Using New Measures to Reassess the Fertility Effects of China's Family Planning Policies

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Abstract

This paper assesses the effects on national fertility levels of China's half century of family planning policies. It uses a pooled cross-sectional sample of ever-married women interviewed in the China Health and Nutrition Survey. The analysis uses improved policy measures that supersede the less accurate measures of previous Chinese fertility studies. While these new measures provide more complete information on variations in family planning policy over time and across populations, they also address endogeneity problems of some previous measures and take into account more heterogeneous policy exposure. Several important findings come from this paper. First, estimated policy effects on fertility generally become stronger over time and are larger for urban populations and the Han ethnic majority, and these findings are consistent with documented historic policy variations. Second, had earlier family planning policies not been replaced by the one-child policy, fertility would still have declined below replacement level (i.e., the additional effects of the one-child policy were fairly limited). Third, in estimating the fertility effects of family planning policies, if incomplete measures, endogenous measures, or measures lacking heterogeneity are used, the estimated policy effects are likely to be significantly biased.

Keywords: Family Planning Policy, Fertility, Policy Measurement, China

Introduction

China's family planning policies have been in effect since 1963, over half a century. The total fertility rate has declined substantially from 5.44 in 1971 (Yang 2004) to 1.18 in 2010 (National Bureau of Statistics of China 2012). This paper assesses the effects of China's family planning policies on national fertility levels and presents simulations of fertility trajectories in various counterfactual policy scenarios. The aim is to comprehensively evaluate China's family planning program and to address the implications of prospective adjustments to the program.

Many studies have examined the contributions of China's family planning policies to fertility change nationwide and, as might be expected, they have reached varying conclusions. The use of different measures in the analyses is a major reason for variations in the conclusions presented by the studies. Further examination, however, suggests that these measures are not only different but have inherent structural problems. It is this issue of improperly constructed measures that needs to be addressed. For example, they might set up policy measures based on incomplete information about family planning programs, or incorrectly apply endogenous measures to fertility estimations. Moreover, their measures have generally ignored the heterogeneous exposure of the population to family planning policy. This paper reassesses the fertility effects of China's implementation of family planning policies. This reassessment will use newly constructed policy measures that exceed previous ones in three ways. First, the new measures take advantage of more complete policy variations over time and across population groups. China's family planning policies started modestly in the 1960s, became stricter in the 1970s, and finally culminated in the harsh one-child policy in 1980. Moreover, the policies have been more stringent for urban populations and the ethnic majority Han population than for rural populations and non-Han minorities. The new measures fully reflect the changes over the three periods and the residential (urban/rural) and ethnic policy differences. Second, the variations in the new measures are constructed mainly on mothers' birth cohorts, which are more exogenous. Third, the new measures are more heterogeneous by taking into account the duration of mothers' policy exposure and their ages during exposure. The second and third improvements may also be generalized to the evaluation of other countries' family planning programs.

Using a pooled cross-sectional sample of ever-married women with detailed birth records from the China Health and Nutrition Survey, this paper regresses women's total number of births from 15 to 49 years of age on their exposure to the family planning policies and a variety of demographic and socioeconomic variables. Based on the estimates, this paper calculates the policy effects for different policy periods and population groups, and simulates fertility trajectories along mother's birth cohort in counterfactual policy scenarios. The paper also compares the results generated from the new policy measures with those generated from the inadequate measures used by previous studies.

This paper has several main findings. First, in general, the estimated policy effects on fertility become stronger over time, and are greater for urban populations and the Han ethnic majority. The temporal and cross-sectional patterns are consistent with the history of China's family planning policies. Second, had there been no family planning policies, fertility levels would be higher for all birth cohorts of mothers, and would fall at a slower rate along mothers' cohorts. Had the policy of the 1970s not been replaced by the one-child policy and continued to be effective, fertility would eventually drop below replacement level for young cohorts. In other words, given the implementation of the more lenient policies of the 1960s and 1970s, the additional effects of the one-child policy on pushing down the fertility levels have been fairly limited. Third, the policy measures that omit earlier periods would underestimate the fertility effects of later periods. Using endogenous measures and measures that lack heterogeneity would also bias the estimates.

Brief History of China's Family Planning Policies

China's Population and Family Planning Law[1] (Order of the President No. 63), which went into effect September 1, 2002, states in Article 2 that: *China being a populous country, family planning is a fundamental State policy. The State adopts a comprehensive measure to control the size and raise the general quality of the population. The State relies on publicity and education, advances in science and technology, multi-purpose services and the establishment and improvement of the reward and social security systems in carrying out the population and family planning programs.*

The *comprehensive measure* referred to consists mainly of public information campaigns, family planning services, and birth quotas. Government agencies publicize family planning policies to reshape people's fertility preferences and to educate them to plan their fertility behaviors. Local clinics offer free contraceptives and low-priced family planning medical services (e.g., sterilization). The family planning institutions reward compliance and penalize families having more children than the birth quota. While public information campaigns and family planning services are commonly seen in the family planning programs of other countries, birth quotas are an exclusive feature of China's policies and play a crucial role in fertility behaviors.

The application of birth quotas defines three distinct periods of family planning policy in China. Policies in the first period (1963–1970) were relatively lenient, with narrowly implemented policies lacking intensity or stringency; the second period (1971–1979) was

[1] http://www.gov.cn/english/laws/2005-10/11/content_75954.htm.

characterized by rigidly enforced policies that were broadly implemented; the third period (since 1980) is defined by the one-child policy. In each period, the birth quota is relaxed for rural populations and ethnic (non-Han) minorities because 1) the mindset of big families and son preference is more deep-rooted in rural areas, and 2) it is considered important to maintain the size of ethnic minority populations, to preserve ethnic diversity.

The rest of this section introduces the period without birth quota (1949–1962), and presents the policy history of the three periods—denoted as Period 1, Period 2, and Period 3—as well as the residential (urban/rural) and ethnic (Han/non-Han) policy differences in each period.

No Birth Quotas (1949–1962)

On the eve of the founding of the People's Republic of China, the supreme leader Mao Zedong stated, "It is a very good thing that China has a big population" (Mao 1949). Influenced by the pro-natal policy of the Soviet Union, China imposed strong restrictions on sterilization and abortion, and subsidized large families during the period 1950–1952.[2] During 1949–1953, China's population increased by 46 million, which led to some government relaxation of restrictions on family planning in the period 1953–1957.[3]

In 1958, the Great Leap Forward campaign took the stage and aimed to use China's vast population to rapidly transform the country from an agrarian economy into a modern communist society.[4] As a result, family planning again became politically inappropriate. A great famine followed the campaign and fertility rates fell dramatically from 6.68 in 1958 to 3.29 in 1961.[5]

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[2] Yang (2004), pp. 44–45.
[3] Ibid., pp. 46–58.
[4] http://en.wikipedia.org/wiki/Great_Leap_Forward.
[5] Yang (2004), pp. 61.

Under such circumstances, family planning was a topic rarely discussed. When the famine ended in 1962, fertility increased (again dramatically) to 6.02 in 1962 and even reached 7.50 in 1963.[6]

Period 1: Softly and Narrowly Implemented Family Planning Policy (1963–1970)

Pushed by the post-famine fertility boom, the Chinese government issued an official document about family planning at the end of 1962. This event marked the beginning of China's family planning policies.[7] The Period 1 policy set population growth targets, advocated late marriage, established family planning institutions, and disseminated family planning knowledge and technologies.[8] In this period, the national slogan for the birth quota was—"one (child) is not few, two are just right, three are too many." Local authorities shared similar views. For instance, Shanghai advocated that married couples should not have more than three children.[9] Therefore, this paper assumes that the birth quota for Period 1 is three children. Families complying with the birth quota were rewarded through wages, housing, and commodity distribution.[10]

The Period 1 policy was implemented mainly in urban areas (Lavely and Freedman 1990). By the end of 1965, Period 1 family planning policy was in effect in 168 cities. In rural areas, however, except for a few pilot projects, family planning policy had limited coverage.[11] Additionally, Period 1 policy was carried out only for the ethnic majority Han population. It did not reach the areas occupied by ethnic minorities, the non-Han populations.[12]

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[6] Ibid., pp. 69.
[7] Yang (2010). As the document was released in the end of 1962, we assume that it came into effect in 1963.
[8] Yang (2004), pp. 62–67.
[9] Ibid., pp. 68.
[10] Ibid., pp. 64.
[11] Ibid., pp. 68–69.
[12] Ibid., pp. 142–143.

In 1966–1970, The Cultural Revolution paralyzed family planning institutions. Although the policy was unchanged, implementation was interrupted.[13]

Period 2: Strongly and Broadly Implemented Family Planning Policy (1971–1979)

Fighting against the negative impact of the Cultural Revolution, the Chinese government issued another official document in 1971, restating the importance of family planning. The document signified that family planning policies had entered a new stage.[14] The Period 2 policy is known as "*late, long, few*". "Late" means late marriage and childbearing. The recommended minimum age of marriage was 25 for men and 23 for women; women were encouraged to have births after 24. "Long" means the birth spacing should be more than 3 years. "Few" means a married couple could have at most two children, which was the birth quota of this period.[15] The systems of housing, food and land distribution were designed to favor families that complied with the birth quota. In 1978, family planning policy was included in the Constitution.[16]

The Period 2 policy was effective in both urban and rural areas, but the urban population growth target was stricter than the rural target,[17] implying that the rural birth quota was more relaxed. Similar to the Period 1 policy, the Period 2 policy was enforced only for Han populations, but family planning services were available in the regions occupied by non-Han populations.[18]

Period 3: One-child Policy (since 1980)

[13] Ibid., pp. 71.
[14] Ibid., pp. 73.
[15] Ibid., pp. 73.
[16] Ibid., pp. 74.
[17] The annual population growth rate was set to be 1% for urban areas and the rural rate was 1.5% (Ibid., pp. 72).
[18] Ibid., pp. 143.

As a natural evolution of the Period 2 policy, the one-child policy was launched in 1980.[19] The one-child policy generally allows married couples to have only one child. The strictness of the one-child policy is guaranteed by its enforcement. The implementation of the Period 1 and Period 2 policies mainly relied upon executive measures; the one-child policy is enforced by rule of law. After family planning was written into the 1978 Constitution, more details were added to the 1982 amended Constitution. Since early 1980s, local governments have implemented laws on family planning.[20] Legal measures, such as monetary penalties and subsidies,[21] have ensured the effective enforcement of the one-child policy.

The birth quota varies according to residence (urban/rural) and ethnicity (Han/non-Han). An urban Han family can only have one child,[22] while a rural Han family is allowed to have the second child if certain conditions are met—for example, if the first child is a daughter.[23] An urban non-Han family can have a second child under certain circumstances, and a rural non-Han family can have three or more children.[24]

A few studies have focused on regional variations of the one-child policy rather than urban/rural or ethnic differences. Edlund et al. (2007) consider the availability of family planning institutions across provinces during the one-child policy period. Huang et al. (2014) measure the one-child policy with provincial-level monetary penalties. McElroy and Yang (2000), similarly,

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[19] Ibid., pp. 86.
[20] Ibid., pp. 161.
[21] One-child families receive one-child subsidies and various social security benefits. Families that have excessive births have to pay fines. Fines can be many times the local annual income, but standards vary across provinces. For example, Beijing women who illegally have a second birth would have to pay fines three to ten times the Beijing average annual income.
[22] Many provinces relaxed the one-child policy to a conditional two-child policy for urban Han populations. For example, if both parents are the "one child" in their respective families, they may have a second child. Because the first generation of children from "one-child" families was born in the 1980s, qualifying parents were few until the recent decade. Therefore, for simplicity, the birth quota for the urban Han population in the one-child policy period is assumed to be one in this paper. In 2013, the restrictions on additional births were further relaxed; if one of the parents is the only child in her family, the couple may have a second child. The sample used in the paper does not cover the period after 2013.
[23] Yang (2004), pp. 87.
[24] Ibid., pp. 148.

use county-level monetary penalties. Poston and Gu (1987) use 10 variables of family planning behaviors at the beginning of the one-child policy. Qian (2009) takes advantage of the variations of the conditional two-child policy across rural regions. Schultz and Zeng (1995) measure the policy with the availability of family planning services across rural villages. However, regional variations of the Period 1 and Period 2 policies are far from being clear.[25] For the sake of consistency, this paper only considers urban/rural and ethnic differences in assessing fertility changes across the three policy periods.

Summary of the Policy History

China's policy history on birth quotas during the three policy periods is summarized according to residence (urban/rural) and ethnicity (Han/non-Han) in Table 1.

[Table 1]

Over time, birth quotas have become more restricted for all population groups. Within each period, the birth quota is smaller for urban and Han populations than for rural and non-Han populations. The intensity of public information campaigns about family planning and the availability and quality of family planning services have also been changing over time and across populations, exhibiting a consistent pattern with birth quotas. Therefore, Table 1 uses birth quotas to present the intensity of family planning policies in China, and policy variations by period, residence (urban/rural), and ethnicity (Han/non-Han) will be used to construct policy measures.

[25] For instance, Dai (2013) indicates that Beijing, Shanghai, Tianjin and Liaoning implemented family planning policies in the 1960s, with most of the other provinces phased in during the 1970s. However, Yang (2004) points out that many provinces other than the four also had family planning policies during the 1960s.

Review of Past Measures of China's Family Planning Policies

Previous measures have not only ignored ethnic and residential policy variations, but also ignored parts of the three periods of family planning policy, analyzing only one or two of the periods. Such incomplete measures are of little use in the task of evaluating the entirety of China's family planning policies.[26] Some measures only take advantage of the temporal (short-term) policy changes. Banerjee et al. (2010) use a dummy variable indicating whether the eldest child was born after 1971, the first year of the Period 2 policy, to capture the effect of the Period 2 policy on the number of children. Narayan and Peng (2006) use time dummies for 1970–2000, 1970–1979 and 1980–2000, to measure the policy intensities before and after 1970, and the intensity differences between the Period 2 and Period 3 policies. Yang and Chen (2004) use the year dummies of being married, from 1970 to 1989, to capture the change in policy intensities along marriage cohorts. Some studies only use cross-sectional policy variations. Cai (2010) measures the county-level intensity of the one-child policy with the percentage of rural population and Han population within each county. Li and Zhang (2007) use provincial proportions of non-Han population to measure the intensity of the one-child policy. More studies take both temporal and cross-sectional policy variations into account but either omit the urban/rural or ethnic differences or neglect a part of the policy change over time. Islam and Smyth (2010) take advantage of the policy change between two adjacent policy periods and the urban/rural policy differences to illustrate the policy effects on the number of children. Li and Zhang (2009) and Li et al. (2005) construct policy measures based on the ethnic policy differences before and after the beginning of the one-child policy. Wu and Li (2012) investigate the urban/rural and ethnic policy variations with differing exposure to the one-child policy. This

[26] Not all such incomplete measures were used for assessing the policy effects. Quite a few studies use the incomplete measures as instrumental variables for the number of births, and completeness is not required for the validity of instrumental variables.

paper focuses on policy change across the three periods, looking at urban/rural and ethnic policy variations, to capture a more complete history of China's family planning policies.

Some policy measures are constructed based on mothers' endogenous fertility behaviors. Such endogenous measures may be correlated with unobserved determinants and bias the policy effects on fertility. For example, Banerjee et al. (2010) and Islam and Smyth (2010) measure mothers' policy exposure with dummy variables indicating whether the eldest child was born in a particular policy period. This study constructs policy measures based on mothers' birth cohorts, which are more exogenous.

Other than endogeneity, the policy dummy variables based on the birth timing of the first child also fail to consider the heterogeneity of mothers' policy exposure. For example, if an old-cohort mother and a young-cohort mother both had the first child during the one-child policy period, then the two mothers' policy exposure would both be defined as one. However, the old-cohort mother's *effective* exposure to the one-child policy may be shorter than that of the young-cohort mother, because the former would reach menopause earlier than the latter. Wu and Li (2012) solve the problem by defining a policy variable whose values are proportional to the duration of policy exposure. However, even if two mothers have the same duration of policy exposure, it is possible that one was exposed to the policy during her most-fertile years, while the other was exposed during her least-fertile years, and the former is likely to have greater effective exposure than the latter. Li et al. (2005) explore the heterogeneous policy effects by age. Their results imply that, given the same duration of exposure, those who were exposed to the one-child policy in their 20s, arguably the most fertile years, have greater policy effects than those who were exposed at younger or older ages. They estimate the age-specific effects by controlling individual age dummies, which will work properly only for sufficiently large samples. Instead, we propose simpler heterogeneous measures that take into account both the duration of policy exposure and ages during exposure by using the probabilities of childbearing across mother's age.

Data

This paper employs pooled cross-sectional data on ever-married women with birth records from the China Health and Nutrition Survey (CHNS). The CHNS is one of the most widely used micro-data sources on China. Conducted by an international team, the CHNS collects information on households and individuals regarding economic, demographic, and social variables, particularly those concerning health and nutrition. Surveys were conducted in 1989, 1991, 1993, 1997, 2000, 2004, 2006, 2009, and 2011 across 12 provinces.[27] A large proportion of respondents have been followed longitudinally through successive survey rounds.

The CHNS interviewed ever-married women aged 18 to 52,[28] about their birth history in seven of the nine survey rounds (1991, 1993, 2000, 2004, 2006, 2009, and 2011). A woman can be tracked from one round to the next. The CHNS combined the birth history data from all seven rounds, keeping only the most recent record for each woman, and released the data online.[29] In this study, we use the standard fertile age range for women (15–49); therefore, to rule out

[27] Before 2000, the survey covered eight provinces: Guangxi, Guizhou, Henan, Hubei, Hunan, Jiangsu, Liaoning, and Shandong. Heilongjiang was included in 2000 and thereafter. Beijing, Chongqing, and Shanghai were included in 2011.
[28] The surveyed women were aged18 to 50 in 1991.
[29] The birth history data used by this paper is named "m12birth" and was released in January 2013 on the official CHNS website. Each observation of "m12birth" represents a birth record. We reshaped the data to a pooled cross-section of mothers with birth records. The birth history data did not include childless women. We identified childless women from other data in the ever-married women module and appended them to the birth history data. Moreover, the birth history data had no information about survey years. We merged the data with other data in the ever-married women module that have the information on survey years, and mapped the latest survey year to each woman in the birth history data.

extreme cases, we deleted women from the data who had given birth when they were younger than 15 or older than 49.[30]

The birth history data include the date of birth, gender, living arrangement, and date of death of every child that a woman has ever had and allows us to map the history of family planning policies onto the entire childbearing process. Demographic and socioeconomic variables of mothers and their spouses can be found from other modules of the CHNS.[31]

Only ever-married women were asked about their birth history because marriage is a pre-condition for childbearing in China, both traditionally and legally. According to the CHNS data, the fraction of non-marital childbearing is below 5% and shows no rising trend over mothers' cohorts, which is quite different from the results of Hotz et al. (1997) with regard to non-marital childbearing in the United States.[32]

Table 2 shows descriptive statistics of selected variables for ever-married women in the sample.

[Table 2]

Means and standard deviations are shown for the full sample, and for different birth cohorts of women. The sample comprised 7105 women. They had 1.70 children on average, about half having no more than one birth and 40% having two or three births. They were on average about 41 years old at the time of the survey. A total of 36% women lived in urban areas and 88% women were Han Chinese. Over 70% of the women had not completed high school.

Over birth cohorts, the average number of births decreases from about three to below one. The fertility decline should be partly attributed to unfinished childbearing of young cohorts.

[30] Only 0.3% women were dropped.
[31] The variables of women's spouses are only available for currently married women.
[32] They point out that, in the United States, fewer than 6% of births were to unmarried mothers in 1963, while this proportion rose to 30% in 1992.

Nevertheless, the fertility transition remains remarkable from the oldest cohort to the cohort of 1970, who were on average above 40 and had essentially completed childbearing by the survey. Figure 1 plots detailed fertility trend by cohort. The number of births drops from about 3.64 of the 1940 cohort to about 1.22 of the 1970 cohort, a two-thirds reduction. The fraction of urban women increases, then decreases over cohorts. The rising part reflects urbanization, and the falling part implies that urban young cohorts are less likely to be married than rural peers and are less likely to appear in the sample. The highest level of education increases over cohorts.

[Fig. 1]

The CHNS sample is not nationally representative as it underrepresents the population of northwest China. Our investigation shows that the average number of births by birth cohort from the one-percent random sample of China's 1990 census is fairly similar to that in Fig. 1, implying that the CHNS sample is at least representative in terms of the fertility transition over cohorts.

Theory, Empirical Strategy and Policy Measures

In a demand model of fertility (e.g., Hotz et al. 1997), a married couple maximizes their utility function by choosing the number (and the quality) of children and level of consumption, subject to budget and time constraints. Then, the demand function for the number of children, n, can be expressed as $n = N(\boldsymbol{p}, w, I, \boldsymbol{\theta})$, where $\boldsymbol{p}$ is a vector of prices, w is the wages of mothers (the price of mothers' time), I is the household non-labor income, and $\boldsymbol{\theta}$ is a vector of attributes that affect n, including parental preferences, technologies, and parental fecundity. China's family planning policies can enter the demand function through several channels. For example, public information campaigns about family planning shift parental preferences,[33] family planning services lower the cost of contraceptives, and the birth quota raises the cost of high-order births.

Easterlin and Crimmins (1985) propose a different analytical framework for fertility, which specifies three channels through which various factors affect the number of children: demand for children, supply of children, and fertility regulation. The demand function $N(\boldsymbol{p}, w, I, \boldsymbol{\theta})$ with family planning policies matches well with their framework, and all function arguments can be mapped onto the three channels. For example, parental fecundity influences the supply of children; prices and income affect the demand for children; family planning policies are included in fertility regulation. In addition, their supply channel highlights the survival rate (or mortality rate) of children, which could be added to $\boldsymbol{\theta}$.

As the policy effects on *n* are the major interest of this paper, other factors will be broken down into exogenous variables. In other words, a reduced-form equation will be estimated, as in Eq. 1.

$$n_i = \alpha + \sum_{j=1,2,3} \left(\beta_{j0} FPP_{ji} + \beta_{j1} FPP_{ji} \times Urban_i + \beta_{j2} FPP_{ji} \times Han_i\right) + \delta Urban_i + \theta Han_i + \textstyle\sum_k \gamma_k X_{ki} + \eta_c + \varepsilon_i, \tag{1}$$

In Eq. 1, *i* indicates woman *i*; n_i is the number of children ever born to woman *i*; FPP_{ji} measures woman *i*'s exposure to the Period *j* policy (*j* = 1, 2, 3). Because China's family planning policies differ by residence (urban/rural) and ethnicity (Han/non-Han), FPP_{ji} is further interacted with an urban dummy and a Han dummy. Correspondingly, separate urban and Han dummies are also

[33] Merli and Smith (2002) find that the acceptance of policy-sanctioned family size reflects the degree of policy enforcement.

included. In other words, the policy measures in Eq. 1, comprising nine variables, have captured the residential and ethnic variations for all three policy periods. ***X*** involves a set of variables of women and their spouses, such as schooling dummies, province dummies, and age dummies. η_c represents cohort variables, including a cohort linear trend, 5-year cohort dummies,[34] interactions of 5-year cohort dummies and urban dummy, interactions of 5-year cohort dummies and Han dummy, and interactions of 5-year cohort dummies and province dummies.

FPP_{ji} is defined as follows,

$$FPP_{ji} = \sum_{a=15}^{49} p(a) I\left[a_{sji} \leq a \leq a_{eji}\right]. \tag{2}$$

I is an indicator function; a represents age; a_{sji} and a_{eji} are woman i's age when the Period j policy started and ended. According to the policy history, a_{sji} and a_{eji} are defined as

$$\begin{aligned} a_{s1i} &= 1963 - birth\ year\ of\ i, \\ a_{e1i} &= 1970 - birth\ year\ of\ i, \\ a_{s2i} &= 1971 - birth\ year\ of\ i, \\ a_{e2i} &= 1979 - birth\ year\ of\ i, \\ a_{s3i} &= 1980 - birth\ year\ of\ i, \\ a_{e3i} &= latest\ survey\ year\ of\ i - birth\ year\ of\ i. \end{aligned} \tag{3}$$

$p(a)$ measures the probability of childbearing at mother's age a. Figure 2 illustrates $p(a)$, which is derived from the birth records of all women in the sample. The probabilities of childbearing

[34] The linear cohort trend attempts to capture the varying cohort effects within each 5-year cohort dummy. Estimation results are robust if the 5-year cohort dummies are replaced by a less restrictive specification, for example, 3-year cohort dummies.

below 15 or above 49 are assumed to be zero. Figure 2 shows that the probabilities of childbearing during the 20s are higher than at younger or older ages.

[Fig. 2]

Essentially, FPP_{ji} is defined as the summation of a set of weighted dummies. Each dummy measures whether woman *i* was exposed to the Period *j* policy at a particular age. Every dummy needs to be weighted by the woman's probability of childbearing at that age. Without $p(a)$, FPP_{ji} will only capture the duration of policy exposure; with $p(a)$, FPP_{ji} could further reflect the heterogeneity of policy exposure by age. The inverse-U shape of $p(a)$ implies that the policy effects would be greater for women who are exposed to a policy at more-fertile ages than for those exposed to the policy at less-fertile ages. This assumption is supported by what Li et al. (2005) have shown. Moreover, FPP_{ji} is mainly defined by birth cohorts, which ensures exogeneity.

Ideally, the weights, $p(a)$, should be the *ex ante* probabilities of childbearing by age, computed based on the women who have never been exposed to family planning policies. Such women, however, do not exist in the sample. To check robustness, we construct eight sets of alternative weights using eight subgroups in the sample, specifically the urban Han women, rural Han women, urban non-Han women, rural non-Han women, cohorts of 1950 or older, cohorts of 1951–1960, cohorts of 1961–1970, and cohorts of 1971 or younger. In particular, the weights derived from the rural non-Han women should be close to the probabilities of childbearing for women who have never been exposed to family planning policies. Wang (1988) indicates that the age-specific fertility rates for sufficiently old women would be very close to a natural fertility regime. The cohorts of 1950 or older may not be old enough to replicate a natural fertility curve, but the weights generated from them would be closer to the natural fertility curve than those from younger cohorts. Wang (2014) shows in greater detail that the policy effects are quite robust with different sets of weights.

Figure 3 illustrates the average of FPP_1, FPP_2, and FPP_3 by birth cohort. Women born in the 1940s, 1950s, and after 1960 have been intensively exposed to the Period 1, Period 2 and Period 3 policies, respectively.

[Fig. 3]

Variables $\boldsymbol{p}$, w, I and $\boldsymbol{\theta}$ in the demand function are assumed to be largely characterized by $\boldsymbol{X}$ and η_c. For example, prices, infant mortality rates, technologies and parental preferences exhibit certain patterns over time, and the patterns might differ by residence and ethnicity. Therefore, the cohort variables and their interactions with residential and ethnic dummies could essentially capture those factors. Moreover, wages and household income are largely determined by schooling and age of women and their spouses. Uncontrolled factors go to the error term ε_i, and are assumed to be uncorrelated with controlled variables.

To complete the empirical specification, we add exposure to the great famine of 1959–1962. This variable is defined similarly to FPP_{ji}, and a_{sji} and a_{eji} are now the ages in 1959 and 1962. This variable captures the fertility dip caused by the famine as well as the fertility make-up that occurred after the famine, which triggered the Period 1 policy. This variable helps deal with the issue of endogenous placement of the Period 1 policy.

Empirical Results

Estimation Results

Table 3 shows estimation results for the ordinary least squares regression of the number of births a woman has ever had, on her characteristics. Standard errors (shown in parentheses) are clustered at the primary sampling unit/5-year birth cohort level.[35]

[Table 3]

The dependent variable is the number of births a woman has ever had. Column (1) is the baseline regression. Column (2) further controls for the triple interactions of policy exposure, urban dummy, and Han dummy, to capture more cross-sectional policy variations. Compared with Column (1), Column (3) additionally includes the variables on women's spouses. The information on women's spouses is not available for women who are divorced or widowed, so the number of observations has decreased.

Through all columns, variables related to family planning policies are generally negative, implying that the policies reduce the number of births, and the policy effects are stronger for urban and Han populations than for rural and non-Han populations. Tests confirm that the effects of the family planning policies are statistically jointly significant in all regressions. The policy effects for different periods and population groups are discussed below in section 6.2. Schooling shows strong and robust effects through all the columns. The higher the level of schooling is, the greater the effect is. In Column (3), the schooling of women's spouses tends to further reduce the number of children.

Policy Effects by Period and Population Group

[35] Each primary sampling unit is an urban or suburban neighborhood in a city, or a town or village in a county. The total number of clusters is 2256.

Based on the estimation results of Table 3, Table 4 calculates the policy effects by period, residence (urban/rural) and ethnicity (Han/non-Han). Table 4 consists of three panels derived from regressions of Columns (1) to (3) of Table 3. In each panel, women are categorized into four groups according to three family planning policy periods, as in Table 1.

[Table 4]

Each figure in the table represents the effect of 1 year of exposure to a particular family planning policy on the number of births for a specific population group, other variables being constant. For example, in Panel 1 the figure −0.051 corresponds to "Rural Han" and "Policy 2", which means that 1-year exposure to Period 2 family planning policy would result in a rural Han woman having 0.051 fewer children, all other factors being kept constant. The −0.051 is calculated from $(-1.890 + 0.112) \times \frac{1}{35}$, where −1.890 and 0.112 are the coefficients of "Policy 2" and "Policy 2 × Han". If a woman were fully exposed to a policy from age 15 to 49, her exposure would be valued as "one". Therefore, 1 year of exposure on average would be valued as $\frac{1}{49-15+1} = \frac{1}{35}$. In Panel 2, the calculation considers the triple interactions.

In Panel 1, all policy effects are negative, implying that the family planning policies would decrease women's fertility levels. For any group, the policy effects tend to increase in magnitude over the policy periods.[36] From Period 1 to Period 2, the increases are large, while the additional effects of the one-child policy to the Period 2 policy are very limited. Within each period, the magnitude of policy effects for urban women and Han women tend to be stronger than rural women and non-Han women.[37] These features are essentially consistent with the

[36] Any magnitude decrease over policy periods is non-statistically significant. In other words, statistically, the magnitude of policy effects of later periods is greater than or equal to that in earlier periods, within each group.
[37] In Periods 1 and 2, the magnitude of policy effects is smaller on Han women than on non-Han women, but none of these differences are statistically significant. In other words, in any period, the magnitude of policy effects on

implications of Table 2.[38] Panels 2 and 3 have shown similar results, implying that the policy effects are robust to the change in model specifications.

Policy effects also vary by mothers' education and gender of the first birth. Wang (2014) shows that the policy effects on fertility are greater for less-educated mothers and for mothers whose first child is a daughter. One possible explanation for this phenomenon is that less-educated women tend to have more births, and thus would face greater restrictions from family planning policies. Similarly, because of the preference in China for having male children, women whose first child is a daughter tend to have more births to obtain a son, and thus would face more restrictions from family planning policies. Family planning policies are less binding for better-educated women and women whose first child is a son.

Simulated Fertility by Cohort in Counterfactual Scenarios of Policy History

This section seeks to determine to what extent family planning policies have caused the fertility decline across birth cohorts, as seen in Fig. 1. Fertility change from cohort 1943 to cohort 1973 will be examined because 1) the average number of births in cohort 1943 is the maximum, and 2) cohorts younger than 1973 were on average under 35 years of age during the surveys and probably had not completed childbearing by then.[39]

The contribution of family planning policies to fertility decline will be explored by simulating fertility levels in counterfactual policy scenarios. In Fig. 4, the top short-dashed line shows how fertility levels would change by cohort had there been no family planning policy.

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urban women and Han women is statistically greater than or equal to the magnitude of policy effects on rural women and non-Han women.

[38] Urban non-Han women have significant effects when they were theoretically not covered by any policy. This feature is probably the result of externality. Public information campaigns and family planning services for urban Han populations were also available for urban non-Han populations in earlier periods.

[39] Figure 2 implies that women have basically completed childbearing around age 35.

This simulation was done by turning off all family planning variables in the baseline regression of Table 3. Fertility levels are high for all cohorts but still decrease from 4.53 to 3.75 across cohorts, an 17% reduction caused by factors other than the family planning policies. The middle dashed line simulates fertility levels—had the Period 1 policy lasted throughout the survey years and not been replaced by later policies. This simulation was done by turning off the policy variables of Periods 2 and 3 in the baseline regression and resetting the Period 1 policy variable based on its new ending year, using Eq. 2. Exposure to Period 1 policy shifts fertility levels down by about one for almost all cohorts,[40] and the number of births decreases from 3.89 to 2.79 across the cohorts. The lower long-dashed line illustrates the cohort trend of fertility levels—had the Period 2 policy been long-lasting after it replaced the Period 1 policy in 1971. This simulation was done by keeping the actual Period 1 policy variable, turning off the Period 3 policy variable, and resetting the Period 2 policy variable based on its new ending year, using Eq. 2. Fertility levels decline substantially, particularly for younger cohorts that have been fully exposed to Period 2 policy. Across cohorts the decline is from 3.62 to 1.64. The bottom solid line shows fertility levels according to actual policy history. It can be seen that the one-child policy pushes fertility further down, particularly for younger cohorts, but its additional effects are limited.

[Fig. 4]

The simulations imply that the "softer" policies before the one-child policy would have been sufficiently effective to cause fertility to drop below replacement level. Miller et al. (2015) reported that Period 2 policy may explain the bulk of China's fertility decline. The limited additional effects of the one-child policy have not been commensurate with its fame. China has been gradually relaxing the one-child policy to a conditional two-child policy. It has been

[40] As the effects of the Period 1 policy on fertility are statistically insignificant, the fertility shift may not be statistically significant.

reluctant to proceed further because of concern over the prospect of a possible baby boom. According to the simulations, however, a universal two-child policy would be unlikely to cause a major rebound in fertility.

Sensitivity of Policy Effects to Different Policy Measures

This section examines the negative impact on policy effects that occurs when incomplete measures, endogenous measures, and measures lacking heterogeneity are used for estimation of fertility change.

Table 5 shows the policy effects derived from regressions with different policy measures, other control variables remaining unchanged as in Column (1) of Table 3. Each figure in Table 5 indicates the effect of 1 year of policy exposure on the number of births. Panel 1 shows the policy effects from the baseline regression, as shown in Panel 1 of Table 4. The policy effects in Panel 2 come from a regression dropping the Period 1 policy variable and its interactions with urban and Han dummies. In Panel 3, the policy effects are generated from a regression that only keeps the variables of the Period 3 policy. In other words, Panels 2 and 3 show how policy effects would differ if the policy variations of earlier periods have been ignored. Panel 4 shows what the policy effects would be if the policy is measured by a dummy indicating whether the eldest child was born in a particular policy period—arguably an endogenous variable. In Panel 5, the policy measure is defined by a dummy indicating whether a woman has ever been exposed to a policy between ages 15 and 49. This measure is exogenous, but ignores all heterogeneity of policy exposure. In the last panel, the policy measure is proportional to the duration of exposure but does not vary by age during exposure.

[Table 5]

Comparing Panels 2 and 3 to Panel 1, it can be concluded that if earlier policies are omitted, the policy effects of later periods will be systematically underestimated because the estimated effects are actually the *additional* effects based on earlier policies. If endogenous policy variables are adopted (Panel 4), policy effects could be substantially biased from baseline. If policy measures lack heterogeneity (Panel 5), the policy effects could also be very different. However, if some heterogeneity is considered (Panel 6), the policy effects would be closer to baseline.

Conclusions

This paper assessed the fertility effects of a half century of China's family planning policies using new policy measures. The new measures provide more complete policy information over time and cross population groups. The time dimension of the new measures is based on mothers' birth cohorts that are more exogenous than some previous measures. The new measures have also sufficiently considered the heterogeneity of policy exposure and allow the values of the measures to vary by exposure duration and age of women during exposure.

Based on the new measures, the resulting estimated policy effects were consistent with historically documented policy variations and are robust to different model specifications. Simulations show that some family planning policies, particularly those in place before the one-child policy, could lead to substantial reductions in fertility. The one-child policy, however, has had limited additional effects on lowering fertility. This conclusion suggests that if China is planning to deal with the issues of an aging population by relaxing family planning policies, but is unwilling to accept a substantial rebound in fertility, a universal two-child policy could be an option. Finally, if earlier policy variations are omitted from the fertility estimation, the effects of later policies may be underestimated. Moreover, endogenous measures and measures lacking heterogeneity are likely to significantly bias estimated policy effects.

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Table 1 Birth quotas during China's three family planning policy periods, by residence (urban/rural) and ethnicity (Han/non-Han)

	Period 1 (1963–1970)	Period 2 (1971–1979)	Period 3 (Since 1980)
Urban Han	Three	Two	One
Rural Han	No birth quota	More than two	Two subject to certain conditions
Urban non-Han	No birth quota	No birth quota	Two subject to certain conditions
Rural non-Han	No birth quota	No birth quota	Three or more subject to certain conditions

Table 2 Characteristics of ever-married women from the China Health and Nutrition Survey

		Birth Cohort of Ever-married Women				
	Full Sample	1950 or Older	1951–1960	1961–1970	1971–1980	1981 or Younger
Number of Births	1.70	3.11	2.03	1.48	1.23	0.87
	(1.12)	(1.43)	(1.07)	(0.79)	(0.66)	(0.61)
Zero-One Birth (%)	53.9	9.5	35.2	60.0	74.0	89.3
	(49.9)	(29.3)	(47.8)	(49.0)	(43.9)	(30.9)
Two-Three Births (%)	39.2	56.2	56.5	38.1	25.4	10.5
	(48.8)	(49.6)	(49.6)	(48.6)	(43.6)	(30.7)
Four or More Births (%)	6.9	34.3	8.3	2.0	0.5	0.2
	(25.3)	(47.5)	(27.6)	(13.9)	(7.1)	(3.9)
Age at Survey	40.81	48.68	48.14	41.82	33.57	25.66
	(8.87)	(3.38)	(4.81)	(6.39)	(4.48)	(2.91)
Urban (%)	36.2	30.4	37.0	38.7	36.6	31.6
	(48.0)	(46.0)	(48.3)	(48.7)	(48.2)	(46.5)
Han (%)	88.4	85.2	88.6	89.8	87.2	89.6
	(32.1)	(35.6)	(31.8)	(30.3)	(33.4)	(30.5)
No Schooling (%)	17.0	49.6	29.0	8.9	5.2	1.7
	(37.6)	(50.0)	(45.4)	(28.5)	(22.2)	(12.9)
Primary School (%)	18.3	29.0	18.7	18.2	15.7	9.6
	(38.7)	(45.4)	(39.0)	(38.6)	(36.4)	(29.5)
Middle School (%)	35.6	14.0	27.3	41.2	43.4	45.8
	(47.9)	(34.7)	(44.6)	(49.2)	(49.6)	(49.9)
High School (%)	20.6	6.6	22.3	23.9	20.8	22.6
	(40.5)	(24.9)	(41.6)	(42.7)	(40.6)	(41.9)
College (%)	8.5	0.8	2.7	7.8	15.0	20.3
	(27.9)	(9.0)	(16.3)	(26.8)	(35.7)	(40.3)
N	7105	863	1648	2375	1564	655

Note: Standard deviations are in parentheses. *Primary school*, *middle school*, *high school* and *college* indicate the highest level of schooling.

Table 3 Ordinary least squares regression of the number of births a woman has ever had, on her policy exposure and other characteristics

Dependent variable: number of births a woman has ever had			
	(1)	(2)	(3)
Policy 1	-1.222	-1.278	-2.308
	(1.469)	(1.476)	(1.414)
Policy 1 × Urban	-1.325	-0.507	-1.491
	(0.688)†	(0.981)	(0.788)†
Policy 1 × Han	0.822	0.917	1.251
	(1.034)	(1.046)	(0.974)
Policy 1 × Urban × Han		-0.880	
		(0.708)	
Policy 2	-1.890	-1.895	-3.521
	(1.325)	(1.351)	(1.376)*
Policy 2 × Urban	-1.129	-0.849	-0.475
	(0.384)**	(0.553)	(0.461)
Policy 2 × Han	0.112	0.146	0.869
	(0.642)	(0.703)	(0.694)
Policy 2 × Urban × Han		-0.293	
		(0.516)	
Policy 3	-2.385	-2.350	-3.170
	(1.212)*	(1.214)†	(1.283)*
Policy 3 × Urban	-0.180	-0.119	0.049
	(0.160)	(0.189)	(0.177)
Policy 3 × Han	-0.132	-0.133	0.062
	(0.193)	(0.195)	(0.211)
Policy 3 × Urban × Han		-0.056	
		(0.100)	
Urban	1.397	1.432	1.098
	(0.724)†	(0.725)*	(0.868)
Han (women)	0.699	0.664	-1.059
	(1.022)	(1.027)	(0.969)
Han (women's spouses)			0.448
			(0.559)
Famine	-1.470	-1.509	-3.620
	(1.678)	(1.681)	(1.683)*
Schooling of Women			
Primary School	-0.252	-0.253	-0.265
	(0.044)***	(0.044)***	(0.050)***
Middle School	-0.485	-0.484	-0.499
	(0.041)***	(0.041)***	(0.047)***
High School	-0.711	-0.709	-0.669
	(0.044)***	(0.044)***	(0.052)***
College or Above	-0.818	-0.816	-0.713
	(0.046)***	(0.046)***	(0.056)***

Schooling of Women's Spouses			
Primary School			-0.013
			(0.060)
Middle School			-0.016
			(0.056)
High School			-0.118
			(0.058)*
College or Above			-0.181
			(0.061)**
Province Dummies	Yes	Yes	Yes
For Women			
Cohort Linear Trend	Yes	Yes	Yes
Five-year Cohort Dummies	Yes	Yes	Yes
Age Dummies	Yes	Yes	Yes
Five-year Cohort Dummies × Urban	Yes	Yes	Yes
Five-year Cohort Dummies × Han	Yes	Yes	Yes
Five-year Cohort Dummies × Province	Yes	Yes	Yes
For Women's Spouses			
Cohort Linear Trend	No	No	Yes
Five-year Cohort Dummies	No	No	Yes
Age Dummies	No	No	Yes
Five-year Cohort Dummies × Urban	No	No	Yes
Five-year Cohort Dummies × Han	No	No	Yes
Five-year Cohort Dummies × Province	No	No	Yes
P Value for Significance of Policy Effects	0.0025	0.0036	0.0386
R-squared	0.5388	0.5392	0.5684
N	7105	7105	5922

Note: Standard errors, in parentheses, are clustered at the primary sampling unit/5-year birth cohort level. † $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. The base group for 5-year cohort dummies consists of the cohorts older than 1941. Cohort 1986 and younger cohorts belong to the same cohort group.

Table 4 Policy effects for three periods, by residence (urban/rural) and ethnicity (Han/non-Han)

	Policy 1	Policy 2	Policy 3
Panel 1 Derived from Column (1) of Table 3			
Urban Han	-0.049	-0.083*	-0.077*
Rural Han	-0.011	-0.051	-0.072*
Urban Non-Han	-0.073	-0.086*	-0.073*
Rural Non-Han	-0.035	-0.054	-0.068*
Panel 2 Derived from Column (2) of Table 3			
Urban Han	-0.050	-0.083*	-0.076*
Rural Han	-0.010	-0.050	-0.071*
Urban Non-Han	-0.051	-0.078*	-0.071*
Rural Non-Han	-0.037	-0.054	-0.067†
Panel 3 Derived from Column (3) of Table 3			
Urban Han	-0.073†	-0.089*	-0.087*
Rural Han	-0.030	-0.076*	-0.089*
Urban Non-Han	-0.109*	-0.114**	-0.089*
Rural Non-Han	-0.066	-0.101*	-0.091*

Note: † $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table 5 Policy effects derived from incomplete measures, endogenous measures, and measures lacking heterogeneity

	Policy 1	Policy 2	Policy 3
Panel 1: Derived from Baseline Regression			
Urban Han	-0.049	-0.083*	-0.077*
Rural Han	-0.011	-0.051	-0.072*
Urban non-Han	-0.073	-0.086*	-0.073*
Rural non-Han	-0.035	-0.054	-0.068*
Panel 2: Missing Period 1 Policy			
	Policy 1	Policy 2	Policy 3
Urban Han	-	-0.047***	-0.044***
Rural Han	-	-0.028**	-0.045***
Urban non-Han	-	-0.044*	-0.039**
Rural non-Han	-	-0.025	-0.039**
Panel 3: Missing Periods 1 and 2 Policies			
	Policy 1	Policy 2	Policy 3
Urban Han	-	-	-0.006
Rural Han	-	-	-0.012†
Urban non-Han	-	-	-0.002
Rural non-Han	-	-	-0.007
Panel 4: Eldest Child Born in a Policy Period			
	Policy 1	Policy 2	Policy 3
Urban Han	0.064***	0.043***	0.029***
Rural Han	0.048***	0.034***	0.027***
Urban non-Han	0.060***	0.042***	0.028***
Rural non-Han	0.044***	0.033***	0.026***
Panel 5: Ever Exposed to a Policy			
	Policy 1	Policy 2	Policy 3
Urban Han	0.048	-0.002	-0.038
Rural Han	0.026	0.000	-0.037
Urban non-Han	-0.056	-0.012	0.054**
Rural non-Han	-0.077*	-0.010	0.056***
Panel 6: Policy Measures are Proportional to the Duration of Exposure			
	Policy 1	Policy 2	Policy 3
Urban Han	-0.012	-0.134*	-0.094†
Rural Han	0.036	-0.059	-0.087†
Urban non-Han	-0.138	-0.207**	-0.092†
Rural non-Han	-0.090	-0.133†	-0.085

Note: † $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

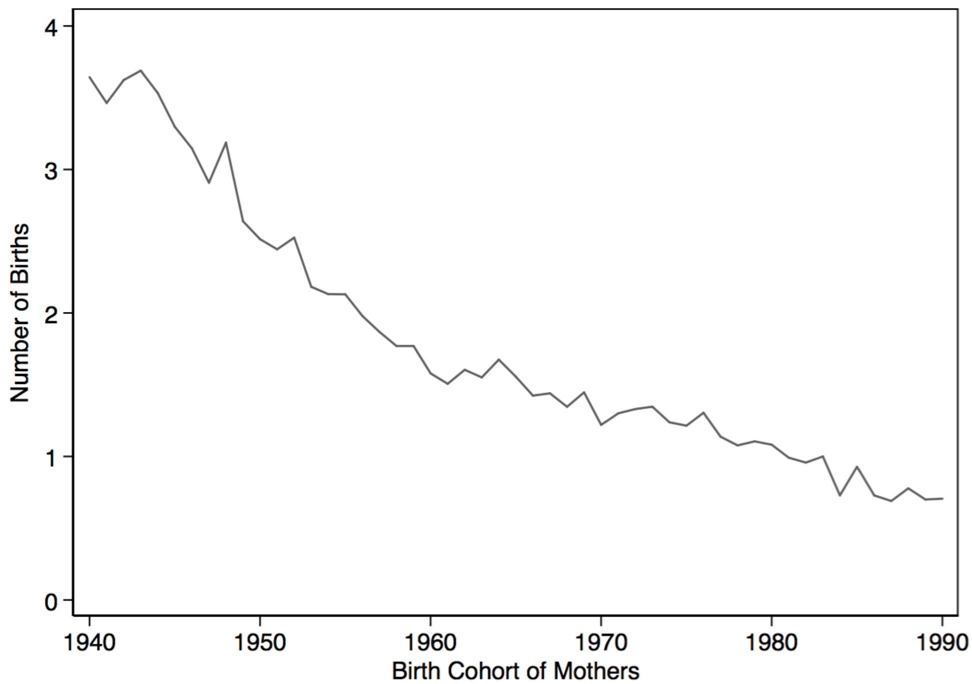

Fig. 1 Number of births by year of mother's birth

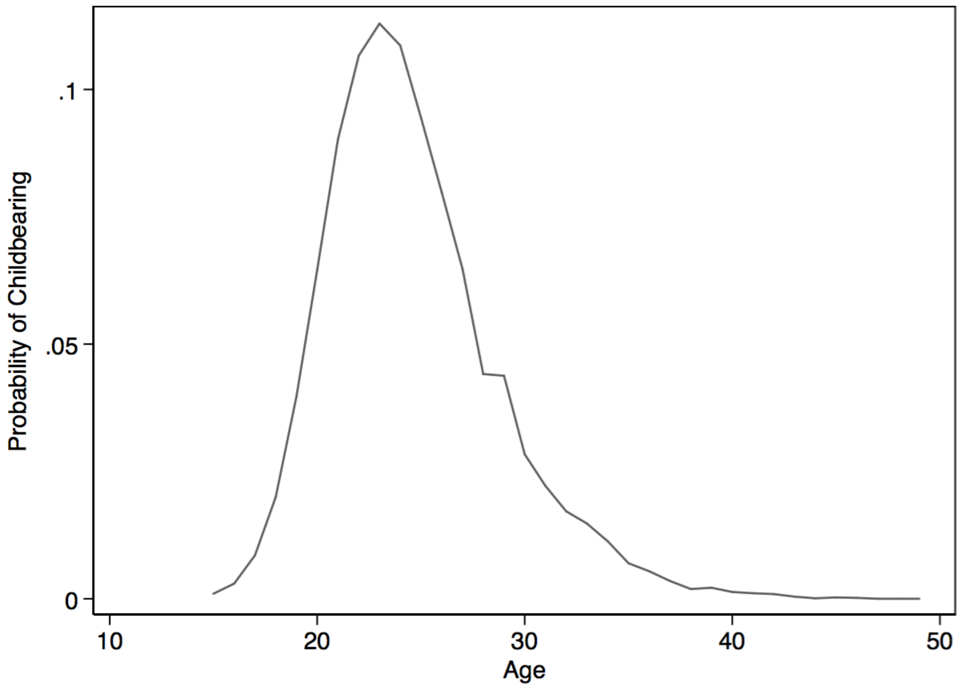

Fig. 2 Probability of childbearing by age

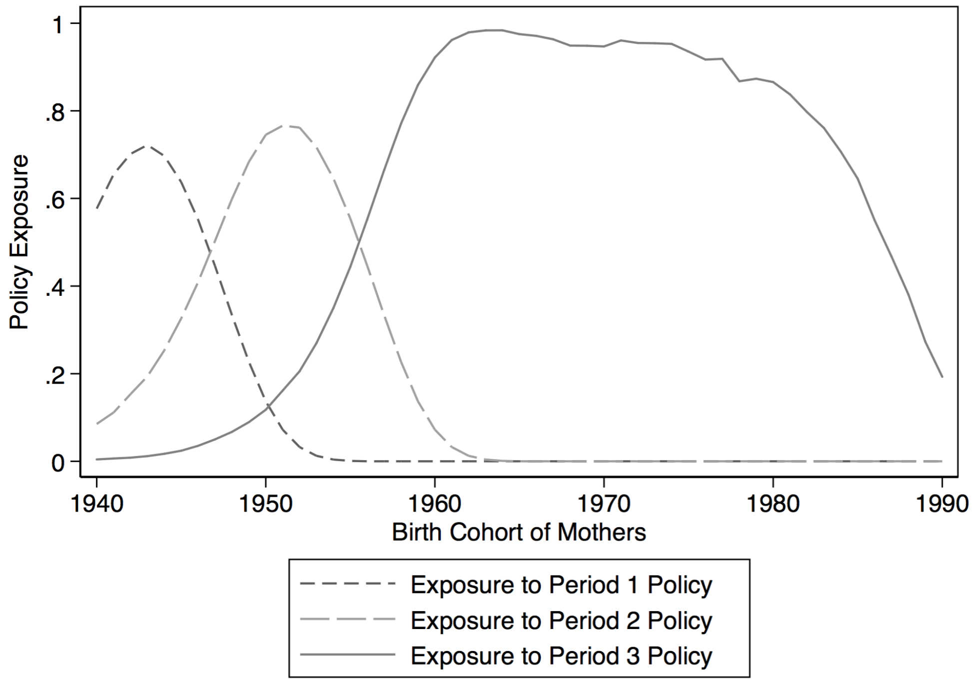

Fig. 3 Measures of exposure to three policies by cohort

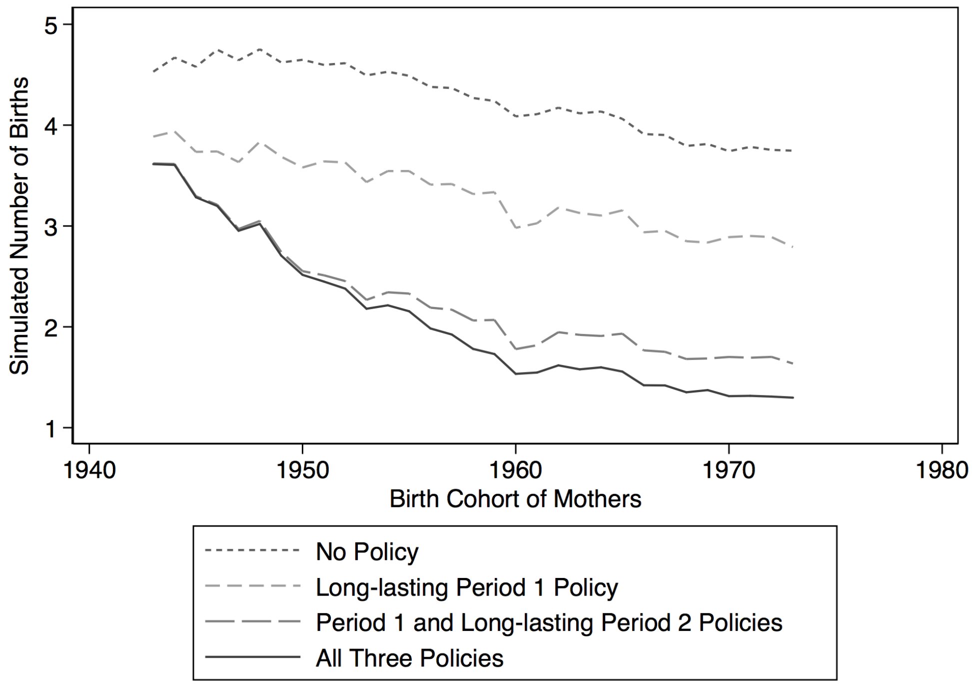

Fig. 4 Simulated number of births in counterfactual policy scenarios