quotas to couples. There quotas were strictly implemented by the Population and Family Planning Commissions (PFPC) at every level of government. The OCP had large ethnic, spatial, temporal variations in implementation. First, different birth quotas assigned to Both-Han (H-H), Both-minority (M-M) and Han-minority (H-M) couples, even in different regions. In almost all the provinces, H-H couples are strictly constrained to have only one (or conditionally two) births, while M-M couples are usually subject to no or less regulations of the OCP(Baochang et al., 2007; Li, Yi, and Zhang, 2011; Huang, Lei, and Zhao, Forthcoming). For H-M couples, about one-third of the provinces allowed them to have more than one births (there provinces will be called preferential-policy regions), while the others did not (non-preferential-policy regions). Second, different levels of financial penalties were imposed for an illegal birth across provinces and across years. These OCP penalties, ranged from one to five times a local household's yearly income, and they were uniformly applied to any illegal birth above the quota.[2]

To investigate how marriage outcomes were affected by the expected marriage gains, we derive three intuitive and testable hypotheses after incorporating the OCP in the model of Choo and Siow (2006). The first hypothesis supposes that, the OCP would increase the unmarried rate due to a lower expected gain from marriage, especially for Han people; second, the OCP would increase the H-M marriage rate, particularly in the preferential-policy regions; and third, the OCP would increase the utility transfer from a Han spouse to the minority partner within H-M couples in the preferential-policy regions but not in the non-preferential-policy regions.

initiated in the late 1970s and has restricted the fertility of hundreds of millions of couples for about 35 years. On Oct 29th 2015, China's government announced it would abandon the one-child policy and all couples would be allowed to have two children.

[2]Local governments are responsible for collecting the financial penalties, and a number of administrative penalties such as confiscation of property and excluding children born outside from the hukou system if the OCP penalty was not paid—are employed to assist the penalty collection.

Our empirical results provide sound evidence for the hypotheses above. Using the regional and temporal variations in the fertility-penalty rate combined with census data in China, we find that an increase in the fertility penalty at age 18-25 by one local household's yearly income increases the unmarried rate by 1.7 percentage points (39 percent of the mean) among people of Han ethnicity.[3] In addition, the fertility penalty also increase the H-M marriage rate for both Han and minority people in the preferential-policy regions; the same increase in fertility penalty increases the H-M marriage rate by 0.6 (20 percent of the mean) and 2.1 (15 percent of the mean) percentage points for the Hans and the minorities, respectively.[4] In addition, among H-M couples in the preferential-policy regions, higher fertility penalties are associated with higher-educated partners for the minorities but not for the Han people in such couples.

Investigation using several control groups further provides additional evidence for the hypotheses and support the exogeneity of the variations we employ. In contrast to the above significant impacts, fertility penalties have had a much smaller and even insignificant impact on the unmarried rate of the minorities, as well as on the H-M marriages in the non-preferential-policy regions. Also, among the H-M couples in regions without the preferential policy, the penalty rate is not correlated with partner's education for either the Hans or the minorities.

As the model suggests, the OCP implementation affects marriage outcomes through changing the expectations in the number of potential births and the relevant costs of having and raising a child. Although the expectations are not observed, we still provide some evidence by showing that the policy-induced H-M marriages tend to result in the birth of

[3]The unmarried rate among the Han ethnicity is 4.4 percent. That is, 4.4 percent of Han people aged between 25 and 55 have a status as single. Please note that being unmarried does not mean staying single forever. Especially for those under 30, many of them did not marry because they merely delayed their potential marriages. Hence, increased unmarried rate may be simply due to people delaying their marriages.

[4]The H-M marriage rates are 3.0 percent for Han and 14 percent for minorities in the preferential-policy regions. In the econometric framework, besides the local minority proportion and fixed effects for the ethnicities, type of hukou, provinces, cohorts, and calendar years, we additionally control for the province-specific linear trends in birth cohorts throughout the whole analysis to capture the heterogeneous time trends, which may be caused by differences in economic development or in an attitude change toward interethnic marriages across the regions.

more children *ex post*. More specifically, we examined whether the negative effects of the OCP on the fertility of H-M couples were smaller in regions where there are more policy-induced marriages. Our estimates show that, in the presence of preferential policies, the regions with larger positive effects of the OCP on the H-M marriage rate tend to have smaller negative effects from the OCP on fertility; however, the correlation is much weaker in the non-preferential-policy regions. These findings consistently suggest that these policy-induced H-M marriages could be motivated by the reduction in marriage gains due to the OCP in terms of the restriction on the number of permitted children.

The OCP-induced marriage behaviors are fairly consistent with the predictions originating from the transferable utility model of Choo and Siow (2006) and we conclude that the OCP has caused significant distortion in China's marriage market. Therefore, it is natural to ask how much social welfare loss is caused by this OCP-induced marriage distortion since individual behavior distorted by tax or public policies is generally associated with a social welfare loss (Chetty, 2008, 2009a,b; Hendren, 2013). The approach to welfare analysis in this paper is different from the traditional approach of structurally estimating a model's primitives and then numerically simulating the effects of policy changes. Following the methodology in Chetty (2009b), we derive a formula for the social welfare loss caused by the OCP and this formula only depends on the estimated reduced-form elasticities. Specifically, the welfare deadweight loss (DWL) is composed of two parts: the first one originates from the policy-induced declined fertility ("mechanical" effects); while the second part pertains to the marriage distortions analyzed above ("distortion" effects). Compared to the traditional method, this approach is less model-dependent and more empirically credible (Chetty, 2009b; Einav, Finkelstein, and Cullen, 2010). To the best of our knowledge, this is the first study to estimate the welfare loss caused by the OCP and also the first endeavor to apply the *sufficient statistics* approach to the marriage market.

By applying the reduced-form estimates to the model, we show that the total social-welfare loss is about 4.9 percent of total yearly household income, of which 0.85 percent

originates from the marriage distortion. Note that the traditional way to estimate the welfare loss only considers the direct mechanical-behavior response (i.e., lower fertility as described above). Our results suggest that, without accounting for the "distortion" effect, the traditional procedure would substantially underestimate the total social welfare loss by 17 percent. This finding presents the necessity to include the distortion of the marriage market when calculating the total welfare loss. As marriages are almost prerequisites for children in China, marriage choices are "distorted" by fertility policies and thus a welfare loss based only on the fertility reduction of married couples is not the whole story. These results highlight that the unintended behavioral responses following from the OCP in terms of marriage-market distortion composed a significant part of the welfare loss and should be considered by policy makers. These findings also provide some new insights into public economics, namely that the relationship between commodities need to be considered when estimating the welfare loss caused by taxes.[5]

This paper is organized as follows: section II introduces the context of this study, especially the background of the OCP and China. Section III develops a theoretical framework for the empirical predictions and the welfare implications. Section IV presents the empirical strategy and the marriage distortions caused by the OCP. Section V calculates the welfare loss caused by the OCP based on the estimates in the previous sections, while section VI concludes the paper.

II. Context: China's One-Child Policy

China's OCP was first announced in 1978, and it appeared in the amended Constitution in 1982 in further. Legal measures such as monetary penalties and subsides were employed for the effective enforcement of OCP from 1979 (Banister, 1991). In early 1984, the Communist

[5]In this study, children are considered to be downstream "goods" of marriages. Taxing children (OCP) has brought significant distortions in marriage behaviors because people can expect their gains in the potential marriages to be eroded. Our results are similar to the findings in Busse, Knittel, and Zettelmeyer (2013) who found that gasoline prices have significant impacts on the prices and quantities of sales in the new and used car markets.

Party Central Committee issued Central Document 7 as a guideline for local implementation of fertility policies (Greenhalgh, 1986). Due to the "practical difficulties" experienced in previous years, one important feature of Document 7 was greater flexibility in local practices. As a slogan at that time said, "Open a small hole to close up a big one." The central government believed that some small compromises would make the whole policy more acceptable.

The central government authorized provincial governments to design specific regulations according to their local conditions. Indeed, both the effectiveness of the implementation of the OCP and inter-ethnic harmony were on the list of evaluation criteria for local officials.[6] Therefore, preferential terms were exclusively granted to M-M families or H-M families(Baochang et al., 2007). Han residents living in urban areas were mostly allowed to have only one child, but those living in rural areas could have one or two. In almost all provinces, M-M couples were legally permitted to have more births or were not even subject to the OCP.[7] For another, about one-third of provincial governments extended the coverage of this exemption to H-M couples. For example, the Population and Family Planning Statute of Qinghai states, "Families can have one more births, if one or both sides of the couple are from minority groups."[8] We collected data regarding "exemption" terms for H-M couples in every province from the website of the National Health and Family Planning Commission of China.[9]

According to the historical policies that were available, there was no temporal variation in preferential terms for H-M couples in various provinces. We coded the dummy for the preferential policy as a 1 if the province had such terms that favored mixed couples, and a 0 otherwise. We then plotted results geographically in Figure 1.[10] In around one third of the

[6]Appendix A provides more details about China's ethnic minorities.

[7]Except for Beijing, Shanghai, Tianjin and Jiangsu.

[8]The details of this Statute are available on the National Health and Family Planning Commission (NHFPC website): http://www.nhfpc.gov.cn/zhuzhan/dftl/201304/173cafa2f5ce4ef095f392b5201b03d6.shtml

[9]The data source is the website of the National Health and Family Planning Commission: http://www.nhfpc.gov.cn/zhuzhan/dftl/lists.shtml

[10]For example, Zhuang ethnicity may not have a preferential policy in certain regions and we just code 0 for these people. Many provinces also specify that the preferential policy may only apply for rural areas and not for urban areas and we also account for this variation.

provinces (about 1.6 million people out of our 4.6 million sample lived in these provinces), the H-M couples were permitted to have one extra birth or even more. In other words, the minority people in these provinces were endowed with a nontransferable "birth quota" which could only be shared through marriage.

[Figure 1 about here]

We additionally use the average monetary-penalty rate for one unauthorized birth on the province-year panel from 1979 to 2000. The data is from Ebenstein (2010). The OCP penalty rate was formulated in multiples of yearly income, which agrees with its wide use in previous literature (Ebenstein, 2010; Wei and Zhang, 2011; Huang, Lei, and Zhao, Forthcoming). Figure 2 shows the pattern of policy fines from 1980 to 2000 in each province. It is obvious that the fines in different provinces generally follow different patterns, both in timing and in magnitude. For example, Liaoning provinces raised the fine from one year's income to five in 1992, while Guizhou raised the fine from two to five years income in 1998. The average level of the penalty was higher in the 1990s than in the 1980s, which is consistent with stricter policy enforcement in the 1990s (Attane and Courbage, 2000). We use this to identify the impact of the OCP on marriage outcomes in the following empirical analysis.

[Figure 2 about here]

III. The Model And Its Implications

3.1 Marriage distortion under the One-child policy

We follow the framework of Choo and Siow (2006) to analyze the impact of the OCP on marriage outcomes. People are divided into two types: OHan (H) or minority (M). Under the circumstance of the OCP, we suppose there are two periods: in the first period, people decide whether to marry with others and to whom they marry; in the second period, married people decide how many children to have according to the local fertility policies. However,

we assume that people are not myopic in the first period, and are able to plan the number of children to give birth to in the second period and thus behave correspondingly.

Fertility choice under the OCP First, we seek to solve the problem backwardly. A certain couple (i, j) choose the number of children to give birth to, n_{ij}, in order to maximize the household utility under the fertility policy depicted by $(\overline{n}_{ij}, f)$, where $\overline{n}_{ij}$ is the birth quota assigned to the couple (i, j), and f is the penalty fine rate for an additional illegal birth. Because the policy is very strict and only allows one birth for most couples, it is reasonable to assume it is binding (i.e., the optimal number of children to give birth to is not smaller than the birth quota, i.e., $n^*_{ij} \geqslant \overline{n}_{ij}$). For simplicity, we further assume the households utility function is quasi-linear, and they solve the problem:

$$\max_{n_{ij}} u(n_{ij}) + y_{ij} - n_{ij}C - (n_{ij} - \bar{n}_{ij})f$$

where $u(.)$ is the utility from the number of kids to give birth and is uniformly applied to all the couple, with $u' > 0$ and $u'' < 0$. y is the exogenously given household income. In the quasi-linear utility function, the financial penalties f enter the utility directly and the utility can be interpreted in monetary unit directly.[11]

The endogenous variable n_{ij} is the number of anticipated children; and C is the fixed cost of raising up a child. For simplicity, we assume the couple can choose any positive number of children ($n_{ij} \in \mathbb{R}^+$) and that there is an interior solution. We define u_{ij} as the maximized expected utility gain from the number of children for couple (i, j), which satisfies $\frac{\partial u_{ij}}{\partial f} = -(n^*_{ij} - \overline{n}_{ij}) \leq 0$, implying that potential fertility penalties will reduce the utility. However, thereduction in utility caused by a one unit increase in the penalty would be smaller as the assigned birth quotas $\overline{n}_{ij}$ increase. [12]

[11]The quasi-linear utility function simplifies the welfare implication in a large previous literature. See Chetty (2009b) for examples.

[12]For example, in some regions, minority couples are not subjected to the OCP, which suggest that $\overline{n}_{MM} = n^*_{MM}$ and thus $\frac{\partial u_{MM}}{\partial f} = 0$.

Marriage market distortion Following the setting in Choo and Siow (2006), for a type i man to marry a type j woman, he must transfer an amount of income τ_{ij} to her. The marriage market clears when, given equilibrium transfers τ_{ij}, the demand by type i men for type j spouses is equal to the supply of type j women for type i men for all i, j. We assume the numbers of men and women of Han ethnicity are both $\overline{H}$ and those of the minority are $\overline{M}$, with $\overline{H} > \overline{M}$. Each individual considers matching with a member of the opposite gender. Let the utility of a type i man g who marries a type j woman be

$$V_{ijg} = \tilde{\alpha}_{ij} - \tau_{ij} + \epsilon_{ijg}$$

where $\tilde{\alpha}_{ij}$ denotes the gross marriage gain to the man i in potential marriage (i, j). For simplicity, we consider a gender-symmetric equilibrium and suppose the above utility gained from number of children are divided between men and women equally. Therefore, $\tilde{\alpha}_{ij} = \frac{1}{2}u_{ij} + \tilde{a}_{ij}$, where $\frac{1}{2}u_{ij}$ denotes the utility gained from the expected number of children for man i and $\tilde{a}_{ij}$ represents the systematic gross return to a type i man married to a type$j$ woman other than that from the quantity of children. The payoff to g from remaining unmarried is denoted by $V_{i0g} = \tilde{\alpha}_{i0} + \epsilon_{i0g} = \tilde{a}_{i0} + \epsilon_{i0g}$. Following the assumption in Choo and Siow (2006), we also assume that ϵ_{ijg} and ϵ_{i0g} are independently and identically distributed random variables with a type I extreme-value distribution. A man g of type i will choose according to $V_{ig} = max_j\{V_{i0g}, V_{iHg}, V_{iMg}\}$.

The women's problem is symmetric, thus we let the utility of type j women g who marry a type i men be

$$W_{ijg} = \tilde{\gamma}_{ij} + \tau_{ij} + \varepsilon_{ijg}$$

in which $\tilde{\gamma}_{ij} = \frac{1}{2}u_{ij} + \tilde{b}_{ij}$, where $\frac{1}{2}u_{ij}$ denotes the utility gained from the expected number of children to women j and $\tilde{b}_{ij}$ represents the systematic gross return to a type j woman married to a type i man other than that from the quantity of children. The payoff of remaining unmarried is given by $W_{0jg} = \tilde{\gamma}_{0j} + \varepsilon_{0jg}$. Similarly, ϵ_{ijg} and ϵ_{i0g} are independently and

identically distributed random variables with a type I extreme-value distribution. Women g of type j will choose according to $W_{jg} = max_i\{W_{0jg}, W_{Hjg}, W_{Mjg}\}$.

Defining $\alpha_{ij} = \tilde{\alpha}_{ij} - \tilde{\alpha}_{i0}$, $\gamma_{ij} = \tilde{\gamma}_{ij} - \tilde{\gamma}_{i0}$ and μ_{ij} as the number of (i, j) marriages, we consider the symmetric equilibrium for men and women (i.e. $\mu_{ij} = \mu_{ji}$), and then the following holds in equilibrium for i,$j \in \{H, M\}$

$$\tau_{ij} = \frac{ln\mu_{i0} - ln\mu_{0j} + \alpha_{ij} - \gamma_{ij}}{2}$$

$$ln\mu_{ij} - \frac{ln\mu_{i0} + ln\mu_{0j}}{2} = \frac{\alpha_{ij} + \gamma_{ij}}{2}$$

$$\text{with } \mu_{H0} + \mu_{HH} + \mu_{HM} = \overline{H},\ \mu_{M0} + \mu_{MH} + \mu_{MM} = \overline{M}.$$

We have $\overline{n}_{HH} < \overline{n}_{HM} \leqslant \overline{n}_{MM}$ for preferential-policy regions; while for non-preferential-policy regions, we have $\overline{n}_{HH} = \overline{n}_{HM} < \overline{n}_{MM}$. For convenience, we define the married rate as r^i_m and the H-M marriage rate (conditional on married) as r^i_{HM} for type i individuals ($i \in \{H, M\}$). Assuming that the fertility fines do not impact the utility of being single or the systematic gross return other that than that from the number of children, we have the following empirically examinable implications (Note, the detailed mathematic proofs are provided in Appendix B).

- *The fertility fines increase the unmarried rate of Han people, especially in non-preferential-policy regions (i.e.* $\frac{\partial r^H_m}{\partial f} < 0$ *and* $\frac{\partial r^H_m}{\partial f}|_{no-pre} < \frac{\partial r^H_m}{\partial f}|_{pre} < 0$*);*

Since the fertility penalties and limited birth quotas decrease the expected utility of marriage, there would be more people choosing not to marry. In addition, because the minority couples are generally not subject to the restrictions, the effects are mainly expected among the Han ethnicities and the minorities can be used as control group when investigating the effects of the OCP on unmarried rate. Since the Han people in preferential-policy regions may choose to marry with minorities to escape from the fertility restrictions, the effects should be smaller for them.

- *The fertility fines increase the H-M marriage rate for both Han and minorities only in preferential-policy regions (i.e.* $\frac{\partial r^H_{HM}}{\partial f}|_{pre} > 0$ *and* $\frac{\partial r^M_{HM}}{\partial f}|_{pre} > 0$ *);*

In the presence of preferential policies, because H-M marriage is a way to bypass the fertility restrictions legally for the Han people, the higher level of penalties would induce a greater incentive for them to marry with minorities. Thus, there may be more H-M couples in the preferential-policy regions. However, in the absence of such preferential policies, there is no additional birth quota for H-M couples and thus people may not have an incentive to participate in such marriages. It is noteworthy there that we investigate interethnic marriage not only because interethnic marriage is shaped by the OCP but also because the interethnic marriage rate has been widely used as an indicator of the social boundary and equality between two ethnic groups in sociological and economic studies (Kalmijn, 1991; Qian and Lichter, 2007; Fryer, 2007).

- *The fertility fines increase the marriage transfer from Han to minorities only in preferential-policy regions (i.e.* $\frac{\partial \tau_{HM}}{\partial f}|_{pre} > 0$ *).*

In the preferential-policy regions, the "price" of the minority ethnicity will increase as the fertility penalties increase because the minority ethnicity in these regions is associated with additional birth quotas. Therefore, the utility transfers from Han people to the minorities among the H-M couples will increase. However, since the transfers cannot be directly observed in the data, this paper will use partner's education as a proxy to test this hypothesis.[13]

3.2 Welfare Implications

The model above yields the probability that a utility-maximizing man of type i marries a woman of type j is $P_{ij} = \frac{exp(\tilde{\alpha}_{ij})}{\sum_j exp(\tilde{\alpha}_{ij})}$ and the expected utility of a man of type i is $S_i(\tau) = ln(\sum_j exp(\tilde{\alpha}_{ij}))$. Because the utility is in monetary unit, the social surplus is the

[13]There is also a strand of economic literature studying the marriage transfers in terms of dowries (Botticini and Siow, 2003; Anderson and Bidner, 2015), bride exchange(Jacoby and Mansuri, 2010).

summation of the expected utilities of men and women as well as the penalties collected by the government:

$$\Pi = \sum_i \overline{m}_i ln(\sum_j exp(\tilde{\alpha}_{ij})) + \sum_j \overline{n}_j ln(\sum_i exp(\tilde{\gamma_{ij}})) + \sum_{i,j\neq 0} \mu_{ij}(n_{ij} - \overline{n}_{ij})f$$

where $\overline{m}_i$ and $\overline{n}_j$ denote the constant number of men of type i and that of women of type j, respectively. The first two terms on the right hand side are the expected utility from men and women, respectively, and the final term is the government income from the financial fertility penalties collected from the illegal births. we suppose that the number of illegally-born children for couple (i, j) is $c_{ij} = n_{ij} - \overline{n}_{ij}$, divide the above equation by the total population of men (or women) (i.e.$\overline{H}+\overline{M}$, which is also the number of the households), and then take the derivatives with respect to the penalty fine rate (f).[14] Then, we have

$$\begin{aligned}\frac{d\pi}{df} &= \sum_{i\in\{H,M\}} P_i\big(\sum_{j\in\{H,M\}} \frac{dr^i_m}{df} r^i_{ij} c_{ij} + \frac{dr^i_{ij}}{df} r^i_m c_{ij} + r^i_m r^i_{ij} \frac{dc_{ij}}{df}\big) f \\ &= \sum_{i\in\{H,M\}} P_i\big(\sum_{j\in\{H,M\}} r^i_m r^i_{ij} c_{ij}(e^i_m + e^i_{ij} + e^c_{ij})\big) \quad (*)\end{aligned}$$

where π is the surplus per household, P_i is the proportion of type i people in the population, r^i_m is the married rate for type i people, and r^i_{ij} is the proportion of married type i people involved in type $i-j$ marriages with $i, j \in \{H, M\}$. And e^i_m, e^i_{ij} and e^c_{ij} are the elasticities of r^i_m, r^i_{ij} and c_{ij} with respective to the penalties f. Within the parentheses of equation (i.e., $e^i_m + e^i_{ij} + e^c_{ij}$), the first two terms capture the welfare loss caused by the distortion in marriage market and we term it "distortion" effects. Specifically, the first term captures the part from whether individuals choose to marry or not: it is expected to be negative due to the expected lower utility gained from marriage. The second term captures the welfare gain or loss from the policy-induced marriage matching for different types of people: it may be positive or negative depending on the expected marriage gains assignment.

[14]The details can be found in Appendix C.

The final term originates from the fertility restricted by the potential financial punishments and we name it as "mechanical" effect. It should be negative because the children quantity is expected to be negatively correlated with the penalties. Had we followed the traditional way to only consider the tax incidence on the "taxed goods", the estimated total welfare loss induced by the OCP would be only caused by the reduction in fertility, which is captured by this final term. However, it is an empirical question as to how much the welfare loss caused by marriage distortion contributes to the total. Hence, the next few sections aim to provide some answer to this question.

It is noteworthy that Equation (*) indicates that the welfare loss depends *only* on the behavior responses to the penalties, suggesting that the corresponding elasticities (i.e. e^i_m, e^i_{ij} and e^c_{ij}) are *sufficient statistics* to calculate the welfare loss (Chetty, 2008, 2009a,b; Hendren, 2013). Most importantly, these behavioral responses can be derived directly from OLS estimations.

IV. Data

The main data used in this study are the 2000 Population Censuses and the 2005 One Percent Population Survey (referred as Census 2000 and 2005, thereafter). Both of the datasets contain gender, education level, year and month of birth, region of residence, type of *hukou* (urban/rural), *hukou* province, ethnicity, marital status, number of siblings and relation to the household head. For each household, every individual relationship with the household head is provided, which may include spouse, offspring, siblings, and parents etc. We use this information to identify couples in the households. Because the sampling rate is different in the two datasets, sampling weights are applied throughout the analyses.

We restricted our sample to those aged between 25 and 55.[15] Note that the OCP started in 1979, and the affected individuals were those who were not married yet but were likely to

[15]We restricted the minimum age to 25 because the majority of people marry before 25 (over 85 percent). We also restricted the maximum age to 55 because seniors may suffer from mortality selection or may be widowed; thus, spousal information would be missing.

marry in the near future. Thus, the affected cohorts were those born in or after 1955 (aged 24 when the OCP started). In addition, those aged 55 composed the 1945 birth cohort in the 2000 census and the 1950 birth cohort in the 2005 census, which were respectively about 10 and 5 years earlier than the first policy-affected cohort. Extending the birth cohort to older individuals may not bring a valid variation as a result. However, it is noteworthy that our results are robust with different age sample restrictions.

There are two expected outcomes in our paper: unmarried status and H-M marriages.[16] In the questionnaire, marital status is categorized in five groups: 1 for unmarried, 2 for those in a first marriage, 3 for remarried, 4 for divorced, and 5 for widowed. The married persons were asked about the year and month of their first marriage. For accuracy and simplicity, we restrict the sample to those who were single or in their first marriages (96 percent of the original sample).

To make the empirical results easier to interpret, we also use two different samples separately for the two outcomes. In practice, we use the full sample derived above to study the impact of the OCP on whether the person is married or not.However, we keep the married ones with information on spousal characteristics (88% of the sample), to study the impact of the OCP on whether people married others of their own ethnicity (Han/minorities), or different ethnicities.[17]

Table 1 shows the mean values and standard deviations for the main variables used in this study, by the Hans and the minorities. The first three columns are for the full sample, and the next three are for the married. Panel A presents the results for marriage outcomes. According to the results, 4.6% of people (i.e., 4.4% of Han and 6.6% of minorities) were unmarried at the time of the survey. Among married people, 2.9% were involved in H-M

[16]Because we analyze the sample by the Hans and the minorities, the two outcomes capture whether the respondents were married and to whom they married, respectively.

[17]The information of the spouses is missing mainly because the spouses were not currently living in the household or they refuse to provide an answer. We also use the original sample and find similar results. Based on the ethnicity information, we are able to define three categories of marriages: Han-Han (H-H), Han-minority (H-M) and minority-minority (M-M).

marriages, which is 1.6% of Han and 17.4% of minorities.[18] Given the population share of minority groups, H-M marriages are still relatively rare compared to homogamy.[19]

[Table 1 about here]

Panel B of Table 1 presents descriptive statistics of the demographic variables. On average, minorities are of lower socio-economic status than Han people. The proportion of the Hans living in urban regions (43 percent) is much higher than that of the minorities (26 percent). The average educational attainment of minorities is also substantially lower, with 16% being illiterate. However, there is no significant difference in gender composition or average age between Hans and minorities; as gender is almost balanced and the average age is about 39 across all samples.

V. Empirical Results

5.1 Marriage outcomes responding to the OCP fine rate change

We start the analysis by applying an "event study" to investigate how marriage outcomes respond to the variations in the fertility fines. We first calculate the changes in the fine rate at ages 18-25, as well as the changes in marriage outcomes (i.e., the unmarried rate and the H-M marriage rate) in two consecutive birth cohorts, within the same *hukou* province, based on the type of *hukou* (urban/rural), ethnicity (Han/minorities), and in the same survey year. We then plot or regress the changes in the marriage outcomes against those in the fine rate changes, weighted by the population in each cell of the cohort-*hukou*-province. We use

[18]Because the number of Han people and the number of minority people involved in H-M marriages are the same while the population size of the minorities is smaller, the H-M marriage rate is much higher for the minorities.

[19]Note this value is smaller than if Han and minorities married randomly (6.5 percent if marriages were randomly matched). One possibility is that people prefer homogamy partially due to the sharing same culture and language, as well as lower communication costs. Another possibility is that the interaction across different ethnicities is relatively less than that within the same ethnicity because the minorities tend to inhabit certain regions. This phenomenon is also found in the US (Fryer, 2007) and is similar to the homophily in the coauthorship of scientific papers (Freeman and Huang, 2015).

the fine rate for people at aged 18 to 25 because this is when most individuals prepare for marriage, form expectations, and seek spouses.[20]

We also trim the sample for the event study to those born later than 1950, because those born earlier would not have been subject to variations in the fine rate at their 18-25.Figures 3a and 3b show the correlations of the changes in the fine rate with changes in marriage outcomes.[21] The change in the fine rate is divided into five categories (i.e. -0.08-0, 0-0.08, 0.08-0.16, 0.16-0.24, and 0.24 or above). A higher value means a stricter policy at age 18-25 compared to the prior birth cohort. The positive slopes for the thick blue lines in both figures indicate that the stricter fertility policy increases the unmarried rate as well as the H-M marriage rate in the treated groups for each outcomes. In contrast, the increase in the fine rate appears to be uncorrelated with these outcomes in the control groups (i.e. the minorities for the unmarried rates, and people in the regions without the preferential policy for the H-M marriage rate).[22]

[Figure 3a and Figure 3b about here]

5.2 Econometric framework

To estimate the impact of the OCP on the marriage outcomes, we conduct the following regressions:

[20]The data shows that most marriages are formed during this period (about 80 percent). Figure A2 shows the distribution of marriage age. We also tried the fine rate at other age periods and the results are consistent. We also look at the mean fine rate for three years prior to the marriage, which also yields similar results, but we do not use it because the age at marriage may be endogenous to the OCP.

[21]For the outcome of unmarried status, we divide the sample into Hans and minorities because the OCP mainly aims to restrict the fertility of Han people, rather than minorities. Thus, Han people are taken as the treated group and the minorities are the control group. For the outcome of H-M marriages, we also divide the sample into preferential-policy regions and non-preferential-policy regions, and consider the former as a treated group. This is because in preferential-policy regions, Han people can obtain more birth quotas via interethnic marriage and therefore have a higher incentive to marry a minority spouse.

[22]Table A1 provide OLS consistent estimates for these by additionally controlling for ethnicities, type of residence, year of birth, calendar year, and interactions of the last two. The results show that, if the OCP penalty rate increases by one year of local household income, then the unmarried rate will increase by 1.1 percentage points and the H-M marriage rate for Han people in the preferential-policy regions will increase by 0.6 percentage point, respectively. The marriage outcomes of the control groups are not significantly influenced by the changes in penalty rate, and both the coefficients are much smaller and insignificant. Ideally, the total number of observations should be 6448. However, the number usually is smaller due to some missing values. All the standard errors are clustered at the province level.

$$Y_{ijbt} = \beta_0 + \beta_1 Fine_{jb}^{18-25} + X_{ijbt} + D_{ijbt} + \gamma_j Prov_j \times YoB_b + \epsilon_i \quad (1)$$

where the dependent variable, Y_{ijbt}, is the marriage outcome variable of an individual i of birth cohort b in province j and year t. It can be the unmarried status or the status of H-M marriages. $Fine_{jb}^{18-25}$ denotes the mean value of the penalty rate for an illegal birth in province j for birth cohort b when aged 18-25. The coefficient, $\beta_1(s)$, is of central interest because it captures the effects of the OCP penalties on marriage outcomes. It is noteworthy that we match the penalty rate according to the individual *hukou* province and their birth cohort,. Therefore, there are two potential issues. First, the husband and wife may have different hukou-registered provinces. In our sample, the proportion of couples with different hukou-registered provinces is only 0.3%, which indicates that this is not an important issue. The results are almost the same if we drop these couples. Second, the other issue is cross-province migration because it makes the province matched not the actual province where people seek for spouses. We use hukou province rather than current living province, and this can significantly alleviate the issue because most migrants in China cannot change their hukou place. In addition, the 2005 census provides birth province information and we find that only 3% of individuals have hukou province different from birth province. This number suggests the migration should not be the an important issue.

The term, X_{ijbt}, includes continuous variables such as the male and female proportions of minorities in the local province j of birth cohort b, which can be used to capture the relative size of Han and minorities in the local marriage market. The other term, D_{ijbt}, includes a series of other covariates: dummies for ethnicities to capture the time-invariant differences among the different ethnicities, such as ethnicity-invariant cultures or attitudes toward interethnic marriages; dummies for gender, age, and the combination of the two, to allow for the time-invariant and age profile differences between men and women; dummies for province, type of *hukou* and their combination, to control for the geographical fixed effects; and dummies for the year and their combination with birth cohort dummies, to allow for the changes of the age profile over time. Finally, we also control for the provincial specific linear

trends in the birth cohort, $Prov_j \times YoB_b$, to capture the potential changes in local subjective attitudes towards staying single or being in an interethnic marriage. This framework is the main identification strategy throughout our analysis, and the standard errors are clustered at the province level to allow autocorrelation within the same region over time. As we are comparing within regions, we do not need to include the timing and magnitude of the fine rate of the policy implementation to be randomly assigned across localities (Black, Devereux, and Salvanes, 2005; Meghir and Palme, 2005).

Considering the different marriage markets and marital norms of Hans and minorities, we allow for this heterogeneity by dividing the sample by Hans and minorities to conduct regressions for the two groups separately.[23] In addition, the coefficients β_1 could be interpreted at the individual level rather than at the couple level and then could be plugged into Equation (*) directly to calculate the potential welfare loss.

5.3 The OCP increased the proportion with an unmarried status

Table 2 reports the OLS estimates for the impacts of the OCP on unmarried status.[24] The first three columns are the results for Han ethnicity people and the rest are for the minorities. The estimates suggest that an increase in OCP penalty rate by one year of local household income predicts an increase of 1.7 percentage points in the unmarried rate for the Hans, while the estimate is insignificant and much smaller (0.46 percentage point) for the minorities. Since the mean value of the unmarried rate is 4.4 percent for Han people and 6.6 percent for the minorities, the coefficients for Han are larger than those for minorities, for both absolute and relative scales.

By dividing the Han sample into preferential-policy regions and non-preferential-policy regions, we find the effects of the OCP on unmarried status are greater and more significant

[23] Since the numbers of Han and minority people involved in H-M marriages are the same but the proportions in each group are different, it may not be so straightforward to interpret the coefficients if we combined the two groups together.

[24] Note that being unmarried does not mean staying in single indefinitely. Especially for those aged less than 30, many have not married because they merely delay their potential marriages. The increased unmarried rate may therefore reflect people delaying their marriages.

in non-preferential-policy regions while there is no significant difference between the mean unmarried rates for the two different types of regions.

[Table 2 about here]

Figures 4a and 4b show the gender-specific point estimates for $\beta_1(s)$, as well as the corresponding 90 percent confidential intervals. Figure 4a presents the results for the Han people. All the coefficients are positive and significant except for that for men in preferential-policy regions. The magnitude ranges from 2 to 3, which implies that an increase of one year of local household income in the penalty rate causes an increase of 2 to 3 percentage points in unmarried rates among Han people. Also, the magnitudes are larger for men than women. For example, in non-preferential-policy regions, the coefficient for men is 2.5 times larger than that for women. But this may not mean that the effects for men are larger. Because the mean values of the unmarried rates for men is also much higher than that for women,the effects of the OCP on unmarried status are similar for men and women on a relative scale.[25]

[Figures 4a and 4b about here]

In contrast, Figure 4b shows that the impact of the OCP on the unmarried rate is consistently much smaller and more insignificant for the minorities in all the subsamples. These intuitive results are consistent with the fact that the design of the OCP means it is mainly restricted the fertility of Han people, rather than the fertility of minority people. These results also provide some supportive evidence to the exogeneity of the fertility-penalty rate. That is, we should also find some effects of the OCP for the minorities if the effects were driven by some omitted variables correlated with both penalty rates and the unmarried rates, such as changes of attitudes towards marriage or economic development.

[25]In detail, 7.2 percent of Han men and 1.6 percent of Han women are unmarried, and 10.3 and 2.6 percent of minority men and women, respectively, are unmarried.

5.4 The OCP increased H-M marriages

In this section we investigate the effects of the OCP on H-M marriages. As mentioned above, some regions consistently allowed H-M couples to have more children, while others did not. The non-preferential-policy regions are used as the control group in this section.[26] Before the regression analysis, we test the parallel trends in the H-M marriage rate across the two types of regions. Figure 5 plots the H-M marriage rate of all couples over the birth cohorts based on whether local regions had the preferential policy, in order to shed some light on this apsect.

[Figure 5 about here]

Figure 5 shows fairly parallel trends in the H-M marriage rate across the two regions before the early 1950s cohorts. The preferential-policy regions saw an increase from 3.5 to 7 percent and the non-preferential-policy regions saw an increase from 1.5 to 2.3 percent. However, the two lines start to diverge after the 1955 birth cohorts, who were aged 25 at the start of OCP. The preferential-policy regions increased by 3 percentage points from 4 to 7 percent while those without the preferential policy just increased by 0.3 percentage points from 2 to 2.3 percent. However, the birth cohort trends for the average fine rates at age 18-25 for both types of regions, as presented by the two dashed lines, are very similar. This implies that the strictness of OCP itself may not have created significant differences. Thus, the divergence of the H-M marriage rate of the two types of the regions is mainly caused by the preferential policy.

One potential issue with Figure 5 is that the increase in the H-M marriage rate in the preferential-policy regions may merely be due to a higher minority proportion in the local population. Therefore, we also divide the sample into Hans and minorities and then conduct the regression analysis separately. The results are reported in Table 3. If the rise in the H-M

[26] Because our identification is based on the differences over time within local regions, we do not need this assignment to be completely random, although the preferential-policy regions are more likely to be those with more minorities.

marriage rate in preferential-policy regions is merely driven by higher minority proportions, we should expect that the policy-induced increased H-M marriage rate would only exist for the Han ethnicity, but not for the minorities. However, the estimates in columns 1 and 4 of Table 3 show positive impacts of the OCP on the H-M marriages for both the Han and for the minorities and both the effects are even larger and more significant for the preferential regions, suggesting that the local minority proportion may not be the first-order factor that leads to the pattern in Figure 5. Specifically, an increase in the penalty rate by one year of local household income is associated with an increase of 0.6 percentage points in the H-M marriage rate for Han people and with an increase of 2 percentage points for the minorities, while the effects are much smaller and insignificant for the Han people in the non-preferential-policy regions. We also find that, in the non-preferential-policy regions, the minorities became less likely to marry Han people because doing so would "waste" the birth quota, which is valid only if they were to marry other minorities.

[Table 3 about here]

Figures 6a and 6b show consistent results in the gender-specific subsamples. Also note that the impact of the OCP is quite similar between men and women; we do not find a significant gender difference in the marriage-behavior response to the OCP, either in absolute or relative scales.

[Figures 6a and 6b about here]

As mentioned before, we use the married-couple sample where information is complete for both spouses, so the effects estimated here must be interpreted as those effects that are conditional on being married. The first concern is that marriage ages are different across groups: if the H-M marriages systematically have a higher or lower marriage age and this difference is correlated with the fertility-penalty rate, then the estimates of the impacts of the OCP on H-M marriages could be biased. However, we argue that this may not be a

first-order issue. For one thing, the age difference between H-M marriages and others are small for first marriages,[27] and we find no evidence that H-M couples tend to marry later due to the OCP; For the other, we trim the sample to those aged over 30 and still find consistent effects. Note that over 95 percent of all marriages are formed before age 30, for any ethnicity and for any type of marriages.[28]

Another concern is about the OCP-induced patience in marriage market. Due to the reduction in marriage gains, people become more patient in seeking spouses. They will get to meet more people before marriage and thus the marriage outcomes tend to be more diversified, especially for the preferential-policy regions because of the higher minority rate. To rule out this possibility, we conduct a similar analysis of the interethnic marriages among the minorities and report the results in Table A3. The coefficients suggest that the OCP did not motivate minorities to marry other minorities, and indicate that the above concern may be not a first-order issue.

5.5 Children: incentives for H-M marriage

We argue above that a primary motivation for the H-M marriages in the preferential-policy regions is to have more children legally. This section aims to provide evidence to support this argument. The main difficulty in performing such a test is that the expected number of children is unobservable. Based on the ex-post data, we examine this by checking whether the regions with a more positive impact on H-M marriages are also the regions with less negative impacts on the number of children of H-M couples. The rationale is straightforward: if policy-induced H-M couples are formed to seek additional childbirth quotas, they would be more likely to have more births ex-post, and thus the negative effect of the penalties on the number of children should be smaller.[29]

[27]For men, the average age of H-M marriages is 23.8 and that of the other marriages is 24.2; for women, the ages are 22.0 and 22.2, respectively.

[28]The results are available upon request.

[29]We thank Professor Lawrence Katz for providing guidance and help for this methodology. Any errors are ours.

The presence of non-preferential-policy regions provides a natural control group. In these regions, we expect that in these regions the impact on H-M marriages should not be correlated with the impact on the number of children because individuals have no policy-induced incentives to form H-M couples. Specifically, we divide the Han ethnicity people into 62 subsamples by province and by the type of *hukou* (Urban/Rural). Then for each subsample, we conduct the following regressions:

$$HM_{ibt} = \theta_1 Fine_b^{18-25} + X_{ibt} + D_{ibt} + \epsilon_{i1} \quad (2\text{-}1)$$

where the dependent variable, HM_{ibt}, denotes whether an individual i is involved in a H-M marriage;[30] $Fine_b^{18-25}$ denotes the average penalty rate at age 18-25 for the birth cohort b in the local province j; X_{ibt} denotes the minority proportion for both males and females in the birth cohort b of the local province; and D_{ibt} denotes a set of control variables, including indicators for education levels, gender, calendar year and groups of birth cohorts (i.e. for every ten years).[31] Then we keep the Han people involved in H-M marriages and conduct the following regressions on each subsample:

$$Children_{ibt} = \theta_2 Fine_b^{18-25} + X_{ibt} + D_{ibt} + \epsilon_{i2} \quad (2\text{-}2)$$

Here we keep all the other control variables the same and only switch the dependent variable to the number of children ever born to the mother in the household. For each subsample (s), we can get a θ_1^s and θ_2^s. We plot θ_2^s against θ_1^s and investigate how they are correlated, weighted by the population size in each cell. Figure 7a shows the pattern in non-preferential-policy regions and Figure 7b shows the pattern in the presence of preferential policies.[32] . We find a very weak correlation between the impacts on fertility and those

[30] Like the regression before, the dependent variable is multiplied by 100 and thus the coefficients can be interpreted as percentages.

[31] We cannot control for the specific year of birth dummies here because the $Fine_b$ is in the level of the year of birth. The results are robust to the different years of birth categories.

[32] Consistent with the finding that the policy-incluced H-M marriages mostly happened in the preferential-policy regions, the weighted mean value of the impacts on H-M marriage is 0.1 in Figure 7a but 0.3 in Figure 7b.

on H-M marriages in Figure 7a, but a significantly positive correlation in Figure 7b, which implies that the effect of the OCP on fertility would be partially offset by the policy-induced H-M marriages. Therefore, Figures 7a-b provide some evidence that the expected number of children is an important factor that individuals consider in their marriage decision.

5.6 Impact of the OCP on partner's education among H-M marriages

The third hypothesis of the model states that more "transfers" from Han spouses to minority spouses in H-M couples will happen if the implementation of the OCP becomes tougher and a preferential policy is in place. This is because the value of a minority partner as reflected by the additional birth quota can be brought into marriage. However, the "utility transfers" are not directly observable. Thus we examine, in the preferential-policy regions, whether the minorities in H-M marriages marry higher educated people when the penalty rate is higher. We expect that the educational attainments of the minorities' partners should be higher in H-M couples since the minorities are more "valuable" in the marriage market as the penalty rates increase. In contrast, this should not hold true for either the spouses of the Han people in the same regions or for the people in the non-preferential policy regions. Therefore, we trim the sample to those H-M couples, and divide the sample into regions with preferential policies and those without, and then conduct the following regressions separately by Han ethnicity and minorities:

$$Education_{ijbt}^{spouse} = \alpha_0 + \alpha_1 Fine_{jb}^{18-25} + X_{ijbt} + D_{ijbt} + \gamma_j Prov_j \times YoB_b + \epsilon_i \quad (3)$$

where the dependent variable is spousal education level, on a scale of 1 to 5—the larger the value, the higher the education level . All the other variables are kept the same as those in Equation (1). Panel A and Panel B of Table 4 report the ordered logit estimates for the Hans and for the minorities, respectively Consistent with our expectation, the estimates show higher penalties are significantly associated with a higher education level of the spouses of the minorities in H-M couples. The remaining two columns report the coefficients for regions with

and those without the preferential policies. They suggest that a more significant association between the penalties and spousal education *only* exists for the minorities in the preferential-policy regions. The coefficient is as high as 0.96. By comparison, the coefficient for the Hans in the same regions is 0.019, and that for minorities in non-preferential-policy regions is 0.03. Both of these are not significant at a 10 percent significance level.

[Table 4 about here]

VI. Welfare Analysis

Recalling that reduced-form elasticities are sufficient statistics for the social welfare deadweight loss, this section applies the individual behavioral response to the OCP penalties to the Equation (*) to calculate the welfare loss caused by the distortion. The most important parts of Equation (*) are the three terms in parentheses. The first two terms reflect the distortion in the marriage market and the third term captures the distortion in fertility.

Based on the data of the number of children observed in the each household, we can directly calculate the number of illegal children c_{ij}. Then we use the same identification strategy above to estimate $\frac{dc_{ij}^{i}}{df}$ for different types of marriages. Table 5 reports the results. Consistent with our expectations, the effects are mainly from H-H couples. The insignificant but sizable coefficient for Han-Han couples reflects that a large heterogeneity within the population and are consistent with the on-going debate about the magnitude of the policy-induced fertility decline.

[Table 5 about here]

In Table 2, 3, and 4, we have estimated the marriage and fertility responses to the OCP penalties. Then all the other parameters in equation (*) can be derived from the results directly.

Table 6 reports the procedures for estimating the welfare loss. We calculate the loss by Han and minorities, respectively. Panel A reports the basic statistics of the data that are

required to calculate the welfare loss. The notations are the same with those in Equation (*). Panel B reports the elasticities of unmarried, intra- or inter-ethnicity marriage, and number of illegal children born with respect to the fertility penalties, by the ethnicity combinations of i and j. Panel C reports the welfare gain/loss induced by one unit increase in the penalties (i.e. the unit is yearly local household income) for each ethnicity $i \in \{H, M\}$, based on the basic statistics and elasticities in the first two panels by plugging them into the Equation (*). Along with the notation in the equation (*), we specifically calculate the marriage distortion and the fertility distortion in the parentheses for each ethnicity combination, and report them in the first two rows of Panel C. The unit for welfare loss is the percentage of yearly household income (*per* household). So for the Han ethnicity, the welfare loss originates from both fertility reduction (-3.32) and marriage market distortion (-0.71), indicating that the distortion of marriage market actually captures 18 percent of the total welfare loss for the Han people. For the minorities, some of them actually were better off from the OCP in the marriage market and the welfare loss in the fertility reduction is also smaller in magnitude than that of Han people. The final column report the social welfare loss by calculating the mean values weighted by the population proportion P_i. These estimates suggest that the one unit increase in penalties will induce a welfare loss, which is 3.75 percent of local yearly household income. Because the average penalty at age 18-25 is 1.3 (times of household income) for those birth cohorts born later than 1955, by assuming that the elasticities are constant across the birth cohorts afterwards, we conclude that the total welfare loss caused by the OCP is 4.9 percent of yearly household income, to which marriage distortion contributes 0.85 percent of yearly household income. It indicates that the traditional way to calculate the policy's welfare loss, which doesn't consider the distortion in marriage market (i.e. the selection effects), would significantly underestimate.

[Table 6 about here]

Therefore, these findings highlight the importance of considering the "distortion effects" when calculating the relevant welfare loss. This raises the question as to under what cir-

cumstances do we need to consider the "distortion effects" and why most of the previous studies did not take them into account in their welfare analyses. Children ("the good" that is taxed) are different from most normal goods in the market, because most children are born in wedlock and children are the natural fruits of marriage. When "children" are taxed, as we analyzed in this paper, the potential marriage gains will be reduced as a consequence. A higher tax will prevent more people from marriage because their expected marriage gains become lower than the "married or not" threshold. The "mechanical effects" only consider the welfare loss among those who are married, and thus do not take into account those whose expected marriage gain would fall below the threshold because they are censored when conducting the traditional analysis.

However, this study is not the first one to consider the relationship between different "goods" and its consequences. For example, Busse et al. (2013) found that gasoline prices have significant impacts on prices and quantities of sales in the new and used car market. The results, however,may be more intuitive and straightforward since gasoline is necessary when driving cars. This paper contributes to this branch literature by extending the sufficient statistic approach in public economics to demography and family economics, and the findings highlight the importance of considering the relationship between different goods in policy analysis.

VII. Conclusions and Discussion

This study provides new evidence on the implications and extensions of the transferable utility model by exploiting the plausibly exogenous deductions in marriage gains that are caused by the large, strict, and long-lasting fertility policies in China, and, for the first time, estimates the welfare loss caused by the OCP in both fertility and marriage.

Using the temporal and regional variations in the penalty rate for an additional illegal birth, as well as regional variations in the implementation of certain preferential fertility

policies for H-M couples, we find evidence for the model by showing that 1) The higher the OCP penalty at age 18-25 is, the higher the unmarried rate is, especially for the Han ethnicity; 2) an increase in the fine rate induces more H-M marriages, but only in the preferential-policy regions; and 3) the minorities in interethnic marriages are more likely to marry Han spouses with higher education when the penalty rate is higher in the presence of preferential policies.

Based on the theoretical framework, we further estimate the welfare loss induced by the OCP. The welfare loss is composed of two parts: one is the distortion in individual fertility (the "mechanical" effect), and the other is the distortion in the marriage market ("distortion" effects). More importantly, the welfare loss depends only on the fertility and marriage outcome elasticities, with respect to the penalty rate. The elasticities provide sufficient statistics to calculate the corresponding social-welfare deadweight loss. Applying the estimated reduced-form elasticities to the model shows that the distortion of marriage market actually brings about a welfare loss approximately equal to 0.85 percent of the yearly household income, which captures about 17 percent of the total loss caused by the OCP.

The estimates suggest that the OCP has lead to a large distortion in the marriage equilibrium outcomes. The large impact on H-M marriage outcomes implies that the unintended but rational behavioral response to the policy potentially creates large and persistent impacts on the culture, development, and societies of the minorities. This calls for future studies on the behavioral and social impacts of other similar ethnic-specific polices.

Our findings also suggest a significant welfare loss caused by the OCP in both fertility and marriage. Previous papers in public economics have usually focused on the social insurance programs and tax incidences, but this paper enhances the current literature by studying the largest fertility policy in the world and by extending the *sufficient statistic* approach to the marriage market. The estimates suggest that the relationship between different goods needs to be considered when studying the potential consequences of policies or taxes. Children (the "goods" that are taxed by the OCP) are different from other normal goods because

they are the natural fruits of marriages. Our findings suggest the heavy tax on children has distorted the marriage market, which has contributed a significant proportion of welfare loss. In other words, if the distortion in the marriage market is not considered, the total welfare loss caused by the OCP would be underestimated.

This study also suffers some limitations. First, the most important measure for the OCP is the financial penalty for an additional illegal birth. However, the government implemented other strict regulations at the same time. For example, workers in the public sector risked losing their jobs if they did not comply with the OCP, and this is not covered by the monetary penalty we consider here. Although the evidence in this paper shows that the penalty rate may be a good measure as suggested in previous literature (Edlund, 2000; Wei and Zhang, 2011; Huang, Lei, and Zhao, Forthcoming), we need to bear in mind when interpreting the estimates that they only reflect the impacts of the OCP penalties rather than the overall effects of the OCP.

In addition, some social conflicts have happened in the process of collecting the OCP fines, especially in remote and poor regions. There are also some illegally born children who were not registered and were not eligible to receive formal education. These facts suggest that the deadweight loss induced by the OCP may be underestimated in our study.

Finally, our model and empirical analysis look into the direct effects on marriage and fertility only, but can not take into account other dimensions, including the impacts of the fertility policies on the status of women and the quality of children, as well as some possible spillover effects on human capital and social burden, though all of these factors are emphasized in previous literature. We are looking forward to future studies, which may shed light on these important questions.

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Table 1. Summary Statistics

Sample	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample			Married sample		
	Full	Han	Minority	Full	Han	Minority
Panel A: Marriage outcomes						
Unmarried (%)	4.62	4.44	6.57			
	(21.00)	(20.59)	(24.78)			
H-M marriage (%)				2.94	1.61	17.38
				(16.88)	(12.58)	(37.89)
H-H marriage (%)				90.10	98.39	
				(29.86)	(12.58)	
M-M marriage (%)				6.96		82.62
				(25.45)		(37.89)
Panel B: Demographics and Education levels						
Minority (%)	8.64			8.42		
	(28.10)			(27.78)		
Male (Yes = 1)	0.50	0.50	0.51	0.49	0.49	0.49
	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)
Urban (Yes = 1)	0.41	0.43	0.26	0.41	0.42	0.26
	(0.49)	(0.49)	(0.44)	(0.49)	(0.49)	(0.44)
Age	39.40	39.49	38.42	39.82	39.91	38.89
	(8.21)	(8.21)	(8.21)	(8.03)	(8.02)	(8.04)
Education Levels						
Illiterate	0.06	0.05	0.16	0.06	0.05	0.16
	(0.24)	(0.23)	(0.37)	(0.24)	(0.22)	(0.37)
Primary School	0.31	0.31	0.40	0.32	0.31	0.40
	(0.46)	(0.46)	(0.49)	(0.47)	(0.46)	(0.49)
Junior High	0.43	0.44	0.30	0.43	0.44	0.30
	(0.49)	(0.50)	(0.46)	(0.50)	(0.50)	(0.46)
Senior High	0.14	0.14	0.10	0.14	0.14	0.09
	(0.35)	(0.35)	(0.29)	(0.35)	(0.35)	(0.29)
College or above	0.06	0.06	0.05	0.05	0.06	0.04
	(0.23)	(0.24)	(0.21)	(0.23)	(0.23)	(0.21)
Observations	5,677,311	5,223,157	454,154	4,692,977	4,330,059	362,918

Notes: Data source is Census 2000 and 2005. Sampling weights applied. Standard deviations are in parentheses.

Table 2. Impact of OCP on Marriage Outcomes: Unmarried Status

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	Unmarried status (Yes = 100)					
Sample	Han sample			Minority sample		
	Full sample	Preferential-policy regions	No-preferential policy regions	Full sample	Preferential-policy regions	No-preferential policy regions
Mean of Dep. Var.	4.44	4.95	4.21	6.57	6.61	6.49
Fertility fine rate at age 18-25	1.746***	0.934	1.971***	0.457	-0.204	0.439
	(0.528)	(0.537)	(0.611)	(0.619)	(0.411)	(0.583)
Observations	5,223,157	1,622,652	3,600,505	454,154	289,864	164,290
R-squared	0.102	0.104	0.102	0.125	0.119	0.145
Covariates Controlled for						
Local Minority Prop.	Yes	Yes	Yes	Yes	Yes	Yes
Ethnicity FE	Yes	Yes	Yes	Yes	Yes	Yes
Gender & Age FE	Yes	Yes	Yes	Yes	Yes	Yes
Province & Hukou FE	Yes	Yes	Yes	Yes	Yes	Yes
Age & Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Province-Yob Trends	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Data source is Census 2000 and 2005. Dependent variable is multiplied by 100 so the coefficients can be interpret in percent. The covariates include the local minority proportion in the birth cohort (Local Minority Prop.), dummies for ethnicities (Ethnicity FE), gender, age and their interaction (Gender & Age FE), hukou province, type of hukou and their interaction (Province & Hukou FE), survey year and its interaction with age (Age & Year FE). The province-specific year of birth linear trends (Province-Yob Trends) are also included to control the potential changes in local subjective attitudes towards marriage. Sampling weights are applied and robust standard errors in parentheses are clustered at province level.
*** p<0.01, ** p<0.05, * p<0.1

Table 3. Impact of OCP on Marriage Outcomes: Han-Minority Marriage

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	Han-Minorities Marriage (Yes = 100)					
Sample	Han sample			Minority sample		
	Full sample	Preferential-policy regions	No-Preferential policy regions	Full sample	Preferential-policy regions	No-Preferential policy regions
Mean of Dep. Var.	1.61	3.00	1.01	17.4	14.3	23.7
Fertility fine rate at age 18-25	0.227**	0.607***	0.116	0.863	2.063*	-0.666*
	(0.122)	(0.269)	(0.074)	(0.773)	(1.139)	(0.359)
Observations	4,330,059	1,320,064	3,009,995	362,918	231,661	131,257
R-squared	0.037	0.037	0.028	0.194	0.154	0.256
Covariates controlled in both panels						
Local Minority Prop.	Yes	Yes	Yes	Yes	Yes	Yes
Ethnicity FE	Yes	Yes	Yes	Yes	Yes	Yes
Gender & Age FE	Yes	Yes	Yes	Yes	Yes	Yes
Province & Hukou FE	Yes	Yes	Yes	Yes	Yes	Yes
Age & Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Province-Yob Trends	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Data source is Census 2000 and 2005. The covariates are the same as those in Table 2. Sampling weights are applied and robust standard errors in parentheses are clustered at province level.
*** p<0.01, ** p<0.05, * p<0.1

Table 4. Ordered Logit Estimation: Impact of OCP fine on Spousal Education among H-M marriages

Dependent variable	(1)	(2)	(3)
	Spousal Education Level (1-4, larger for higher education)		
Sample	Full sample	Preferential-policy regions	No-Preferential policy regions
Panel A: The sample is the Minorities in the H-M marriages			
Fertility fine rate	0.0578**	0.0955*	0.0306
at age 18-25	(0.0273)	(0.0507)	(0.0339)
Observations	63,005	34,566	28,439
Panel B: The sample is the Han people in the H-M marriages			
Fertility fine rate	0.0380	0.0187	0.0579
at age 18-25	(0.0259)	(0.0428)	(0.0450)
Observations	63,005	34,566	28,439
Covariates controlled for in both panels			
Local Minority Prop.	Yes	Yes	Yes
Specific Ethnicity FE	Yes	Yes	Yes
Gender & Age FE	Yes	Yes	Yes
Province & Hukou FE	Yes	Yes	Yes
Age & Year FE	Yes	Yes	Yes
Province-Yob Trends	Yes	Yes	Yes

Notes: Data source is Census 2000 and 2005. The covariates are the same as those in Table 2. Ordered logit estimation is applied. Sampling weights are applied and robust standard errors in parentheses are clustered at province level.
*** p<0.01, ** p<0.05, * p<0.1

Table 5. Impact of OCP on Illegal Births

Dependent variable	(1)	(2)	(3)	(4)
	Number of illegal births			
Sample	All the couples	Han-Han Couples	Han-Minority Couples	Minority-Minority Couples
Fertility fine rate at age 18-25	-0.0191	-0.0231	-0.00620	0.000130
	(0.0285)	(0.0326)	(0.00928)	(0.000142)
Observations	4,692,977	4,263,273	133,375	296,329
R-squared	0.263	0.248	0.255	0.016
Covariates controlled for				
Local Minority Prop.	Yes	Yes	Yes	Yes
Ethnicity FE	Yes	Yes	Yes	Yes
Gender & Age FE	Yes	Yes	Yes	Yes
Province & Hukou FE	Yes	Yes	Yes	Yes
Age & Year FE	Yes	Yes	Yes	Yes
Province-Yob Trends	Yes	Yes	Yes	Yes

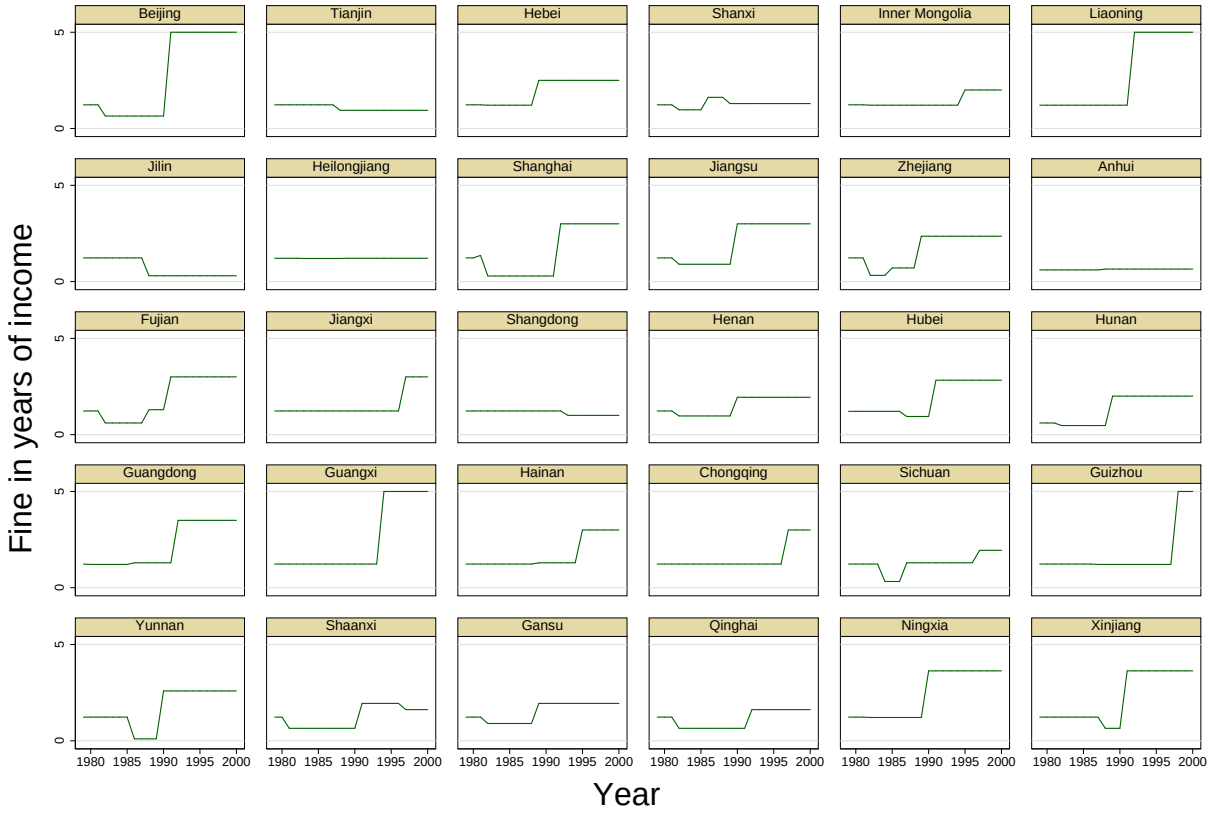
Notes: Data source is Census 2000 and 2005. The covariates are the same as those in Table 2. Sampling weights are applied and robust standard errors in parentheses are clustered at province level.
*** p<0.01, ** p<0.05, * p<0.1

Table 6. Welfare loss caused by the OCP, by types of marriages

	(1)	(2)	(3)	(4)	(5)
Ethnicity i	Han		Minority		Welfare gain/loss
Ethnicity j	Han	Minority	Han	Minority	(Weighted by P_i)
Panel A: Basic statistics in the data					
(P_i) Prop. of i	0.93		0.07		-
(r_m^i) Married rate of i	0.96	0.96	0.94	0.94	-
(r_{ij}^i) Prop. of i married to j	0.98	0.02	0.17	0.83	-
(c_{ij}) Illegal births	0.25	0.10	0.10	0.00	-
Panel B: Estimated Elasticities with respect to penalties					
(e_m^i) Married rate of i	-0.03	-0.03	-0.01	-0.01	-
(e_{ij}^i) Marriage $i-j$	0.00	0.22	0.08	-0.02	-
(e_{ij}^c) Illegal births	-0.14	-0.09	-0.09	0.00	-
Panel C: Welfare gain/loss of unit change in fine rate (% of yearly household income)					
Marriage Distortion	-0.71		0.11		-0.65
Fertility Reduction	-3.32		-0.15		-3.10
Total	-4.02		-0.04		-3.75

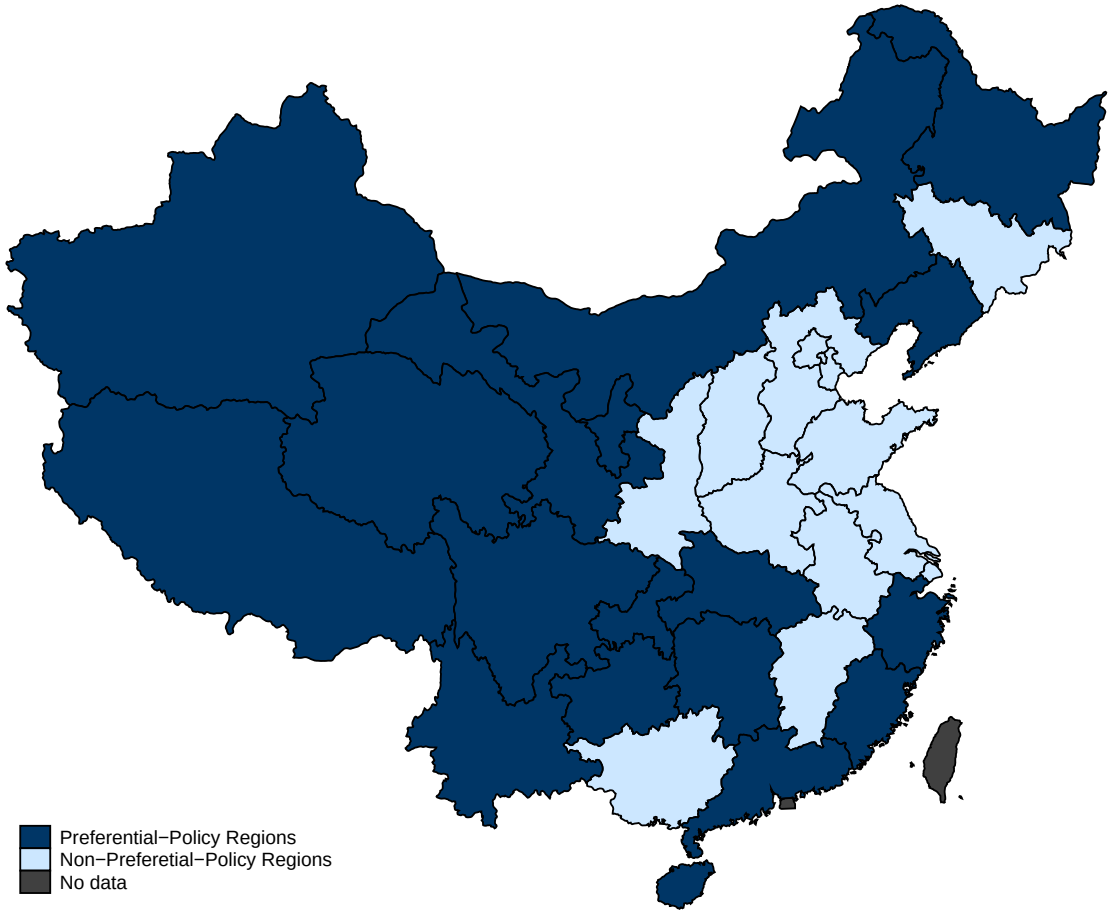
Notes: Data sources are Census 2000 and 2005. Statistics in Panel A are calculated from the corresponding samples. The estimates in Panel B are calculated from the results in Tables 2, 3 and 5. The estimates in Panel C are calculated from the results in Panel A and Panel B by plugging them into the equation (*). Welfare loss estimated in column 5 is the population weighted mean of those for the Han people and minorities.

Figure 1: One-Child Policy Regulatory Penalties in 1980-2000, by Province



Notes: Data source is Ebenstein (2010). The unit of penalties is times of local household yearly income.

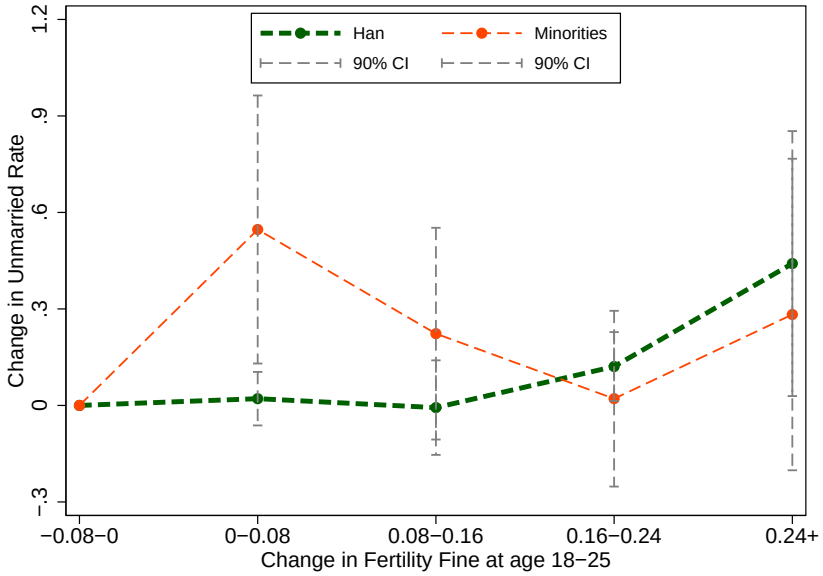
Figure 2: Preferential-Policy Regions and Non-Preferential-Policy Regions in China



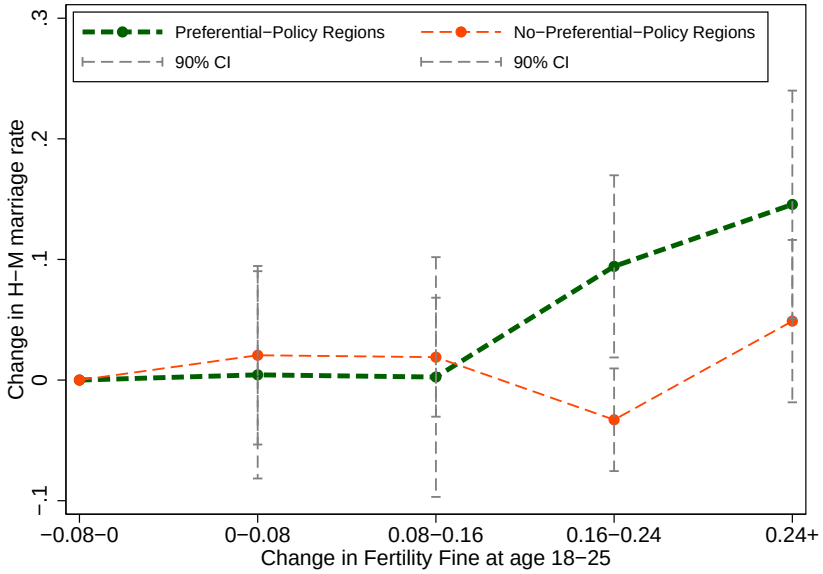
Notes: Data source is from the website of National Health and Family Planning Commission of the people's Republic of China.
The website is http://www.nhfpc.gov.cn/zhuzhan/dftl/lists.shtml (Chinese Website accessed in November 2015).

Figure 3: Marriage Outcomes Changed according to the Changes of the OCP Penalties at age 18-25

a. Unmarried status, by Han and Minorities



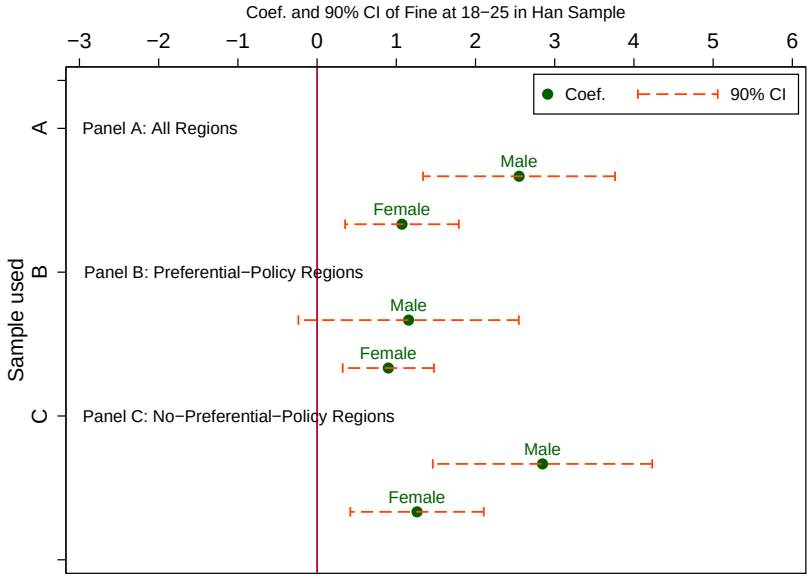
b. H-M marriage, by Preferential-Policy or No-Preferential Policy Regions



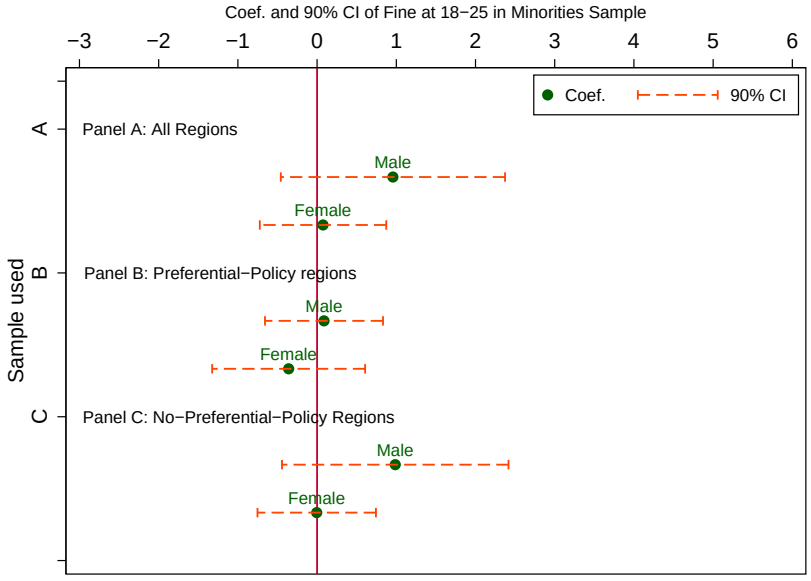
Notes: The data source is Census 2000 and 2005. X-axis is the categories of changes in the OCP penalties at age 18-25 in two consecutive birth cohorts and the Y-axis is the corresponding changes in unmarried rate (for Figure a) and H-M marriage rate (for Figure b) in each category. Standard errors are clustered at province level and 90% CIs are reported. The estimation is weighed by the population size of each birth cohort. The treated groups for unmarried rate and H-M marriage are Han ethnicity people and the people in preferential-policy regions, respectively.

Figure 4: Impact of the Fine Rate of the OCP at age 18-25 on Unmarried Status, by Gender, Region and Ethnicity

a. Impact of the OCP on unmarried for Han ethnicity, by Gender and Region

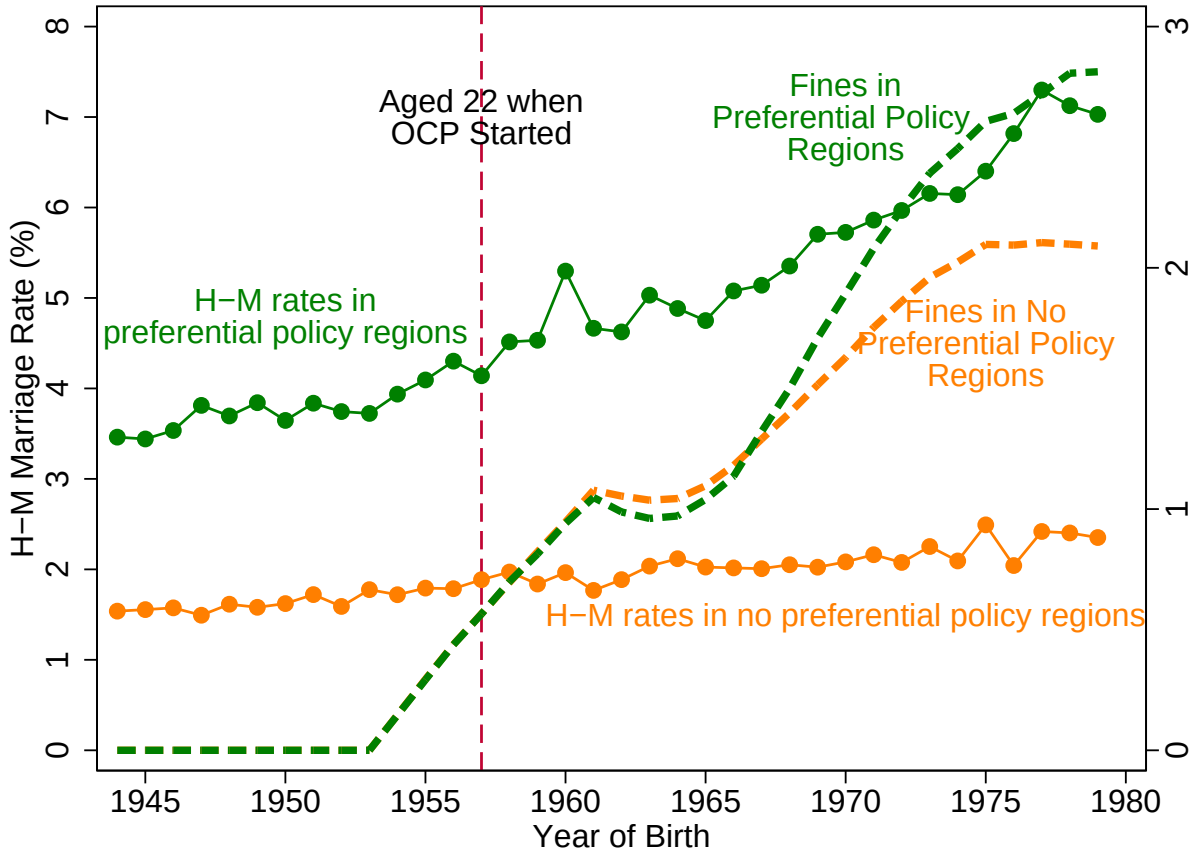


b. Impact of the OCP on unmarried for the Minorities, by Gender and Region



Notes: The data source is Census 2000 and 2005. We use equation (1) to estimate the effects of the OCP penalties on the unmarried rate. Figure a and figure b report the OLS coefficients on the fertility penalties at age 18-25 and the corresponding 90% confidential intervals for the Han people and minorities, respectively. Standard errors are clustered at province level and sampling weights are applied.

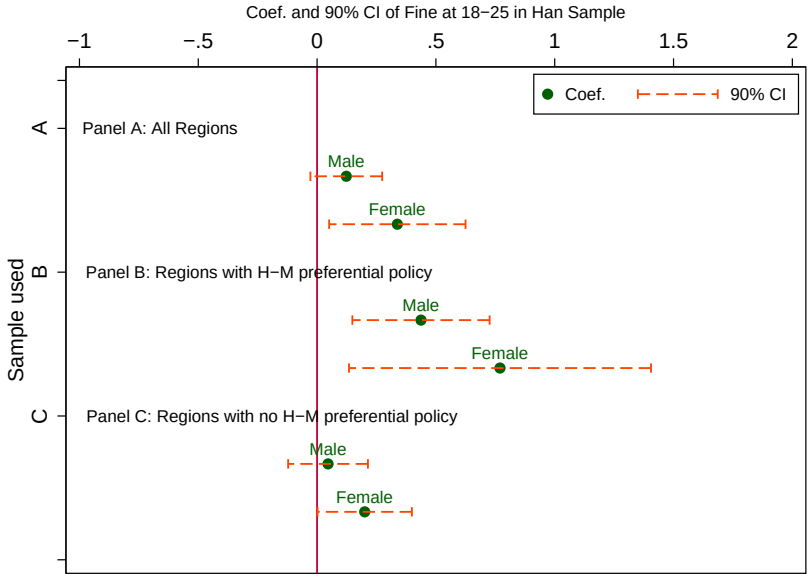
Figure 5: H-M Marriage rate and Fertility Fine at 18-25 over Year of Birth, by Preferential-Policy or No-Preferential Policy Regions



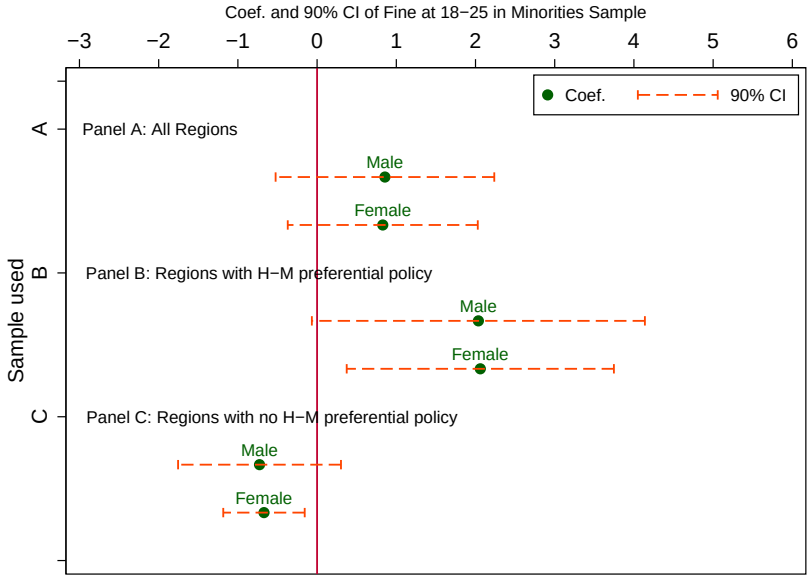
Notes: The data source is Census 2000 and 2005. The H-M marriage rates and penalties are plot against the birth cohorts, by whether the region has preferential policies or not. Sampling weights are applied.

Figure 6: Impact of the Fine Rate of the OCP at age 18-25 on H-M Marriages, by Gender, Region and Ethnicity

a. Impact of the OCP on H-M Marriages for Han ethnicity, by Gender and Region



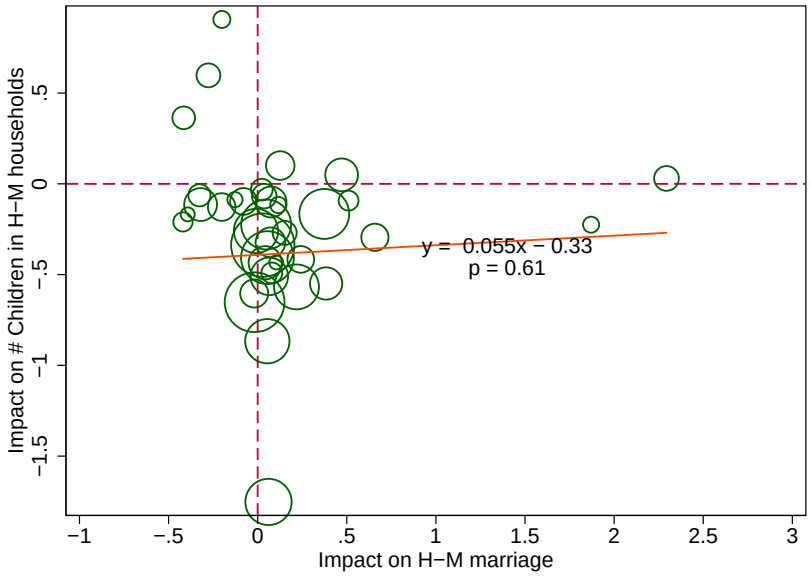
b. Impact of the OCP on H-M Marriages for the Minorities, by Gender and Region



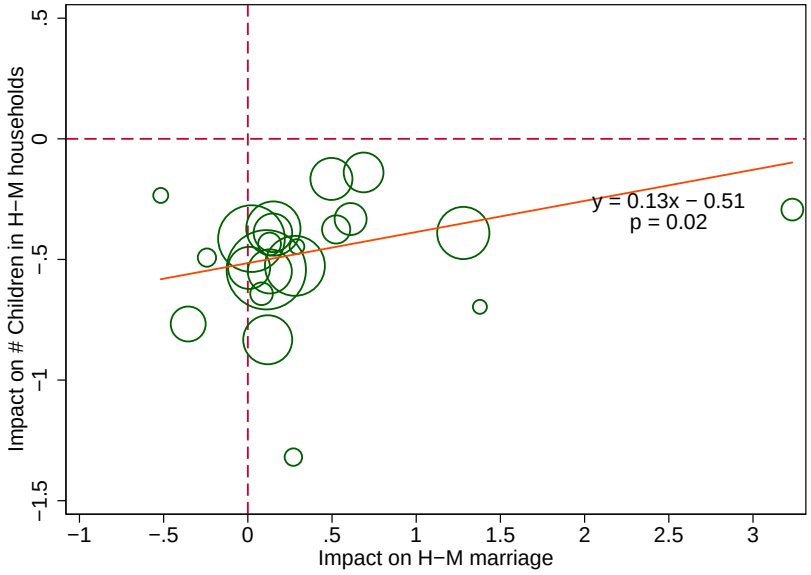
Notes: The data source is Census 2000 and 2005. We use equation (1) to estimate the effects of the OCP penalties on the H-M married rate. Figure a and figure b report the OLS coefficients on the fertility penalties at age 18-25 and the corresponding 90% confidential intervals for the Han people and minorities, respectively. Standard errors are clustered at province level.

Figure 7: Associations between Impacts of the OCP on H-M marriages and those on Fertility of these couples, by Preferential-Policy or No-Preferential Policy Regions

a. Regions with no-preferential policy to Han-Minority couples



b. Regions with preferential-policy to Han-Minority couples



Notes: The data source is Census 2000 and 2005. The full sample is divided by the province and for each subsample, equations (2-1) and (2-2) are estimated. The X-axis is the effects of the OCP penalties on H-M marriage rate and the Y-axis is the effects on number of children of those couples. Then we divide the sample by whether the region has the preferential policy or not, and report them in figure a and figure b, respectively. The size of the circle reflect the population size.

Online Appendix

Appendix A: Ethnic Minorities in China

China is a populous country with controversial ethnic issues (Sautman, 1998; Kaup, 2000; Ma, 2007). Ma (2007) listed ten of China's ethnic issues that are worthy of academic attention, and the first one among them is ethnic identification and nationalism. China officially has 56 ethnicities. Soon after the founding of the People's Republic of China in 1949, the central government initiated a monumental project of ethnic identification. In the 1953 population census, more than 400 groups applied for national minority status (Fei, 1979). With guidance from a few Western-educated anthropologists, hundreds of research teams were sent to conduct fieldwork and collect information about the history, language and customs of each group. The main work of ethnic identification was finished in 1957, but follow-up revisions continued until the 1970s. The most recent revision was the recognition of the Jino people in 1979, right before the implementation of the OCP. Based on cultural characteristics and the will of the groups concerned, most of these self-nominated groups were recognized as minority people, and they were officially reclassified into 55 groups. Based on cultural characteristics and the will of the groups concerned, most of these self-nominated groups were recognized as minority people, and they were officially reclassified into 55 groups. According to Regulations on Household Registration of People's Republic of China, every newborn's ethnicity should be registered in the *hukou* system in the first month after birth. Ethnic identity is mainly determined by parents' ethnicities. The children of intermarried families are permitted to follow either the father's or mother's ethnicity (Jia and Persson, 2015). Ethnic identity is strictly controlled, and thus it is difficult for individuals to make a fake claim.

According to the 2010 census, the Han ethnicity make up 91 percent of the population, while all of the other 55 ethnic groups account for the remainder. The largest minority group currently in China is Zhuang, with a population of 16.9 million in 2010.The smallest minority

group, the Keba, has only 3682 members. Figure A1 shows the geographic distribution of all the 56 ethnic groups.[1] As shown in the map, most ethnic minority groups live in regions on the western or northeastern boarder. The current geographic pattern of ethnic distribution is mainly caused by the migration history of the Han Chinese (Poston Jr and Shu, 1987).

Appendix B: Marriage Market Distortion by the OCP

B.1 Solving the equilibrium

Based on the equilibirum conditions in Section 3.1, plug in the two ethnicities H and M, and explicitly express the equations by ethnicities. We have the following set of equations:

$$\begin{cases} ln\mu_{HH} - ln\mu_{H0} = \dfrac{\alpha_{HH} + \gamma_{HH}}{2} \\ ln\mu_{HM} - \frac{ln\mu_{H0} + ln\mu_{M0}}{2} = \dfrac{\alpha_{HM} + \gamma_{HM}}{2} \\ ln\mu_{MM} - ln\mu_{M0} = \dfrac{\alpha_{MM} + \gamma_{MM}}{2} \\ \mu_{H0} + \mu_{HH} + \mu_{MH} = \overline{H} \\ \mu_{M0} + \mu_{MH} + \mu_{MM} = \overline{M} \end{cases}$$

For simplicity, we define $\theta_{HH} = \dfrac{\alpha_{HH} + \gamma_{HH}}{2}$, $\theta_{HM} = \dfrac{\alpha_{HM} + \gamma_{HM}}{2}$ and $\theta_{MM} = \dfrac{\alpha_{MM} + \gamma_{MM}}{2}$, which are the expected marriage gains for the H-H, H-M and M-M couples, respectively. Then we translate the equations above into proportions and rates:

[1] This map is from the book "A Mosaic of Peoples: Life Among China's Ethnic Minorities" (1992) by China Nationality Art Photograph Publishing House.

$$\begin{cases} ln(h_m r_H^H) - lnh_0 = \theta_{HH} \\ ln\overline{H}h_m r_H^M - \frac{1}{2}(ln\overline{H}h_0 + ln\overline{M}m_0) = \theta_{HM} \\ ln(m_m r_M^M) - lnm_0 = \theta_{MM} \\ \overline{H}h_m r_H^M = \overline{M}m_m r_M^H \\ h_m + h_0 = m_m + m_0 = r_H^H + r_H^M = r_M^M + r_M^H = 1 \end{cases}$$

where h_m, h_0 are the married and unmarried rates for Han ethnicity; and m_m, m_0 are married and unmarried rates for minorities. Similarly, r_H^H and r_H^M are the proportion of married Han people marrying to Han and minorities, respectively; r_M^H and r_M^M are the proportion of married minority people marrying to Han and minorities, respectively. The first three equations are directly from the first three in (1). The fourth one means that the number of Han people involved in H-M marriages are the same with that of Minorities involved.

Then we take derivatives with f and note that $\frac{\partial\theta_{HH}}{\partial f} = u'_{HH}$, $\frac{\partial\theta_{HM}}{\partial f} = u'_{HM}$, $\frac{\partial\theta_{MM}}{\partial f} = u'_{MM}$, and $\frac{dr_M^M}{df} = -\frac{dr_M^H}{df}$, $\overline{H}h_m r_H^M = \overline{M}m_m r_M^H$, we have

$$\begin{cases} (\frac{1}{h_m} + \frac{1}{h_0})e_h - \frac{1}{r_H^H}e_H^M = u'_{HH} \\ -\frac{r_M^H}{h_m r_M^M}e_h - \frac{r_M^H}{r_H^M r_M^M}e_H^M + (\frac{1}{m_0} + \frac{1}{m_m} + \frac{r_M^H}{m_m r_M^M})e_m = u'_{MM} \\ (\frac{1}{h_m} + \frac{1}{2h_0})e_h + \frac{1}{r_H^M}e_H^M + \frac{1}{2m_0}e_m = u'_{HM} \end{cases}$$

where $e_h = \frac{dh_m}{df}$, $e_m = \frac{dm_m}{df}$, and $e_H^M = \frac{dr_H^M}{df}$. The first two are the responses of married rates of Han and Minorities to one unit increase in the fertility fines; the last one represents the response of the H-M marriage rate among the Han ethnicity with respective to the fertility fines. We can solve these three equations above to derive the expressions in terms of u'_{HH}, u'_{HM} and u'_{MM} for the three unknowns.

We first define $\alpha_1 = (\frac{1}{h_m} + \frac{1}{h_0})$, $\alpha_2 = \frac{1}{r_H^H}$, $\alpha_3 = \frac{r_M^H}{h_m r_M^M}$, $\alpha_4 = \frac{r_M^H}{r_H^M r_M^M}$, $\alpha_5 = (\frac{1}{m_0} + \frac{1}{m_m} +$

$\frac{r_M^H}{m_m r_M^M}$), $\alpha_6 = (\frac{1}{h_m} + \frac{1}{2h_0})$, $\alpha_7 = \frac{1}{r_H^M}$ and $\alpha_8 = \frac{1}{2m_0}$. Obviously, $\alpha_i > 0$, $\forall i$.

By solving the the equations, we have,

$$e_h = \frac{Au_{HH}^{'} + \alpha_2 C}{\alpha_1 A + \alpha_2 B} \tag{1}$$

$$e_H^M = \frac{-Bu_{HH}^{'} + \alpha_1 C}{\alpha_1 A + \alpha_2 B} \tag{2}$$

$$e_m = \frac{u_{MM}^{'} + \alpha_3 e_h + \alpha_4 e_H^M}{\alpha_5} \; (or \; = \frac{u_{HM}^{'} - \alpha_6 e_h - \alpha_7 e_H^M}{\alpha_8}) \tag{3}$$

where $A = \alpha_5\alpha_7 + \alpha_4\alpha_8$, $B = \alpha_5\alpha_6 + \alpha_3\alpha_8$, and $C = \alpha_5 u_{HM}^{'} - \alpha_8 u_{MM}^{'}$.

Because $\alpha_5 > \alpha_8 > 0$ and $u_{HH}^{'} \leq u_{HM}^{'} \leq u_{MM}^{'} \leq 0.$, we have $C \leq 0$.

B.2 Proof of Predictions

Proof of Predictions 1: We have found that $e_h = \frac{Au_{HH}^{'} + \alpha_2 C}{\alpha_1 A + \alpha_2 B}$ and thus it's easy to find that $e_h < 0$. Without the loss of generality, we can reasonably assume that, in the preferential-policy regions, the One-Child policy has very little impact on the welfare of H-M marriage and M-M marriage. That is, $u_{HM}^{'} = u_{MM}^{'} = 0$. Thus, the absolute value of e_h will be lower in the preferential-policy regions because $C = 0$ when $u_{HM}^{'} = u_{MM}^{'} = 0$.

From (3), we have $e_m = \frac{u_{HM}^{'} - \alpha_6 e_h - \alpha_7 e_H^M}{\alpha_8}$. In the preferential-policy regions, the expression of e_m can be simplified as follow:

$$e_m = \frac{(\alpha_7 B - \alpha_6 A) u_{HH}^{'}}{\alpha_8(\alpha_1 A + \alpha_2 B)} \tag{4}$$

By substituting $A = \alpha_5\alpha_7 + \alpha_4\alpha_8$ and $B = \alpha_5\alpha_6 + \alpha_3\alpha_8$, we have $\alpha_7 B - \alpha_6 A = (\alpha_3\alpha_7 - \alpha_4\alpha_6)\alpha_8$. Because $\alpha_3\alpha_7 - \alpha_4\alpha_6 = -\frac{r_M^H}{2h_0 r_H^M r_M^M} < 0$, $e_m > 0$ holds in the preferential-policy regions. That is, in these regions, the One-Child policy may have a positive effect on the marriage rate of minority people.

However, in the non-preferential-policy regions, whether e_m is positive or negative is inconclusive.

Proof of Prediction 2: From $\overline{H}h_m r_H^M = \overline{M}m_m r_M^H$, we have the expression of e_M^H as follow:

$$e_M^H = r_M^H(\frac{1}{h_m}e_h + \frac{1}{r_H^M}e_H^M - \frac{1}{m_m}e_m) \tag{5}$$

According to the formula (2), the sign of e_H^M is not generally determinate. The sign of e_M^H is indeterminate also because it's linear combination of e_h, e_m and e_H^M.

However, in the preferential-policy regions, we have $e_H^M = \frac{-Bu_{HH}^{'}}{\alpha_1 A+\alpha_2 B} > 0$ because C=0. That is, in these regions, an increase of OCP penalty rate would increase the probability that a Han people choose to marry a minority people.

Moreover, in these regions, we can express e_M^H as follow by substituting formulas (1), (2) and (4):

$$e_M^H = \frac{r_M^H(\frac{1}{h_m}A - \frac{1}{r_H^M}B - \frac{1}{m_m}D)u_{HH}^{'}}{\alpha_1 A + \alpha_2 B} \tag{6}$$

where $D = (\alpha_3\alpha_7 - \alpha_4\alpha_6)$. By substituting the values of a_i(s), we find that $(\frac{1}{h_m}A - \frac{1}{r_H^M}B - \frac{1}{m_m}D) = -\frac{1}{2h_0}(\frac{1}{m_m} + \frac{1}{m_0})\frac{1}{r_H^M} < 0$. Thus, $e_M^H > 0$ holds inthe preferential-policy regions.

Proof of Prediction 3: By definition, $\tau_{HM} = \frac{\ln\mu_{H0} - \ln\mu_{M0} + \alpha_{HM} - \gamma_{HM}}{2}$. We take derivatives and then have:

$$\frac{d\tau_{HM}}{df} = -\frac{1}{h_0}e_h + -\frac{1}{m_0}e_m \tag{7}$$

Here, $\frac{d\tau_{HM}}{df}$ is a linear combination of e_h and e_m. In non-preferential-policy regions, it's difficult to see the sign of $\frac{d\tau_{HM}}{df}$. However, in preferential-policy regions, it's obvious that the transfer from the Han spouse to the minority spouse is increasing in the fine rate because $e_h < 0$ and $e_m > 0$.

Appendix C: Welfare Implications

From the social welfare expressed as below,

$$\Pi = \sum_i \overline{m}_i ln(\sum_j exp(\tilde{\alpha}_{ij})) + \sum_j \overline{n}_j ln(\sum_i exp(\tilde{\gamma_{ij}})) + \sum_{i,j\neq 0} \mu_{ij}(n_{ij} - \overline{n}_{ij})f.$$

We take derivative with respective to the fertility penalty f to the equation above. Denote that $P_{ij} = \frac{exp(\tilde{\alpha}_{ij})}{\sum_k exp(\tilde{\alpha}_{ik})}$ is the proportion of type i men married to type j women; correspondingly, $Q_{ij} = \frac{exp(\tilde{\gamma}_{ij})}{\sum_k exp(\tilde{\gamma}_{kj})}$ the proportion of type j women married to type i men. Then we have:

$$\frac{d\Pi}{df} = \sum_i \overline{m}_i \sum_j P_{ij} \frac{d\tilde{\alpha}_{ij}}{df} + \sum_j \overline{n}_j \sum_i Q_{ij} \frac{d\tilde{\gamma}_{ij}}{df} + \sum_{i,j\neq 0} \mu_{ij} c_{ij} + \sum_{i,j\neq 0} (\frac{d\mu_{ij}}{df} c_{ij} + \mu_{ij} \frac{dc_{ij}}{df}) f$$

Assuming the gains of being unmarried is not changed by the penalties, and considering that $\overline{m}_i P_{ij} = \overline{n}_j Q_{ij} = \mu_{ij}$ for given i, j, and $\frac{d\tilde{\alpha}_{ij}}{df} + \frac{d\tilde{\gamma}_{ij}}{df} = \frac{du_{ij}}{df} = -c_{ij}$, we have

$$\begin{aligned}\frac{d\Pi}{df} &= -\sum_{i,j\neq 0} c_{ij}\mu_{ij} + + \sum_{i,j\neq 0} \mu_{ij} c_{ij} + \sum_{i,j\neq 0} (\frac{d\mu_{ij}}{df} c_{ij} + \mu_{ij} \frac{dc_{ij}}{df}) f \\ &= \sum_{i,j\neq 0} (\frac{d\mu_{ij}}{df} c_{ij} + \mu_{ij} \frac{dc_{ij}}{df}) f\end{aligned}$$

Divide the both sides by $\overline{H} + \overline{M}$, we can have the equation (*) in the main text.

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Table A1. Impact of Change in Fertility Fine Rate age 18-25 on Change in Marriage Outcomes

Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)
	Change in Unmarried Rate			Change in H-M Marriage Rate		
Sample	Full sample	Han	Minorities	Full sample	Preferential-Policy Regions	No-Preferential-Policy Regions
Change in Fertility Fine Rate at age 18-25	0.971**	1.067**	0.534	0.293*	0.618**	0.0756
	(0.375)	(0.395)	(0.583)	(0.164)	(0.333)	(0.114)
Observations	6,136	3,106	3,030	6,268	2,463	3,805
R-squared	0.462	0.610	0.138	0.003	0.013	0.004
Covariates controlled for						
Ethnicity (Han/minorities)	Yes	Yes	Yes	Yes	Yes	Yes
Hukou (Urban/Rural)	Yes	Yes	Yes	Yes	Yes	Yes
Year of Birth & Year FE	Yes	Yes	Yes	Yes	Yes	Yes

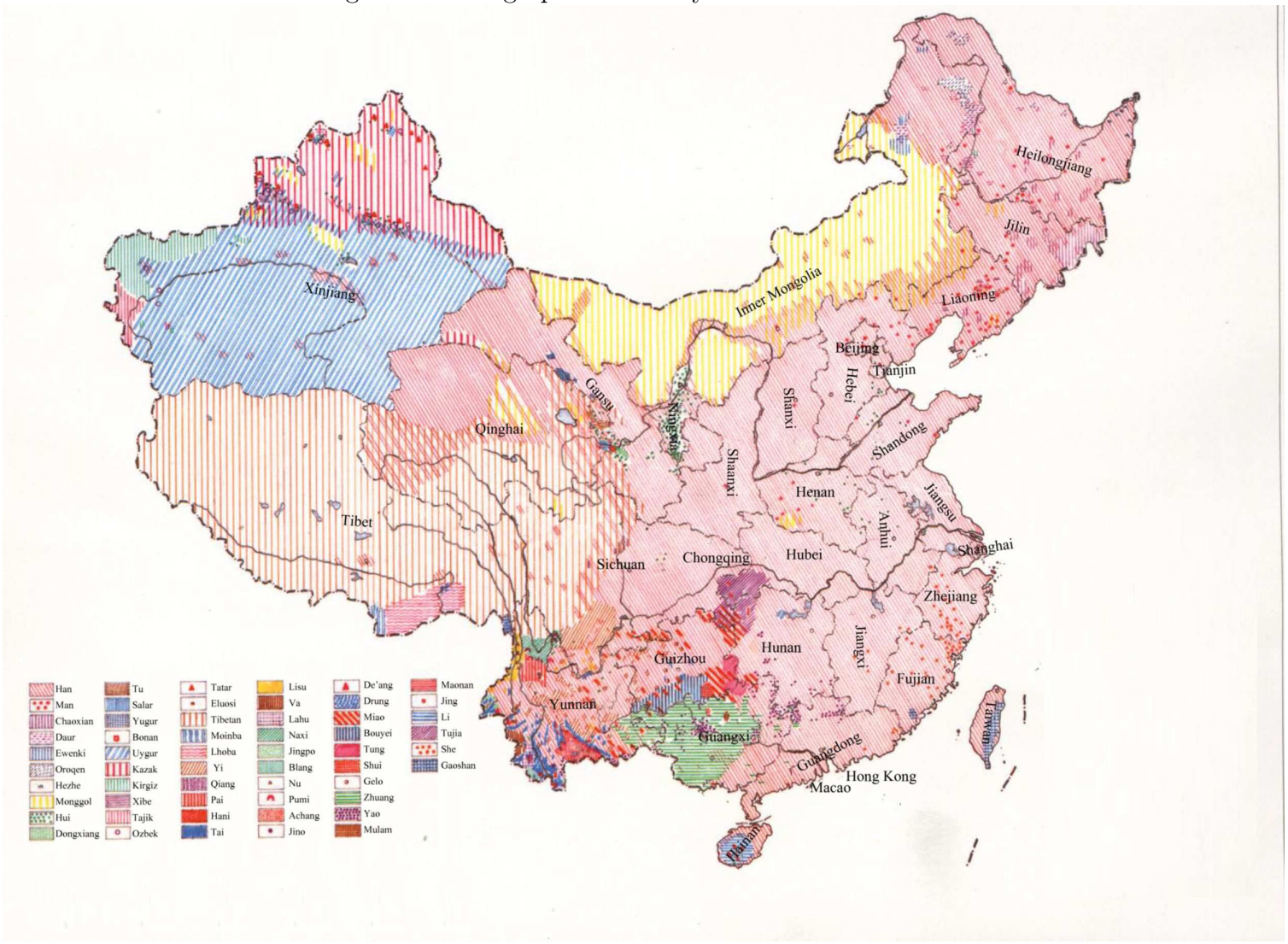
Notes: Data source is Census 2000 and 2005. The covariates include dummies for Han/Minorities, type of hukou, year of birth, survey year and interactions of the last two. Regressions are weighted by population in each birth cohort and robust standard errors in parentheses are clustered at province level.
*** p<0.01, ** p<0.05, * p<0.1

Table A2. Impact of OCP fine on Interethnic Marriages among Minorities

Dependent variable	(1)	(2)	(3)
	Interethnic marriage among minorities (Yes = 100)		
Sample	Full sample	Preferential-Policy Regions	No-Preferential-Policy Regions
Mean of Dep. Var.	3.777	3.950	3.417
Fertility fine rate at age 18-25	0.245	0.0604	0.502
	(0.157)	(0.150)	(0.343)
Observations	362,918	231,661	131,257
R-squared	0.045	0.040	0.072
Covariates controlled for			
Local Minority Prop.	Yes	Yes	Yes
Ethnicity FE	Yes	Yes	Yes
Gender & Age FE	Yes	Yes	Yes
Province & Hukou FE	Yes	Yes	Yes
Age & Year FE	Yes	Yes	Yes
Province-Yob Trends	Yes	Yes	Yes

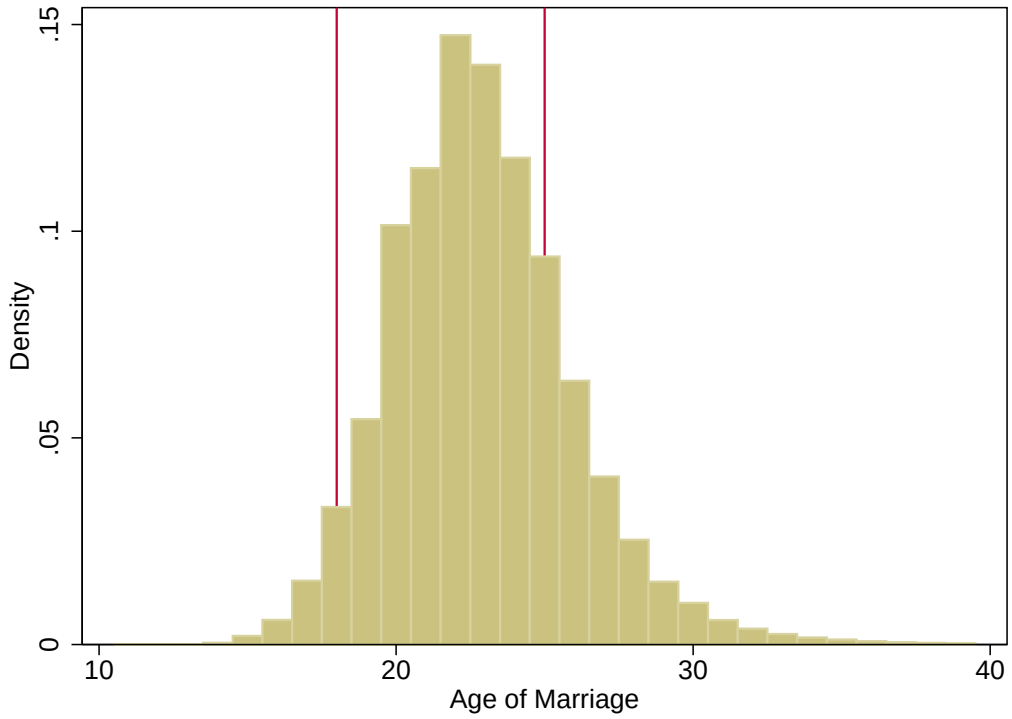
Notes: Data source is Census 2000 and 2005. The covariates are the same as those in Table 2. Sampling weights are applied and robust standard errors in parentheses are clustered at province level.
*** p<0.01, ** p<0.05, * p<0.1

Figure A1. Geographic Ethnicity Distribution in China



Notes: This map is from the book "A Mosaic of Peoples: Life Among China's Ethnic Minorities" (1992) by China Nationality Art Photograph Publishing House.

Figure A2. Distribution of Marriage Age



Notes: Data source is Census 2000 and 2005. Only married and the ones with valid marriage age are kept.