One-Child Policy, Marriage Distortion, and Welfare Loss

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Abstract

This paper studies the marriage distortion and the associated welfare loss caused by the One-Child Policy (OCP) in China. Using the variation in the ethnicity-specific assigned birth quotas and different fertility penalties across provinces over time, we first show that the OCP induced a significantly higher unmarried rate and more interethnic marriages. Using sufficient statistics approach, we then derive a formula for the social welfare loss caused by the OCP-induced lower fertility and marriage distortion, and it only depends on the estimated reduced-form elasticities. Our estimates suggest that the associated welfare loss is around 3.7 percent of annual household income, with marriage distortion contributing 30 percent of this. These findings highlight the unintended behavioral responses to public policies and corresponding social consequences. (*JEL* codes: I31, J12, J13, J18)

Keywords: One-Child Policy, Marriage Distortion, Welfare Loss

"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

1 Introduction

Marriage is an important source of happiness and plays an important role in generating and redistributing welfare among individuals (e.g., Zimmermann and Easterlin, 2006; Dupuy and Galichon, 2014). Over 40 years ago, Becker (1973, 1974) built up the seminal transferable utility model and used it to explain marriage behaviors, and then a large strand of literature used the model and applied its wide-ranging implications (Rao, 1993; Edlund, 2000; Chiappori et al., 2002; Botticini and Siow, 2003; Bitler et al., 2004; Choo and Siow, 2006).

This study builds up the on-going literature by studying the marriage behavior distortion and its associated welfare cost caused by "taxation on marriages". By showing the "taxation-induced" marriage behavior distortions, we present new and direct evidence for the basic assumption in Becker (1973, 1974) that individual marriage behavior and market equilibrium are shaped by expected marriage gains. Given the importance of marriages in economy and society, this exercise does not only deepen our understanding in marriage behaviors, but also provides additional compelling evidence on the unifying power of economic analysis.

The "taxation on marriages" above refers to the One-Child Policy (OCP) in China.[1] Because children are natural and important fruits of marriages, the *compulsory* and *strict* fertility restrictions, in terms of fixed birth quotas assigned (to different types of couples) and the financial penalties for illegal births, provide unique settings to investigate the policy-induced distortions and welfare loss.[2] First, different birth quotas were assigned to both-Han (H-H), both-minority (M-M)

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[1]The presence of "taxation on marriages" is rare since few events or policies in history assigned different gains to various types of marriages.

[2]In China, there are very few women giving birth prior to marriage because of culture and social norm.

and Han-minority (H-M) couples, according to local policies. In almost all provinces, H-H couples are strictly constrained to only one (or conditionally two) births, while M-M couples were not (Baochang et al., 2007). About half of the provinces extended the coverage of this exemption to H-M couples (referred to as preferential-policy regions, hereafter). Second, different levels of financial penalties, ranging from one to five times of a local household yearly income, were imposed for an unauthorized birth across provinces and across years. These quotas and financial penalties were strictly implemented by the Population and Family Planning Commissions (PFPC) at every level of governments. Therefore, the implementation of OCP provides a large ethnic, spatial, and temporal variation for valid estimation in this study.

We first incorporate the OCP into the marriage transferable utility model by Choo and Siow (2006) and derive three testable predictions. The first one is that the OCP would increase the unmarried rate of Han people because of lower expected marriage gains;[3] second, in the preferential-policy regions, the OCP would increase the H-M marriage rate because Han people are motivated to marry to the minorities to get more birth quotas; and third, in the preferential-policy regions, higher fertility penalties would lead to more the utility transfer from a Han spouse to his (or her) minority spouse within H-M couples.

We then use a nationally representative sample composed of those ages between 26 and 55 from census data to verify the above predictions. Using the regional and temporal variation in the fertility penalties, we find that an increase in the fertility penalties at marriage ages (i.e., ages 18-25) by one yearly local household income increases the unmarried rate by 1.7 percentage points among Han people (39 percent of the mean). Moreover, in the preferential-policy regions, the same increase in fertility penalties also increases H-M marriage rate by 0.6 percentage points for Han people (20 percent of the mean) and 2.1 percentage points for minorities (15 percent of the mean), respectively.[4] Finally, among H-M couples in the preferential-policy regions, higher

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[3]Note that being unmarried does not mean staying single forever here. Many merely delayed marriages. Hence, increased unmarried rate can be also understood as not married in early ages.

[4]In the econometric framework, besides the local minority proportion and sex ratios in the birth cohort of local province, we also controlled for the fixed effects for the ethnicities, type of *hukou*, provinces, cohorts, and calendar years, and the province-specific linear trends in birth cohorts throughout the whole analysis.

fertility penalties are associated with higher education of spouses for the minorities.[5]

The exogeneity of the penalties may not be taken for granted. By looking into the historical documents, we show that the changes in the fertility penalties are associated with the central government attitudes towards the fertility restrictions, and the promotion motivation of provincial officials. For example, 12 out of the 16 largest changes in the fertility penalties exactly happened in the first two years of tenure of the new provincial officials inaugurated *just* after the central government included the OCP performance as an aspect to evaluate the local officials in the late 1980s. We also investigate in several comparison groups to provides further evidence. Specifically, in contrast to the above significant impacts on the treated groups, fertility penalties imposed much smaller and insignificant effects 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 non-preferential-policy regions, the fertility penalty is not correlated with the education of spouse for either Han people or the minorities.

As suggested by the model, the motivation for the policy-induced H-M marriages should be more children to be allowed to give birth. According to the policy implementation, this statement should only hold for the regions with preferential policies to H-M couples. We also show that, in the provinces with preferential terms to H-M couples, larger positive effects of the OCP on the H-M marriage rate are associated with weaker negative effects of the OCP on fertility of local H-M couples. Consistent with our story, in the regions without such preferential terms to H-M couples, we do not find any significant evidence for such association as a comparison.

Since the above results imply the "taxation on marriages", in term of the birth quotas and financial penalties, significantly affects marriage behaviors and equilibrium outcomes, it is natural to ask how much social welfare loss is resulted from the distortions (Chetty, 2009; Hendren, 2013). Following the *sufficient statistics* approach in (Chetty, 2008, 2009), we derive a formula for the social welfare loss caused by the OCP in fertility and marriage market as a whole, which only depends on the estimated reduced-form elasticities. Specifically, the welfare deadweight loss is

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[5]Previous literature used education as a pre-marital investment (Chiappori et al., 2009; Lafortune, 2013). We follow this literature here and assume that higher education indicates more transfers to spouse in marriages.

composed of two parts: the first originates from policy-induced declined fertility (direct effects); while the second part pertains to the marriage distortion analyzed above (indirect effects). By applying the reduced-form estimates to the model, we show that the total social welfare loss is about 3.7 percent of total yearly household income, of which 1.1 percent originates from the marriage distortion. Therefore, these estimates suggest that, not accounting for the "distortion" effect would substantially underestimate the total social welfare loss by 30 percent. The results suggest that the welfare loss caused by direct effects of the OCP on fertility of married couples is not the whole story for the OCP. As marriages are almost prerequisites for children in China, marriage choices are also distorted, and the associated welfare loss contribute a significant part.[6]

This paper is organized as follows: Section 2 introduces the context of this study, especially the background of the OCP. Section 3 develops a theoretical framework for the empirical predictions and the welfare implications. Section 4 presents the empirical strategy and the marriage distortion caused by the OCP. Section 5 calculates the welfare loss caused by the OCP based on the estimates in the previous sections, and section 6 concludes.

2 Context: Ethnicity and One-Child Policy

2.1 Ethnicities 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

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[6]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 of taxation. In this study, children are considered to be downstream "goods" of marriages. Taxing children (OCP) has brought significant distortions in marriage behaviors because the expected potential marriages would be eroded for most people. Our results are similar to the findings in Busse et al. (2013) who found that gasoline prices have significant impacts on the prices and quantities of sales in the new and used car markets.

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. 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 3,682 members. Figure 1 shows the geographic distribution of all the 56 ethnic groups. As shown in the map, most minorities are concentrated in certain regions or provinces. For example, over 90 percent of Zhuang ethnicity people are living in the Guangxi province; and over 95 percent of Tibetan are in Tibet province. The current geographic pattern of ethnic distribution is mainly caused by the Chinese migration history (Poston Jr and Shu, 1987). In addition, most ethnic minority groups live in regions on the western or northeastern boarder, where are usually poorer and lower in socioeconomic status.

2.2 One-Child Policy

China's OCP was first announced in 1978, and it appeared in the amended Constitution in 1982. In recognition of the diversity of demographic and socioeconomic conditions across China, the central government issued "Document 11" in February 1982 to allow the local governments to issue specific regulations. Two years later, the Central Party Committee further issued "Document

Figure 1: Geographic Ethnicity Distribution in China

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

7", which totally devolved responsibility from the central government to the local and provincial governments. The "Document 7" stipulated that regulations regarding birth control were to be made in accordance with local conditions and to be approved by the provincial Standing Committee of the People's Congress and provincial-level governments.

2.2.1 Different Policy Implementation to Han and Minorities

Because Han is the largest ethnicity in China which captures over 90 percent of the population, and the government leaders put much weights on "inter-ethnic harmony" and "national unity", preferential terms were exclusively granted to the minorities when the OCP was implemented. The both-Han couples were mostly allowed to have only one child or two, depending on type of *hukou* and local regulations. However, both-minority couples were legally permitted to have more births or even were not subject to the OCP.

However, it is a "grey area" for H-M couples. It is local governments who made the decision

to apply the preferential terms on these couples, and we found that about half of the provincial governments extended the coverage of this exemption to H-M couples but the others did not. We collected data regarding the exemption terms for H-M couples in every region from the website of the National Health and Family Planning Commission of China, and geographically marked these provinces in Figure 2a. We also found that the preferential terms for H-M couples did not present any changes over time within the same province.[7] Note that the provinces with the preferential terms for H-M couples were not random. These provinces were more likely to be those with more minorities and more H-M couples because the local governments did not want to come across mass resistance and complaints, especially from the minorities. For example, Qinghai province, one of provinces with the highest proportion of minorities in China (i.e., 39 percent), allows the H-M couples to give birth to more babies: "Families can have one more births, if one or both sides of the couple are from minority groups." Consistent with the geographical dissertation of minorities shown in Figure 1, the provinces with preferential terms tend to be in western, northeastern, and southeastern parts of China, where there are more minorities according to Figure 1.

2.2.2 Different Financial Penalties across Regions over Time

Since the central government allowed the local governments to have specific fertility policy regulations in the start of OCP, there has been a large variation in the policy implementation across provinces over time. The measure we use is the average fertility financial penalties for an unauthorized birth in all the provinces from 1979 to 2000. The OCP penalties or fertility fines, also known as "social maintenance fees" in China, were formulated in multiples of yearly household income, which is consistent with its wide use in previous literature (Ebenstein, 2010; Wei and Zhang, 2011). Figure 2b plots the pattern of fertility penalty from 1979 to 2000 in each province. The penalties

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[7]The data source is the website of the National Health and Family Planning Commission (Website accessed in December 2015: http://www.nhfpc.gov.cn/zhuzhan/dftl/lists.shtml). However, the exemption terms may have some differences in rural/urban regions. For example, the H-M marriage preferential terms were only applied for rural people in Liaoning, Zhejiang, Guangdong, Hainan, Chongqing, Guizhou, Gansu and Xinjiang. Therefore, the basic region unit in our further analysis is based on both province and type of hukou (urban/rural). It also differs in different ethnicities within provinces. For example, Zhuang ethnicity may not have a preferential policy in certain regions, and some provinces also specify that the preferential policy may only apply for rural areas but not for urban areas. Our analysis has accounted for this by setting them as non-preferential ethnicities.
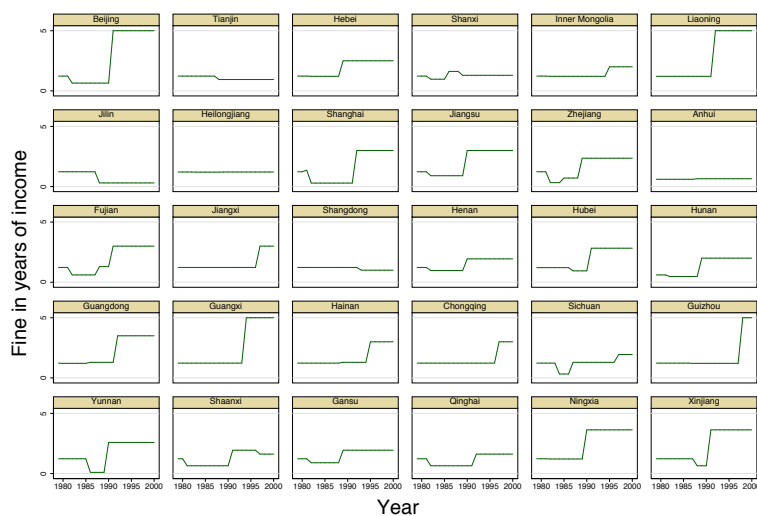
Figure 2: Measures of the OCP: Preferential-Policy Regions and Fertility Penalties

(a) Preferential-Policy Regions v.s. Non-preferential-policy regions

Preferential–Policy Regions
Non–Preferetial–Policy Regions
No data
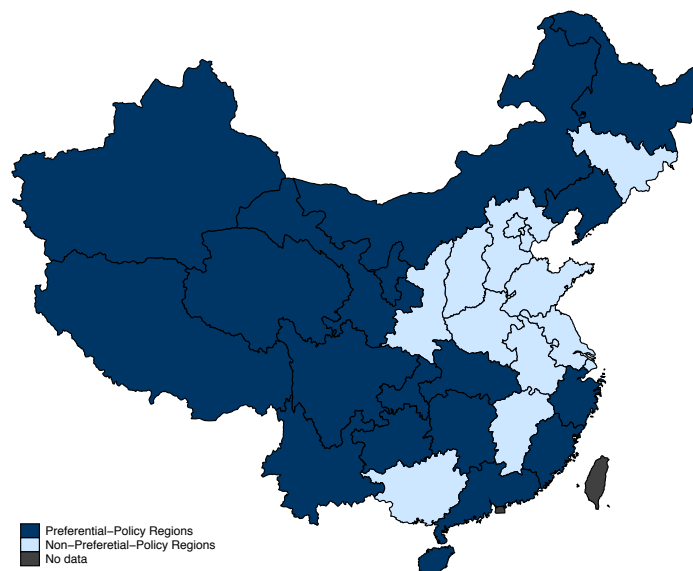
(b) One-Child Policy Regulatory Fertility Penalties in 1980-2000, by Province

Graphs by Province

NOTE: Data source for the preferential-policy regions in figure a 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). Data source for the fertility penalties in figure b is Ebenstein (2010). The unit of penalties is times of local household annual income.

in different provinces generally follow different patterns, both in timing and in magnitude.

The variation presented in figure 2b is what we mainly use to identify the effects of the OCP on marriage outcomes in this paper. It is necessary to know why the governments changed the "tax rates" on the quantities of children. We argue that the changes in the fine rates are closely relevant to the attitudes of central government on fertility as well as the promotion incentives of local officials, as shown below.

At the very beginning of the OCP, vice premier *Chen Muhua* proposed that it would be necessary to pass new legislation imposing an extra child "tax" on excess children. Legal measures such as monetary penalties and subsidies were employed for the effective enforcement of OCP since 1979 (Banister, 1991). In the beginning, central government provided suggested fertility penalties but local governments might made some adjustments. However, it is the subnational leaders, rather than the central government, who faced the practical difficulties in collecting high penalties and beard the costs associated with resistance and complaints directly. For example, Guangdong province received over 5,000 letters complaining the implement of One-Child Policy in a single year. In the first few years, some provincial officials complained: "There is no more difficult work in the world than the OCP implementation."

As mentioned above, because of the "practical difficulties" experienced in earlier years, the Communist Party Central Committee (CPCC) issued several documents in the early 1980s as a guideline for local implementation of fertility policies, which allowed greater flexibility in local practices (Greenhalgh, 1986; Greenhalgh and Winckler, 2005). As a slogan at that time said, "Open a small hole to close up a big one." Since the local governments concerned the social stability and face large resistance from the mass, they had little incentive to design a high fine rate. The fine rates in many provinces, as shown in Figure 2b, went down in the years 1982-1984, when the central government authorized the local governments to design regional specific regulations. The period after 1984 and before 1989 witnessed few changes in the fertility fine rates.

Things started to change in the end of the 1980s, when the central government established the relationship between the OCP performance and promotion of local officials. As Greenhalgh and

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Winckler (2005) wrote in the book Governing China's Population:

"Addressing governors in spring 1989 Li Peng (current premier) said that population remained in a race with grain, the outcome of which would affect the survival of the Chinese race. To achieve subnational compliance, policy must be supplemented with more detailed management by objectives (ME 890406). At a meeting on birth policy in the premier's office, Li Peng explained that such targets should be 'evaluative'."

According to Figure 2b, the fine rate level increased from 0.82 to 2.99 yearly household incomes on average in the period of 1989-1992, *just* after *Li Peng's* speech, which was significantly larger than any other period. Moreover, 16 out of all the 21 significant increases in the history occurred in this period.[8] Indeed, family planning was listed among the three basic state policies in Eight Five-Year Plan passed by National People's Council in March 1991. This document explicitly set an object that the natural growth rate of population should be controlled less than 1.25 percent on average in the following decade. To achieve such a challenging objective, the national leaders employed a management-objective "responsibility system" to induce subnational leaders to set high fine rates and compel local cadres to enforce. We find significant coincidences between fine rate increases and the inauguration provincial officials just after the establishment of the "responsibility system". Among the 16 significant increases happened in 1989-1992, 12 out of them happened exactly in the first two years of new provincial governors tenures.[9] In addition, the average age of these 16 province governors was 56 years old, which was significantly lower than the average age of other provincial governors, 58 years old. These numbers suggest that the promotion incentive of provincial governor could be the main force driving the change of fine rate, and that the strength of such an incentive depended on governor's personal characteristics, such as inauguration time and age.[10]

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[8]The "significant increase" in fine rate here is defined as an increase higher than one-year household incomes.

[9]The average tenure of these 16 provincial governors was about 6 years. And they on average had higher chance of being promoted than their peers. For example, two of them finally became the standing members of the Political Bureau of Central Committee of the Communist Party (CCCP): one was promoted as executive vice premier and the other was promoted as the chairman of Chinese People's Political Consultative Conference (CPCCC).

[10]We also investigate the placements of former governors whose successors raised fine rate by more than one-year

As well known by researchers, the OCP was strictly implemented. For example, Population and Family Planning Commissions (PFPC) were set up at every level of government to carry out registration and inspection work. A large-scale public campaign about the law was launched during the 1980s, and an effective curb on population growth became the highest priority for local officials. To ensure the fine's enforcement upon violation, those who have an "illegal" birth but do not pay the fine can be sued by the local PFPC and the fine will be collected compulsorily. The provincial governments also set up detailed regulations to ensure the effective collection of policy fines. For example, the unauthorized births cannot be registered to the *hukou* system if the fines are not paid;the child cannot go to school as a result. Property can also be confiscated for nonpayment of policy fines. In an extreme case in Shaoyang City, Hunan Province, the "illegal" birth children themselves were confiscated and settled in the social welfare institution because the policy fine was not paid.[11]

3   The Model and Implications

3.1   Marriage Distortion under the One-Child Policy

People are divided into two types: Han (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 and to whom they marry; in the second period, married people decide how many children to have. In the first period, people are able to anticipate the number of children to have according to the potential types of marriages and local fertility policies, and thus behave correspondingly in the marriage market.

Fertility choice under the OCP   We 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

household incomes. We find that these former governors were at least as successful as their peers in political career. In some sense, these former provincial governors were more successful than their peers. Several of them, such as Rongji Zhu, Changcun Li and Guanzheng Wu, even became political leaders of the central government. And we do not find any information showing that one provincial governor was displaced due to bad performance in the OCP implementation.

[11]Source in Chinese: http://baike.baidu.com/subview/5708887/5757115.htm

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 fertility penalty for an unauthorized birth. For simplicity, we assume that the couples maximize the following quasi-linear utility function:

$$\max_{n_{ij}} u(n_{ij}) + y_{ij} - n_{ij}C - \delta_{n_{ij} \geq \overline{n}_{ij}}(n_{ij} - \overline{n}_{ij})f \tag{1}$$

where $u(.)$ is the utility gained from the number of children, with $u' > 0$ and $u'' < 0$; y_{ij} is the exogenously given household income and C is the fixed cost of raising up a child. $\delta_{n_{ij} \geq \overline{n}_{ij}}$ is an indicator which equals to 1 if $n_{ij} \geq \overline{n}_{ij}$, and 0 for otherwise. One inference is that the the same amount of fertility penalties would deduct the household utility more when the birth quotas are fewer.[12] According to the OCP implementation, the negative marginal effects of fertility penalty on the household utility would be larger for H-M couples in non-preferential-policies regions and for all H-H couples, but smaller or even null for H-M couples in preferential-policy regions and for all M-M couples.

Marriage market distortion   We use the transferable utility model in Choo and Siow (2006) to analyze the marriage market. Specifically, 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 both $i, j \in \{H, M\}$. We assume the numbers of men and women of Han people are both $\overline{H}$ and those of minority people are $\overline{M}$, with $\overline{H} > \overline{M}$.

Every individual considers matching with a member of the opposite gender or staying single. Let the utility of a type i man g who marries a type j woman be $V_{ijg} = \tilde{\alpha}_{ij} - \tau_{ij} + \varepsilon_{ijg}$, where $\tilde{\alpha}_{ij}$ denotes the gross marriage gains to the man i in potential couple (i,j). For simplicity, suppose the above utility gained from the number of children are divided between men and women equally: $\tilde{\alpha}_{ij} = \frac{1}{2}u_{ij} + \tilde{a}_{ij}$, where u_{ij} is the maximized utility gained from equation 1. The payoff to a type

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[12]For simplicity, we also assume the couple can choose any positive number of children ($n_{ij} \in \mathbb{R}^+$) , and define u_{ij} as the maximized household utility for couple (i,j). Then we have $\dfrac{\partial u_{ij}}{\partial f} = -\delta_{n_{ij}^* \geq \overline{n}_{ij}}(n_{ij}^* - \overline{n}_{ij}) \leq 0$, implying that fertility penalties would reduce the utility when the birth quota is binding (i.e., $n_{ij}^* - \overline{n}_{ij} \geq 0$).

i man g from remaining unmarried is denoted by $V_{i0g} = \tilde{\alpha}_{i0} + \varepsilon_{i0g} = \tilde{a}_{i0} + \varepsilon_{i0g}$. The women's problem is parallel.[13] In the Appendix, we show the market equilibrium and derive the following three empirically examinable implications.

Prediction 1: The fertility penalties increase the unmarried rate of Han people, especially in non-preferential-policy regions;

Han people would choose to delay their marriages or stay single because of the birth-quota restrictions and fertility penalties have reduced the potential gains from marriage. In preferential-policy regions, Han people may marry minorities to escape from the fertility restrictions, and thus the effects should be weaker.

Prediction 2: In preferential-policy regions, the fertility penalties increase the H-M marriage rate;

In the presence of preferential policies, a higher level of penalty would induce greater incentives for Hans to marry minorities because it is a way to have more children legally. In contrast, people would not have policy-induced incentives to participate in such marriages when the preferential policy is absent because there is no additional birth quota for the H-M couples.[14]

Prediction 3: In preferential-policy regions, the fertility penalties increase the marriage transfer from Han to minorities.

In the preferential-policy regions, the "price" of a minority spouse in the marriage market would increase in cause of heavier fertility penalties, because a minority spouse is associated with additional birth quotas in these regions for Han people. Therefore, the transfers from the Han spouse to the spouse in a H-M marriage would increase when fertility penalty increase.[15]

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[13]The utility of a type j woman k who marries a type i man is $W_{ijk} = \tilde{\gamma}_{ij} + \tau_{ij} + \varepsilon_{ijk}$, in which $\tilde{\gamma}_{ij} = \frac{1}{2}u_{ij} + \tilde{b}_{ij}$. The payoff of remaining unmarried is given by $W_{0jk} = \tilde{\gamma}_{0j} + \varepsilon_{0jk}$.

[14]We investigate interethnic marriage not only because interethnic marriage is an important marriage outcome impacted by the OCP but also because interethnic marriage has been widely used as an indicator of social boundaries between two ethnic groups in sociological and economic studies (Kalmijn, 1991; Fryer, 2007).

[15]However, since the transfers cannot be directly observed in the data, this paper investigates the association of the minority ethnicity with the education level of the spouse in H-M couples to test this hypothesis. There is also a strand of economic literature studying marriage transfers in terms of dowries (Botticini and Siow, 2003; Anderson and Bidner, 2015), bride exchange (Jacoby and Mansuri, 2010).

3.2 Welfare Implications

Since the utility is in monetary units under the quasi-linear utility setting, social surplus is the summation of the expected utilities of men and women, and the fertility penalties collected by the government:

$$\Pi = \sum_i \overline{m}_i ln(\sum_j exp(\tilde{\alpha}_{ij})) + \sum_j \overline{n}_j ln(\sum_i exp(\tilde{\gamma}_{ij})) + \sum_{i,j \neq 0} \mu_{ij} c_{ij} f \tag{2}$$

where $\overline{m}_i$ and $\overline{n}_j$ are the number of men of type i and that of women of type j, respectively; μ_{ij} is the number of (i,j) couples; and $c_{ij} = \delta_{n_{ij} \geq \overline{n}_{ij}}(n_{ij} - \overline{n}_{ij})$ is the number of unauthorized children born by the couple (i,j). Dividing the above equation by the total population of men (or women) (i.e., $\overline{H} + \overline{M}$, the number of the households), and then taking the derivatives with respect to the penalty fine rate, we have the welfare loss equation (See Appendix for mathematic proofs):

$$\frac{d\pi}{df} = \sum_{i \in \{H,M\}} P_i \Big(\sum_{j \in \{H,M\}} r_m^i r_{ij}^i c_{ij} (e_m^i + e_{ij}^i + e_{ij}^c) \Big) \tag{3}$$

where π is the surplus *per* household, P_i is the proportion of type i people in the population, r_m^i is the married rate for type i people, and r_{ij}^i is the proportion of married type i people involved in type $i - j$ marriages with $i, j \in \{H,M\}$. And e_m^i, e_{ij}^i and e_{ij}^c are the elasticities of r_m^i, r_{ij}^i and c_{ij} with respect to the penalties f, respectively. It indicates that the welfare loss for the ethnicity i is $\sum_{j \in \{H,M\}} r_m^i r_{ij}^i c_{ij} (e_m^i + e_{ij}^i + e_{ij}^c)$, and the social welfare loss is the population weighted mean of it.

Similar to other commodity taxes studied in previous literature (Chetty, 2009), the welfare loss caused by the OCP also *only* depends on the basic statistics (i.e., P_i, r_m^i, r_{ij}^i and c_{ij}) and behavior responses to the penalties (i.e., e_m^i, e_{ij}^i and e_{ij}^c). It shows that the corresponding elasticities are *sufficient statistics* to estimate the social welfare loss.[16]

Within the parentheses in the equation, the first term captures the part whether individuals choose to marry or not: it is expected to be negative due to the lower expected gains from mar-

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[16] We thank Professor Raj Chetty and Professor Nathan Hendren for their guidance for this part. Any errors are ours.

riage. The second term captures potential welfare gain or loss from the policy-induced changes in marriage matching for different types of people: it may be positive or negative depending on the assignment of expected marriage gains. These two terms capture the welfare loss caused by the distortion in the marriage market and we term it "distortion" effects.

The final term originates from the fertility restrictions by the penalties and we name it "mechanical" effect. It is expected to be negative. Had we followed the traditional way to consider the tax incidence on the "taxed goods", the estimated total welfare loss of the OCP would only account for the part caused by the reduction in fertility, which is captured by this final term.

It should be noted that the model only looks into the effects of OCP on marriage market and fertility in a partial equilibrium framework. It does not take into account the potential externalities of number of children or other dimensions, including the impacts of the fertility policies on the status of women and the quality of children, though some of these factors are investigated in previous literature (e.g., Miller 2010; Rosenzweig and Zhang 2009).

4 Data

The main data used in this study are the 2000 Population Census and the 2005 One Percent Population Survey (referred as Census 2000 and 2005, thereafter). Both of the data sets contain gender, education level, year and month of birth, region of residence, type of *hukou* (urban/rural), *hukou* province, ethnicity, marital status, and number of children. For each household, the relationship of each member with the household head is also available (e.g., spouse, offspring, siblings, parents, etc), which we use to identify couples within the households.

We restrict our sample to those aged between 26 and 55 at the time of surveys. We keep those aged 26 or above because over 80 percent of people get married before this age, and the late marriage age in China usually refers to age 25. We also drop those aged 55 or above because 1) seniors may suffer from mortality selection and then be widowed after this age; and 2) the marriage market for those aged over 55 would be little affected by the OCP. The cohorts in the sample are

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therefore those born during 1945-1979, suggesting all of them were born before the OCP. Our results are robust with different sample restrictions in age.

In the questionnaire, marital status is categorized into five groups: unmarried, in a first marriage, remarried, divorced, and widowed. For simplicity, we only keep those who were single or in their first marriages (96 percent of the original sample). Based on the answers to the marital status and the ethnicity of spouse, we examine two outcomes in the marriage market: unmarried status and H-M marriage.[17] Because we analyze the sample by Hans and minorities, these two outcomes fully capture whether the respondents were married and to whom they were married. To make the empirical results easier to interpret and to derive the needed parameters in equation 3 for estimating the welfare loss, we use different samples for these two outcomes. First, we use the full sample derived above to study the impact of the OCP on whether the person is married or not. Then, we keep the married ones with information on spouse (88 percent of the sample) to study the impact of the OCP on whether people married others of their own ethnicity (Han/minorities), or of different ethnicities. [18]

Table 1 shows the mean values and standard deviations for the main variables used in this study, by Hans and minorities. The first three columns are for the full sample, and the next three are for married people. Panel A shows that 4.6 percent of people (i.e., 4.4 percent of Han and 6.6 percent of minorities) were unmarried at the time of the survey. Among married people, 2.9 percent were involved in H-M marriages. Because the number of Han people and the number of minority people involved in H-M marriages are the same but the population size of the minorities is much smaller (8.4 percent of the population), the H-M marriage rate is 1.6 percent for Hans and 17.4 percent for minorities. H-M marriages are still relatively rare compared with homogamy because the H-M marriage rate would be 6.5 percent had Han and minorities married randomly. The reasons could

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[17]Note that being unmarried does not mean staying single forever here. Unmarried rate can be also understood as being not married at certain ages.

[18]When information on the spouses is missing, it is mainly because the spouses were not currently living in the household or they refused to answer. The use of all the married couples also gives consistent results. In doing so, we first assume that all the married ones with missing information of spouse are homogamy because most of the marriages are within ethnicity. Then, instead of assuming they are homogamy, we assume they are in another group, namely "missing" group, and repeat our analysis. Both of the two yield consistent results.

Table 1: Summary Statistics

	(1)	(2)	(3)	(4)	(5)	(6)
Sample	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)
Observations	5,677,311	5,223,157	454,154	4,692,977	4,330,059	362,918

NOTE: *The data source is Census 2000 and 2005 Population Study sample.* Sampling weights applied. Standard deviations are in parentheses.

be 1) that people prefer homogamy partially because of the shared culture and language, and lower communication costs; and 2) that the interaction across different ethnicities is relatively less than that within the same ethnicity because the minorities tend to inhabit certain geographical regions.

Panel B presents descriptive statistics of the demographic and socioeconomic status variables. On average, minorities are of lower socio-economic status than Han people. The proportion of Hans living in urban regions (43 percent) is much higher than that of minorities (26 percent). The average educational attainment of minorities is also substantially lower, with 16 percent being illiterate. Gender composition is almost balanced and the average age is about 39 across all samples.

5 Econometric Framework and Empirical Results

5.1 Marriage outcomes responding to the OCP fertility penalties

We start the analysis by conducting a graphic analysis to investigate how marriage outcomes respond to the fertility fines. We want to show how the people in the marriage market alter their behaviors change when facing higher or lower fertility fines. We assume that the marriage market is independent within each province, and that individuals seek for potential spouses in the same *hukou* province. It may be a potential concern if many people once changed their *hukou* provinces or met their spouses in other provinces. We argue this may not be a first-order issue. First, the cohorts we choose in this analysis are born before 1980 and most of the people did not change their *hukou* province form birth to the time of the surveys. According to birth province information in the 2005 census, there are 97 percent of individuals having the same *hukou* province as birth province. Second, the individual activities over the life cycle, such as migration and other social activities, are mostly conducted within the same province. For example, migration in China is mostly intra-province rather than inter-province; the proportion of people whose current living province is the same as their *hukou* province is over 93 percent in our sample. These numbers provide validity for matching the fertility penalties according to the *hukou* province. It is noteworthy that our results are consistent if we use the birth province in census 2005 or current living province to match the information.

For the birth cohorts within each province, we calculate the mean value of the fertility penalties at ages 18-25, and use it as the measure of OCP that is faced by those in the marriage market to investigate the corresponding impacts. We use ages 18-25 here because this is the period when most individuals prepare for marriage and seek spouses: in the sample, over 80 percent of the marriages are formed during this age period. We also tried the penalties at other age periods and the results are consistent.

We then divide the sample into 248 groups, based on the region (i.e., 31 provinces and 2 types of *hukou*), ethnicities (i.e., Han/minorities) and calendar year (i.e., 2000/2005). Within each group,

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we calculate the changes in the fertility penalties at ages 18-25 in two consecutive birth cohorts, as well as the changes in marriage market outcomes in the exactly the same two birth cohorts. We then plot the changes in the marriage outcomes against those in the fertility penalties, weighted by the corresponding population size. Figures 3a and 3b show the results. For the outcome of unmarried status, with the consideration that the OCP mainly restricted the fertility of Han people rather than minorities, we separately show the pattern for the Hans and minorities. . For the outcome of H-M marriage, we separately show the patterns for people in preferential-policy regions and non-preferential-policy regions because Han people are motived to marry the minorities only in the regions with preferential terms for H-M couples.

The change in the penalty rate is divided into five categories. A higher value means a stricter policy at age 18-25 compared to the prior birth cohort. The weighted mean values of the outcomes were calculated accordingly within each category. The positive slopes for the thick blue lines in both figures indicate that stricter fertility policy increases the unmarried rate as well as the H-M marriage rate in corresponding treated groups. In contrast, the increase in the penalty rate appears to be uncorrelated with unmarried rate for the minorities, and H-M marriage rate for the non-preferential-policy regions.[19]

5.2   Econometric framework

Considering the differences in marriage markets between Hans and minorities, we allow for this heterogeneity by dividing the sample by Hans and minorities to conduct the following regressions for the two groups separately:

$$Y_{ipbt} = \beta_0 + \beta_1 Fine_{pb}^{18-25} + Edu_i + \delta_{gbt} + \delta_{ph} + T_{ph} + \varepsilon_i \tag{4}$$

[19]We also conduct OLS estimations to with 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.

Figure 3: Changes in Marriage Outcomes over Changes of the OCP Penalties at age 18-25

(a) Unmarried status, by Han and Minorities
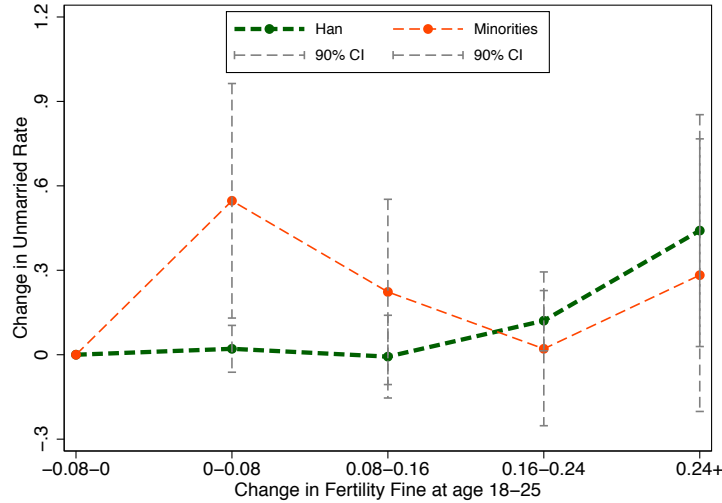
(b) H-M marriage, by Preferential-Policy or No-Preferential Policy Regions
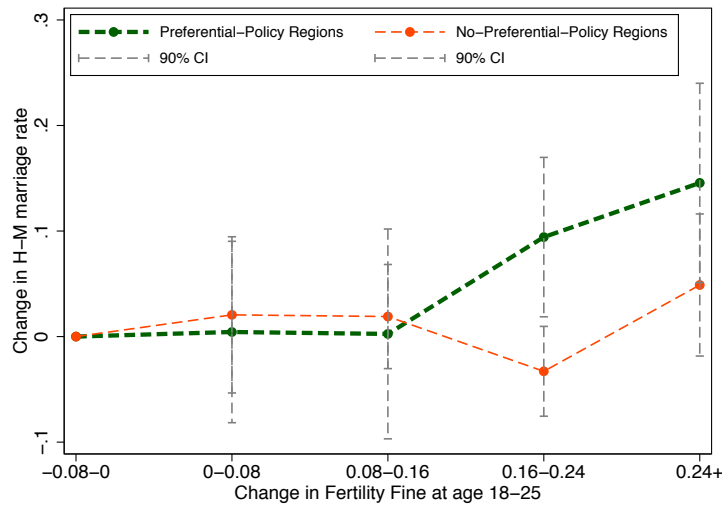
NOTE: The data source is Census 2000 and 2005 Population Study sample. X-axis is the categories of changes in the OCP penalties at age 18-25 in two consecutive birth cohorts and the Y-axis is the corresponding changes in unmarried rate (for figure a) and H-M marriage rate (for figure b) in each category. 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.

where the dependent variable, Y_{ipbt}, is the marriage outcome variable of an individual i of birth cohort b in province p and year t, which can be whether individual i is married or not, or what type of marriage he or she is involved. $Fine_{pb}^{18-25}$ denotes the mean value of the fertility penalties in province p for birth cohort b when aged 18-25. The coefficient, $\beta_1(s)$, is of central interest, which captures the effects of the OCP penalties on marriage outcomes. Edu_i is the dummies for education level of individual i to control for the pre-martial investment (Chiappori et al., 2009; Lafortune, 2013). We control for a set of demographic variables, δ_{gbt}, including dummies of gender (g), birth cohort (b), survey year (t), and all the interactions of the three. By doing so, we control for not only the different levels of outcomes by gender, birth cohorts, age, and survey year, but also the gender-specific age profiles in the two survey years. We also control for a set of regional indicators, denoted by δ_{ph}, which includes the dummies for *hukou* province (p), type of *hukou* (h) and the interactions of the two, to capture the regional time-invariant differences. Since we have 31 provinces and 2 *hukou* types, δ_{ph} has 62 terms in total.

We further control other regional time-variant factors, denoted by T_{ph}. First, T_{ph} includes the male and female proportions of minorities of birth cohort b in the local province p, and their interactions of regional dummies (δ_{ph}). By doing so, we control for the minorities supply in the local marriage market, and allow for people in different regions having heterogenous response in marriage market with respect to the quantities of minorities. Second, T_{ph} also includes the regional specific (i.e., province and type of hukou) linear trends in year of birth, to capture the potential changes in local subjective attitudes towards marriage over time. For each region based on province (p) and hukou type (h), we therefore have three linear terms - male and female proportions of minorities in birth cohort b in province p, and year of birth itself (b). And there are 62*3 = 186 terms in T_{ph} as a result.

By controlling for the above covariates, we use the variation of $Fine_{pb}^{18-25}$ across province over birth cohort to identify the effects of OCP. The exogeneity of this variation may not be taken for granted. As mentioned above, the largest changes in the fertility penalties are coincident with the inauguration of the new provincial officials just after the central government considering the

performance of OCP as an additional evaluative factor. It is thus reasonable to assume they are independent of the individual marriage behaviors. Yet we also investigate in both treated and comparison groups to provide additional evidence (e.g. Han versus minorities for unmarried status, and preferential-policy regions versus non-preferential-policy regions for H-M marriages).

Since the key independent variable, $Fine_{pb}^{18-25}$, in equation 4 is at province-year of birth level, we report two sets of standard errors for all the regression results: those clustered at province-year of birth level, and more conservative ones clustered at province level to allow autocorrelation within the same province over time.

There are some other good reasons to conduct the above regressions by Han and minorities. First, the OCP aims to restrict the population of Han people rather than minorities, and thus we expect differential effects of fertility penalty on unmarried status for the two groups. Second, since the numbers of Han and minority people involved in H-M marriages are the same but the H-M marriage proportion in each group are significantly different because of different population sizes, it may be more straightforward to interpret the estimates if we conduct regressions separately for the two groups. Finally, the coefficients β_1 could be interpreted at the individual level rather than at the couple level for different ethnic groups, and then it would be easier to estimate the corresponding elasticities in equation 3 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. Panel A and Panel B show the results for Han people and those for minorities, respectively. The estimates suggest that an increase in OCP penalties by one year of local household income predicts an increase of 1.7 percentage points in the unmarried rate for Hans (39 percent of the mean), while the comparable estimate for minorities is 0.38 percentage points (5.7 percent of the mean), which is insignificant and much smaller. The effects on unmarried status for Han are larger than those for minorities on both absolute and relative scales.

The next two columns divide the sample into those in preferential-policy regions and those

in non-preferential-policy regions. The effects of the OCP on unmarried status are greater and more significant in non-preferential-policy regions. One unit increase in OCP penalties leads to an significant increase of 2.0 and 0.76 percentage points (i.e., 50 percent and 15 percent of the means), among the Hans in non-preferential-policy regions and those in preferential-policy regions, respectively. Consistent with the predictions, the effect on unmarried rate of the Hans is larger for those in non-preferential-policy regions, on both absolute and relative scales.

It is an empirical question whether the OCP would increase the unmarried rate among the minorities. In contrast, the effects of the fertility penalties are much smaller and insignificant. In general, the coefficients are about one fourth of those for the Han people. In the preferential-policy regions, the sign for the minorities is even opposite. This is consistent with our story: the minority people would become relatively more "valuable" in the marriage market if the penalty has increased, because they have additional birth quotas. In addition, the results for minorities also shed some lights on the exogeneity of the fertility-penalty rate: if the effects of OCP penalties on unmarried rates were driven by some confounding factors correlated with both local penalty rates and the unmarried rates, we would find similar effects of the OCP for the Han people and minorities together.

Figures 4a and 4b show the gender-specific point estimates for $\beta_1(s)$, as well as the corresponding 90-percent confidence intervals. Figure 4a presents the results for the Han people. 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 of the coefficients are larger for men than for women. For example, in non-preferential-policy regions, the coefficient for men is 2.5 times larger than that for women. however, 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.[20] In contrast, Figure 4b shows that the impact of the OCP on the unmarried rate is consistently and significantly smaller for the minorities in all the subsamples.

[20]In the sample, 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.
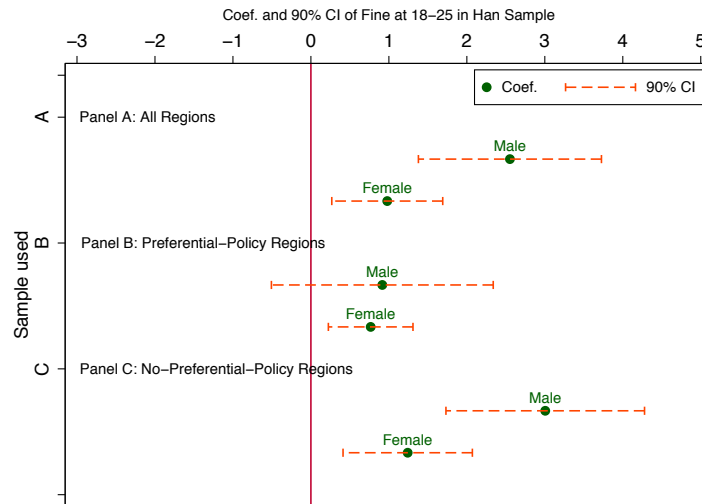
Table 2: Impact of the OCP Penalties on Unmarried Status

|	(1)	(2)	(3)
Dependent variable	Unmarried status (Yes = 100)		
Sample	Full sample	Preferential-policy regions	No-preferential policy regions
Panel A: Han sample			
Mean of Dep. Var.	4.44	4.95	4.21
Fertility penalties	1.702**	0.764**	2.037**
at age 18-25	(0.172)	(0.220)	(0.200)
	[0.511]	[0.541]	[0.572]
Observations	5,223,157	1,622,652	3,600,505
R-squared	0.105	0.107	0.106
Panel B: Minority sample			
Mean of Dep. Var.	6.57	6.61	6.49
Fertility penalties	0.380	-0.283	0.581
at age 18-25	(0.231)	(0.234)	(0.298)
	[0.519]	[0.417]	[0.421]
Observations	454,154	289,864	164,289
R-squared	0.124	0.116	0.145

NOTE: *The data source is Census 2000 and 2005 Population Study sample.* Dependent variable is multiplied by 100 so the coefficients can be interpret in percent. The covariates include dummies of education level; demographic variables such as dummies of gender, birth cohort, survey year, and all the interactions of the three; regional time-invariant variables, including the dummies for *hukou* province, type of *hukou* and the interactions of the two; and regional time-variant variables, including the regional specific (i.e., province and type of hukou) linear terms in year of birth, and male and female proportions of minorities of birth cohort b in the local province p. Sampling weights are applied. Robust standard errors in parentheses are clustered at province-year of birth level, and more conservative standard errors in brackets are clustered at province level.
** $p<0.01$, * $p<0.05$

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


(a) Impact of the OCP Penalties on unmarried for Han ethnicity
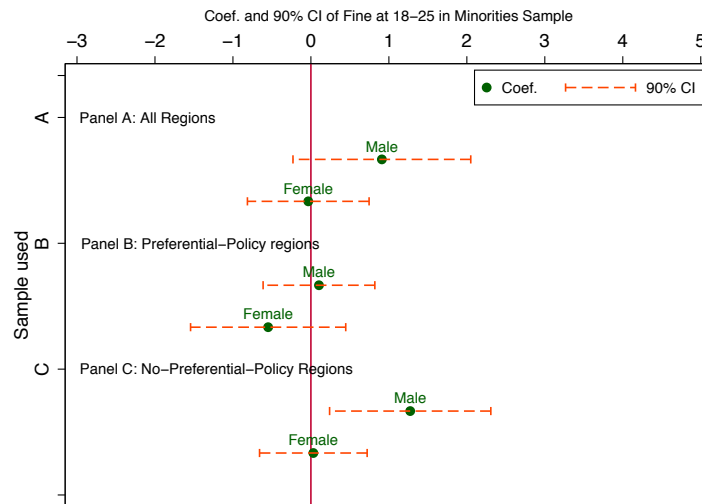
(b) Impact of the OCP Penalties on unmarried for the Minorities

NOTE: The data source is Census 2000 and 2005 Population Study sample. Sampling weights are applied. We use equation 4 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 percent confidential intervals for the Han people and minorities, respectively. The confidential intervals are based on the standard errors clustered at province level.

Figure 5: H-M Marriage rate and the OCP Penalties at 18-25 over Year of Birth, by Preferential-Policy or No-Preferential Policy Regions
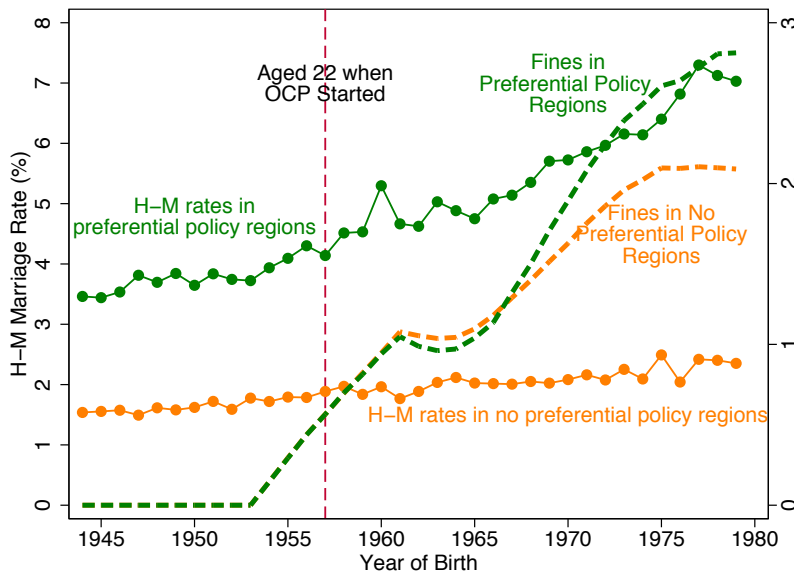
NOTE: The data source is Census 2000 and 2005 Population Study Sample. The H-M marriage rates and penalties are plot against the birth cohorts, by whether the region has preferential policies or not. Sampling weights are applied.

5.4 The OCP increased 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 thus used as the control group in this section. Before the regression analysis, we plot the H-M marriage rate of all couples over the birth cohorts in Figure 5, based on whether the local region had the preferential fertility terms for the H-M couples.

Because of higher minority proportion in preferential policy regions, Figure 5 shows consistently higher H-M marriage rates in these places. For the pre-1955 birth cohorts, the H-M marriage rates are stable and show a fairly parallel pattern across the two types of regions: the preferential-policy regions saw an increase from 3.5 to 7 percent and the non-preferential-policy regions saw an increase from 1.6 to 2.3 percent. However, the two lines start to diverge after the 1955 birth cohorts, who were aged 25 at the start of the OCP. The preferential-policy regions increased by 2.8 percentage points from 4.1 to 6.9 percent while those without the preferential policy only increased

by 0.3 percentage points from 1.9 to 2.2 percent. In contrast,the average fine rates at age 18-25 for both types of regions, shown by the two dashed lines, are very similar. Because whether the preferential fertility policy was in present plays a role like "valve", and the fertility fines indicate how strong the "force" there would be, it is not the strictness of the OCP itself that lead to much higher H-M marriage rates.

To control for the proportion of minority changing over time as well as other confounding factors, we follow the equation 4, conduct the parallel regression analysis as above, and report the results in Table 3. In column 1, Panel A and Panel B show positive impacts of the OCP on the H-M marriages for both Han and for minorities. Specifically, one unit increase in the fertility penalty rate is associated with an increase of 0.19 percentage points (12 percent of the mean) in the H-M marriage rate for Han people and with an increase of 0.66 percentage points (3.8 percent of the mean) for the minorities. The rest of the columns show that the positive effects are mainly driven by the effects in the preferential-policy regions. One unit increase in fertility penalty rate leads to 0.51 and 1.8 percentage points higher H-M marriage rates among the Han people and the minorities (17 and 12 percent of mean), respectively. But the effects are much smaller and insignificant in the non-preferential-policy regions. For example, one unit increase in the fertility fine rate is only insignificantly associated 0.06 percentage points higher H-M marriage rate (6 percent of the mean). The sign is even negative for the minorities: in the non-preferential-policy regions, the minorities had no incentive to marry Han people because doing so would "waste" the birth quota which is valid only if they were to marry other minorities.

Figures 6a and 6b show consistent results with 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.

As mentioned earlier, 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 H-M marriages systematically have a higher or lower marriage age and this difference is correlated with

Table 3: Impact of the OCP Penalties on Han-Minority Marriage

|	(1)	(2)	(3)
Dependent variable	Han-Minorities Marriage (Yes = 100)		
Sample	Full sample	Preferential-policy regions	No-Preferential policy regions
Panel A: Han sample			
Mean of Dep. Var.	1.61	3.00	1.01
Fertility penalties	0.189**	0.508**	0.0642
at age 18-25	(0.0512)	(0.112)	(0.0486)
	[0.112]	[0.240]	[0.0539]
Observations	4,330,058	1,320,072	3,009,986
R-squared	0.038	0.037	0.028
Panel B: Minority sample			
Mean of Dep. Var.	17.4	14.3	23.7
Fertility penalties	0.661*	1.753**	-0.913
at age 18-25	(0.317)	(0.429)	(0.511)
	[0.741]	[1.067]	[0.608]
Observations	362,914	231,661	131,252
R-squared	0.153	0.133	0.164

NOTE: *The data source is Census 2000 and 2005 Population Study sample.* The covariates are the same as those in Table 2. Sampling weights are applied. Robust standard errors in parentheses are clustered at province-year of birth level. More conservative standard errors in brackets are clustered at province level.
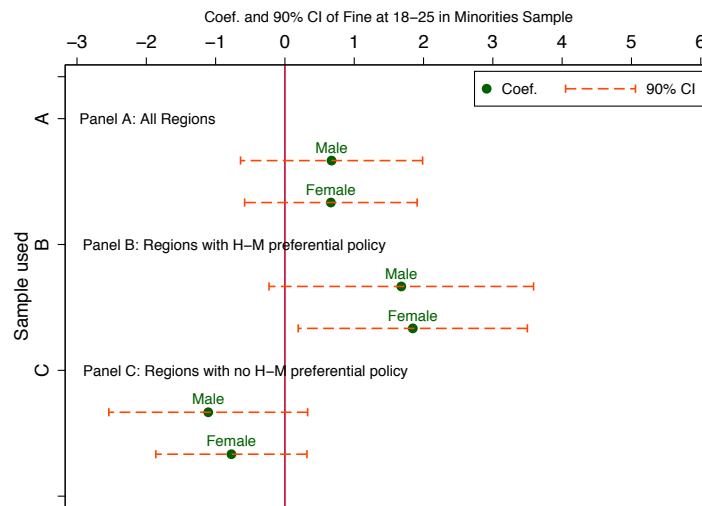** $p<0.01$, * $p<0.05$

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

(a) Impact of the OCP on H-M Marriages for Han ethnicity, by Gender and Region
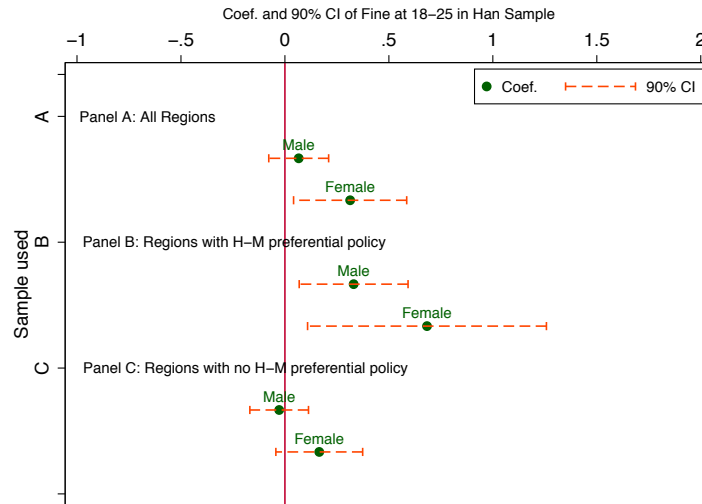
(b) Impact of the OCP on H-M Marriages for the Minorities, by Gender and Region

NOTE: The data source is Census 2000 and 2005 Population Study sample. We use equation 4 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 percent confidential intervals for the Han people and minorities, respectively. The 90 percent confidential intervals are based on the standard errors clustered at province level.

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 serious issue. First, the difference in the age of first marriage between H-M marriages and other types of marriages is small. 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. And we find no evidence that those involved in H-M marriages tend to marry later because of the OCP. Also, if we trim the sample to those aged over 30, we 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.[21]

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 provides evidence to support this argument. The main difficulty in performing such a test is that the expectation about the 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.[22]

The presence of non-preferential-policy regions provides a natural control group. In these regions, we expect that 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 Han people into 62 subsamples (s) by *hukou* province (p) and *hukou* type (h). Then for each subsample (s), we conduct the following regressions:

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[21]The results are available upon request.
[22]We thank Professor Lawrence Katz for providing great suggestions for this part. Any errors are ours.

$$HM_{ibt}^s = \theta_1^s Fine_b^{18-25,s} + X_{ibt}^s + \varepsilon_{i1}^s \tag{5}$$

where the dependent variable, HM_{ibt}^s, denotes whether an individual i of birth cohort b in year t in subsample s is involved in a H-M marriage; $Fine_b^{18-25,s}$ denotes the average penalty rate at age 18-25 for the birth cohort b in the local province p. Likewise, we also include a set of covariates as equation 4. X_{ibt} denotes the minority proportions for both males and females in the birth cohort b of the local province, education level indicators, and dummies for gender, calendar year, of birth cohort groups (i.e., for every 10 years) and all interactions of the three.[23] Then we keep the Han people involved in H-M marriages and conduct the following regressions on each subsample:

$$Children_{ibt}^s = \theta_2^s Fine_b^{18-25,s} + X_{ibt}^s + \varepsilon_{i2} \tag{6}$$

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 correlation pattern for non-preferential-policy regions and Figure 7b for the presence of preferential policies. We find a very weak correlation between the impact on fertility and the impact on H-M marriages in Figure 7a, but a significantly positive correlation in Figure 7b. The results imply that the restrictive effects of the OCP on fertility would be partially offset by the policy-induced H-M marriages. Therefore, Figures 7a and 7b provide some evidence that the expected number of children is an important factor that individuals consider in their marriage decision.

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[23]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.

Figure 7: Impacts of the OCP on H-M marriages and Impacts on Fertility of these couples, by Preferential-Policy or No-Preferential Policy Regions
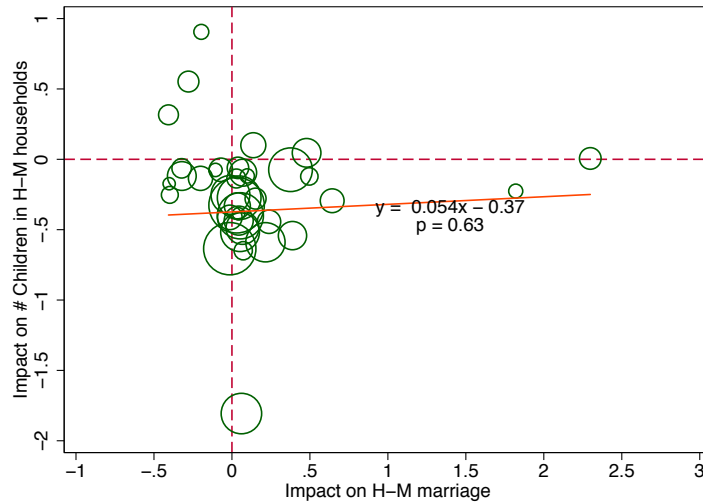
(a) Regions with no-preferential policy to Han-Minority couples
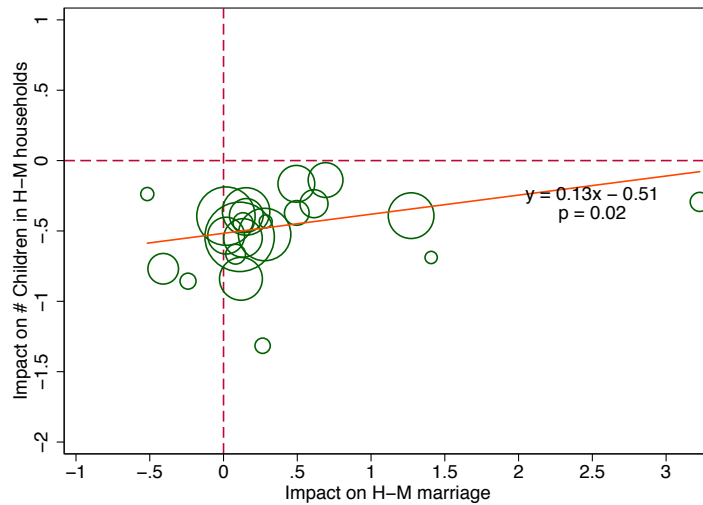
(b) Regions with preferential-policy to Han-Minority couples

NOTE: The data source is Census 2000 and 2005. The full sample is divided by the province and for each subsample, equations 5 and 6 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.

5.6 More "Transfers" to Minority Spouses in H-M couples

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 quotas can be brought into marriage. However, the "utility transfers" cannot be directly observable. Thus we examine, in the preferential-policy regions, whether the minorities in H-M marriages marry more highly educated people in presence of higher fertility penalties.[24] We expect that, in preferential-policy regions, the educational attainments of the spouses of minorities 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 minorities in the non-preferential policy regions. Therefore, we trim the sample to those H-M couples, and conduct the following regression separately by Hans and minorities:

$$Education_{ipbt}^{spouse} = \alpha_0 + \alpha_1 Fine_{pb}^{18-25} + Edu_i + \delta_{gbt} + \delta_{ph} + T_{ph} + \varepsilon_i \tag{7}$$

where the dependent variable is education level of the spouse, on a scale of 1 to 6 (i.e., these levels are illiterate, primary school, junior middle high, senior middle high, college or university, master or above) - the larger the value, the higher the education level. All the other variables are kept the same as those in equation 4. Panel A of Table 4 reports the OLS estimates for the minorities. Consistent with our expectation, the positive coefficients show that higher penalty is significantly associated with a higher education level of the spouses of the minorities within the H-M couples. The next two columns divide the sample into the regions with preferential policy to H-M couples and those without. And we find the positive association *only* exists for the sample of the preferential-policy regions. The coefficient is 0.04 and three times larger than those for non-preferential-policy regions (which is 0.013). These results indicate that the minority ethnicity

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[24]In previous literature (Chiappori et al., 2009; Lafortune, 2013), education is viewed as pre-marital investment and predicts higher household income, and we consider the education of spouse as received utility transfer in marriages.

Table 4: Impact of the OCP Penalties on Education of Spouse among H-M marriages

	(1)	(2)	(3)
Dependent variable	Education Level of Spouse (1-5, larger for higher education)		
Sample	Full sample	Preferential-policy regions	No-Preferential policy regions
Panel A: Minorities in the H-M marriages			
Fertility penalties	0.026**	0.040**	0.013
at age 18-25	(0.010)	(0.015)	(0.014)
	[0.014]	[0.032]	[0.015]
Observations	63,005	34,566	28,439
Panel B: Han people in the H-M marriages			
Fertility penalties	0.002	-0.006	0.018
at age 18-25	(0.011)	(0.015)	(0.017)
	[0.012]	[0.022]	[0.011]
Observations	63,005	34,566	28,439

NOTE: The data source is Census 2000 and 2005 Population Study sample. Only H-M couples are included. The covariates are the same as those in Table 2. Sampling weights are applied. Robust standard errors in parentheses are clustered at province-year of birth level. More conservative standard errors in brackets are clustered at province level.
** p<0.01, * p<0.05

is more valuable under higher fertility fines when the preferential policy to H-M couples is in present. Since Han ethnicity did not enjoy the preferential treatment, we do not find any significant associations between the education of spouse and fertility fine rate among the Han people.

6   Welfare Analysis

Recalling that reduced-form elasticities are sufficient statistics for the deadweight loss of social welfare, this section applies the individual behavioral response to the OCP penalties to the equation 3 to calculate the welfare loss caused by the distortion. The most important parts of equation 3 are the three terms in parentheses. The first two terms reflect the distortion in the marriage market and the third term captures the reduction in fertility given the types of marriages.

Based on the data of the number of children observed in the each household, we can directly calculate the number of unauthorized born children c_{ij}. According to the equation 3, we follow the same identification strategy above to estimate the effects of penalties for different types of marriages. Table 5 reports the results. Consistent with our expectations, the effects are mainly from H-H couples. The coefficient for Han-Han couples reflects the magnitude of the policy-induced lower fertility. Columns 3 and 4 shows that the effects of unauthorized births are one scale smaller for H-M couples, and around zero for M-M couples.

Table 5: Impact of the OCP Penalties on Number of Unauthorized Births

	(1)	(2)	(3)
Dependent variable	Number of Unauthorized births		
Sample	Han-Han Couples	Han-Minority Couples	Minority-Minority Couples
Fertility penalties at age 18-25	-0.0198*	-0.00254	0.000151
	(0.00917)	(0.00934)	(0.000159)
	[0.0364]	[0.0105]	[0.000185]
Observations	4,263,273	133,372	296,327
R-squared	0.257	0.268	0.049

NOTE: The data source is Census 2000 and 2005 Population Study sample. The covariates are the same as those in Table 2. Sampling weights are applied. Robust standard errors in parentheses are clustered at province-year of birth level. More conservative standard errors in brackets are clustered at province level.
*** p<0.01, * p<0.05*

Our above analysis estimated the needed marriage and fertility responses to the OCP penalties to calculate the welfare loss. Table 6 reports the results. We calculate the loss by Han and minorities, respectively. Panel A reports the basic statistics in equation 3 (i.e., P_i, r^i_m, r^i_{ij} and c_{ij}). Panel B reports the elasticities of unmarried, intra- or inter-ethnicity marriage, and number of unauthorized 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 penalty (the unit is yearly local household income) for each ethnicity i. Along with the notation in the equation 3, we specifically

calculate the marriage distortion and the fertility reduction in the parentheses for each ethnicity combination, and report them in the first two rows. The unit for welfare loss is the percentage of yearly household income.

Consider one unit increase in fertility fine rate (i.e., one year of local household annual income). For the Han ethnicity, the welfare loss originating from fertility reduction is 1.85 percent of yearly household income, and that from marriage behavior distortion is 0.8 percent, indicating that the distortion of the marriage market actually captures 30 percent of the total welfare loss. For the minorities, in spite of some welfare loss caused by lower fertility,they actually were better off from the OCP in the marriage market. Therefore, the total welfare loss caused by one unit increase in fertility penalties is 2.5 percent of local yearly household income. Because the average penalty at age 18-25 is 1.5 (times of household income) for those birth cohorts born later than 1960, it suggests that the total welfare loss caused by the OCP is 3.7 percent of yearly household income, to which marriage distortion contributes 1.1 percent of yearly household income. It indicates that the traditional way to calculate the policy-induced welfare loss (i.e., only examine the policy-induced lower fertility among the married couples), which does not consider the distortion in marriage market (i.e., the distortion effects), would significantly underestimate the total welfare loss.

Therefore, these findings highlight the importance of considering the "indirect effects" when calculating relevant welfare loss. This raises the question as to under what circumstances 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 taxed good") are different from most normal goods in the market, because most children are born in wedlock and thus children are the natural fruits of marriages. A higher tax will prevent more people from marrying because their expected marriage gains become lower than the "married or not" threshold. The "direct effects" only consider the welfare loss among those who are married, and cannot take into account those whose expected marriage gains would fall below the threshold of "married or not" because they are censored when conducting the traditional analysis.[25]

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[25]However, this study is not the first one to reveal 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

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

	(1)	(2)	(3)	(4)	(5)
Ethnicity i	Han		Minority		Total welfare
Ethnicity j	Han	Minority	Han	Minority	gain/loss
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	0.45	0.21	0.21	0.00	-
Panel B: Estimated Elasticities with respect to penalties					
(e_m^i) Married rate of i	-0.018	-0.018	-0.004	-0.004	-
(e_{ij}^i) Marriage $i-j$	-0.002	0.118	0.039	-0.008	-
(e_{ij}^c) Illegal births	-0.044	-0.012	-0.012	0.000	-
Panel C: Welfare gain/loss of unit change in fine rate					
(% of yearly household income)					
Marriage Distortion	-0.80		0.12		-0.73
Fertility Reduction	-1.85		-0.04		-1.73
Total	-2.65		0.08		-2.46

NOTE: The data source is Census 2000 and 2005 Population Study sample. Statistics in Panel A are calculated from the corresponding samples. The estimates in Panel B are calculated from the results in Tables 2, 2 and 5. The estimates in Panel C are calculated from the results in Panel A and Panel B by plugging them into the equation 3. Welfare loss estimated in column 5 is the population weighted mean of those for the Han people and minorities.

7 Conclusions and Discussion

This study examines the incidence of "taxation on marriages" by using the variation in the ethnicity-specific assigned birth quotas and different fertility penalties across provinces over time caused by the strict fertility policies in China, and estimates the welfare loss caused by the OCP. In this study, we show 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 penalty 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 highly-educated Han spouses when the penalty rate is higher in the presence of preferential policies. The results suggest that the OCP has led to a large distortion in marriage equilibrium outcomes.

We further estimate the welfare loss induced by the OCP. The welfare loss comes from two parts: one is the reduction in individual fertility (direct effects), and the other is the distortion in the marriage market (indirect effects). Applying the estimated reduced-form elasticities to the model shows that the distortion of the marriage market actually brings about a welfare loss approximately equal to 1.1 percent of the yearly household income, which captures about 30 percent of the total loss caused by the OCP. The large impact on H-M marriage outcomes implies that the unintended but rational behavioral responses to the policy potentially create large and persistent impacts on the culture, development, and societies of minorities. This calls for future studies on the behavioral and social impacts of other similar ethnic-specific policies.

Our findings build up the current literature by studying the incidence of the unique "taxation on marriages" in the world and by extending the *sufficient statistic* approach to the marriage market. The estimates provides new evidence on the implications and extensions of the transferable utility model by, and also suggest that the relationship between different goods needs to be considered when studying the potential consequences of policies or taxations.

This study also has some limitations. First, the government implemented other strict OCP regulations at the same time. For example, workers in the public sector risked losing their jobs if

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in the new and used car market.

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 fertility penalty may be a good measure as suggested in previous literature (Edlund, 2000; Wei and Zhang, 2011), we need to bear in mind when interpreting the estimates that they only reflect the impacts of the monetary penalty rather than the overall effects of the OCP. In addition, some social conflicts have happened in the process of collecting the OCP penalties, 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 beyond the numbers in our study. Finally, our model and empirical analysis look into the effects on marriage and fertility only, but do 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 some of these factors are investigated in previous literature. We are looking forward to future studies, which may shed light on these questions.

Appendix

A1: Market Equilibrium under the OCP

Following the assumption in Choo and Siow (2006), we assume that ε_{ijg}, ε_{i0g}, ε_{ijk}, and ε_{0jk} are independently and identically distributed random variables with a type I extreme-value distribution. A man g of type i will choose according to $V_{ig} = max_j\{V_{i0g}, V_{iHg}, V_{iMg}\}$. A women k of type j will choose according to $W_{jk} = max_i\{W_{0jk}, W_{Hjk}, W_{Mjk}\}$. 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 following symmetric equilibrium for men and women (i.e., $\mu_{ij} = \mu_{ji}$) : for $i, j \in \{H, M\}$,

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

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

For type i individuals ($i \in \{H, M\}$), we denote the married rate as r^i_m, and the H-M marriage rate (conditional on married) as r^i_{HM}. Assuming that the fertility penalty does not affect the utility of being single or the systematic gross return other than that from the number of children, we have the following empirically examinable implications.

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

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

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:

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

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 $\dfrac{\partial \theta_{HH}}{\partial f} = u'_{HH}$, $\dfrac{\partial \theta_{HM}}{\partial f} = u'_{HM}$, $\dfrac{\partial \theta_{MM}}{\partial f} = u'_{MM}$, and $\dfrac{dr_M^M}{df} = -\dfrac{dr_M^H}{df}$, $\overline{H}h_m r_H^M = \overline{M}m_m r_M^H$, we have

$$
\begin{cases}
\left(\dfrac{1}{h_m} + \dfrac{1}{h_0}\right)e_h - \dfrac{1}{r_H^H}e_H^M = u'_{HH} \\[3mm]
-\dfrac{r_M^H}{h_m r_M^M}e_h - \dfrac{r_M^H}{r_H^M r_M^M}e_H^M + \left(\dfrac{1}{m_0} + \dfrac{1}{m_m} + \dfrac{r_M^H}{m_m r_M^M}\right)e_m = u'_{MM} \\[3mm]
\left(\dfrac{1}{h_m} + \dfrac{1}{2h_0}\right)e_h + \dfrac{1}{r_H^M}e_H^M + \dfrac{1}{2m_0}e_m = u'_{HM}
\end{cases}
$$

where $e_h = \dfrac{dh_m}{df}$, $e_m = \dfrac{dm_m}{df}$, and $e_H^M = \dfrac{dr_H^M}{df}$. 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,

$$e_h = \frac{A u_{HH}' + \alpha_2 C}{\alpha_1 A + \alpha_2 B} \tag{8}$$

$$e_H^M = \frac{-B u_{HH}' + \alpha_1 C}{\alpha_1 A + \alpha_2 B} \tag{9}$$

$$e_m = \frac{u_{MM}' + \alpha_3 e_h + \alpha_4 e_H^M}{\alpha_5} \left(or = \frac{u_{HM}' - \alpha_6 e_h - \alpha_7 e_H^M}{\alpha_8}\right) \tag{10}$$

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 $C \leq 0$.

A2: Proof of Predictions

Proof of Predictions 1:   We have found that $e_h = \frac{A u_{HH}' + \alpha_2 C}{\alpha_1 A + \alpha_2 B}$ 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:

$$e_m = \frac{(\alpha_7 B - \alpha_6 A) u_{HH}'}{\alpha_8 (\alpha_1 A + \alpha_2 B)} \tag{11}$$

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:

$$e_M^H = r_M^H(\frac{1}{h_m}e_h + \frac{1}{r_H^M}e_H^M - \frac{1}{m_m}e_m) \tag{12}$$

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):

$$e_M^H = \frac{r_M^H(\frac{1}{h_m}A - \frac{1}{r_H^M}B - \frac{1}{m_m}D)u'_{HH}}{\alpha_1 A + \alpha_2 B} \tag{13}$$

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:

$$\frac{d\tau_{HM}}{df} = -\frac{1}{h_0}e_h + -\frac{1}{m_0}e_m \tag{14}$$

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 $e_m > 0$.

A3: Welfare Implications

From the social welfare expressed as below,

$$\Pi = \sum_i \overline{m}_i ln(\sum_j exp(\tilde{\alpha}_{ij})) + \sum_j \overline{n}_j ln(\sum_i exp(\tilde{\gamma}_{ij})) + \sum_{i,j \neq 0} \mu_{ij} c_{ij} f. \qquad (15)$$

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

$$\frac{d\Pi}{df} = \sum_i \overline{m}_i \sum_j P_{ij} \frac{d\tilde{\alpha}_{ij}}{df} + \sum_j \overline{n}_j \sum_i Q_{ij} \frac{d\tilde{\gamma}_{ij}}{df} + \sum_{i,j \neq 0} \mu_{ij} c_{ij} + (\frac{d\mu_{ij}}{df} c_{ij} + \mu_{ij} \frac{dc_{ij}}{df}) f \qquad (16)$$

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 $\dfrac{d\tilde{\alpha}_{ij}}{df} + \dfrac{d\tilde{\gamma}_{ij}}{df} = \dfrac{du_{ij}}{df} = -c_{ij}$, we have

$$\begin{aligned} \frac{d\Pi}{df} &= -\sum_{i,j \neq 0} c_{ij} \mu_{ij} + + \sum_{i,j \neq 0} \mu_{ij} c_{ij} + \sum_{i,j \neq 0} (\frac{d\mu_{ij}}{df} c_{ij} + \mu_{ij} \frac{dc_{ij}}{df}) f \\ &= \sum_{i,j \neq 0} (\frac{d\mu_{ij}}{df} c_{ij} + \mu_{ij} \frac{dc_{ij}}{df}) f \end{aligned} \qquad (17)$$

Divide the both sides by $\overline{H} + \overline{M}$, we can have the equation 3 in the main text.

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