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Is China's Low Fertility Rate Caused by the Population Control Policy?

by

Liu Qiang
Nanjing Agricultural University

Fernando Rios-Avila
Levy Economics Institute of Bard College

and

Han Jiqin
Nanjing Agricultural University

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Levy Economics Institute
P.O. Box 5000
Annandale-on-Hudson, NY 12504-5000
http://www.levyinstitute.org

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ABSTRACT

Whether China's low fertility rate is the consequence of the country's strict population control policy is a puzzling question. This paper attempts to disentangle the Chinese population control policy's impacts on the fertility rate from socioeconomic factors using the synthetic control method proposed by Abadie and Gardeazabal (2003). The results indicate that the population control policy significantly decreased China's birth rate after the "Later, Longer, and Fewer" policy came into force, but had little effect on the birth rate in the long run. We estimate that between 164.2 million and 268.3 million prevented births from 1971 to 2016 can be attributed to the Chinese population control policy. In addition, we implement a placebo study to check the validity of the method and confirm the robustness of the paper's conclusions.

KEYWORDS: Birth Rate; China; Population Control Policy; Synthetic Control Method; Placebo Study

JEL CLASSIFICATIONS: C21; J13; Q56

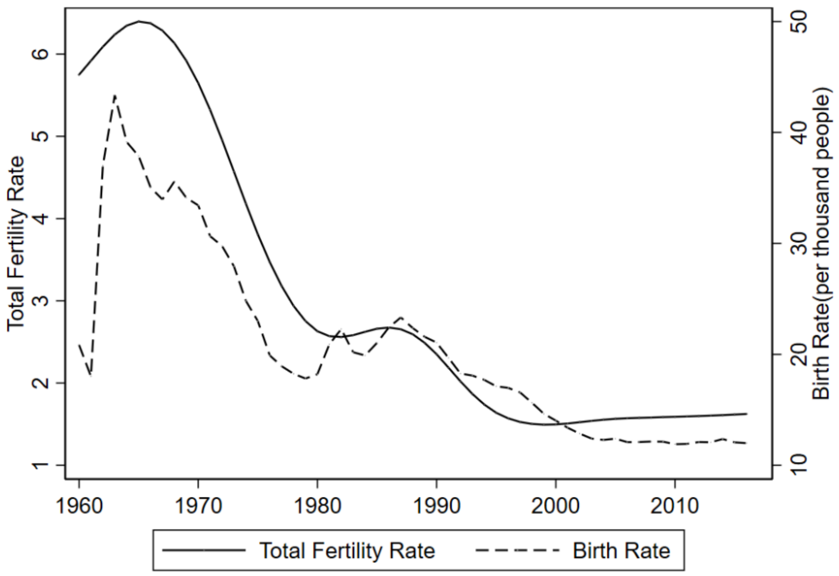
1. INTRODUCTION

Low fertility rates that fall below replacement level have become a public concern for many countries across the world (Morgan 2003). China no exception. From 1994 on, the birth rate fell below the levels seen during the Great Famine period (World Bank 2016), with the number of births hitting the fewest since 1960 in 2018. The number of Chinese newborn babies was only 15.23 million in 2018 (National Bureau of Statistics of China 2018), a 16.71 percent decrease from 17.58 million in 2017, despite the implementation of the universal two child per couple policy in 2016.

China's total fertility rate started to slump shortly after the "Later, Longer and Fewer" (henceforth LLF) campaign was launched in the early 1970s. It quickly dropped from 5.648 children per woman in 1970 to 2.753 in 1979 (World Bank 2016), a 51.25 percent decrease within a decade. This trend continued after the central government coupled the fertility rate to the promotion of local officials in the late 1980s[1] (Huang, Lei, and Sun 2015; Zhang 2017). Since 1995, the total fertility rate remained stable, in the range of 1.5 to 1.6, until now (World Bank 2016). The crude birth rate per thousand people exhibits a similar trend, as figure 1 shows.

[1] The national leaders adopted a management-objective "responsibility system" to evaluate whether the subnational leaders met the goal of controlling the birth rate at a given level (Huang, Lei, and Sun 2015). Those who failed were less likely to be promoted in the future.

Figure 1. China's Total Fertility Rate and Birth Rate, 1960–2016



Note: Data comes from the World Bank (2016). The total fertility rate measures the average number of children per woman. The crude birth rate indicates the number of live births occurring during the year per 1,000 people.

Although decreasing fertility is a common phenomenon in every successfully developing country, China is a special case due to the implementation of a massive and stringent population control policy that's already lasted for decades. Currently, there is debate from both policymakers and scholars on whether this policy should be canceled permanently. For this reason, it is of great importance to evaluate the effect the population control policy has had on China's birth rate.

Estimation of the population control policy's causal effect may be far from straightforward. Although it's quite plausible to believe that such a strict policy imposed a huge and negative impact on China's birth rate, experience from other countries that did not launch family planning programs has shown that economic development also plays an important role in reducing fertility rates through several channels (Whyte, Feng, and Cai 2015; Zhang 2017). First, economic development decreases the infant mortality rate when enhanced medical technology is available and thus lowers the likelihood of risk-averse parents having additional babies (Boldrin and Jones 2002). Second, economic development increases people's education level, which prolongs the periods spent in school and shortens females' fixed time window for reproducing (Bbaale and Mpuga 2011). Third, economic development also improves parents' labor force participation rate, increasing the economic opportunity cost of rearing an additional child (Bhat 2002; Lalive and Zweimüller 2009; Schultz 1973).

As mentioned above, the fundamental challenge in estimating the effect of China's population control policy is decomposing the decline in the fertility rate into two different parts: one caused by the strict population control policy, and the other caused by the changes in socioeconomic factors. Using the synthetic control method (henceforth SCM) proposed by Abadie and Gardeazabal (2003), it is possible to distinguish the effect of the population control policy on the year-over-year fertility rate using aggregate data. This methodology helps to identify the effect of the population control policy by constructing a weighted combination of other countries/regions to use as control units. This construction can be used to estimate what would have happened to China in the absence of the policy intervention, but assuming China still followed the same socioeconomic path. This method can account for the effects of confounders (such as economic growth or improvements in educational attainment) changing over time by synthesizing a "twin" treatment group, which is constructed using observed characteristics at the country level before the intervention took place.

To the best of our knowledge, the existing literature has paid limited attention to analyzing the long-term effect the policy interventions had on China's fertility rates. Zhang (2017) selected Thailand, Mexico, South Korea, and India as the base group of countries and compared their total fertility rate with rural and urban China, concluding that even without the one child policy, China's fertility rate would have declined substantially after 1978. But Zhang only compared the overall downward trend in fertility of these countries/regions and did not estimate the effects imposed by the policy.

Whyte, Feng, and Cai (2015) revisit misconceptions regarding China's birth control programs, including the claim that those programs prevented 400 million extra births from 1970 to 1998. They argue that this estimate overstates the true impact of China's birth control program because it is based on an oversimplified counterfactual, it ignores the role of previous birth control programs that reduced the fertility rate before the implementation of the one child policy, and disregards the rapid economic development China went through since the 1970s, which also contributed to the decline in fertility rates in the country. The paper provides estimations of the impact of the one child policy comparing China's crude birth rate trends to that of 16 countries[2] with similar levels of birth rates in the 1970s, providing a more conservative estimation of the impact of the birth control policy. Nevertheless, this paper does not take the heterogeneity of economic development across different counties into account, and simply compares the average birth rates of the 16 selected countries with China. Our paper fills the gap by evaluating the year-by-year effects of the population control policy using the preintervention economic development variables controlled with SCM.

Our findings suggest that China's population control policy had a significant short-term effect on its birth rate, with a decrease of 6.5 births per thousand from 1971–79 on average, but has had little effect in the long run. By 2016, the estimated effect on birth rate was 0.446 births per thousand and not statistically significant. Furthermore, we estimate the number of prevented births that can be attributed to the Chinese population control policy is between 164.2 million to 268.3 million from 1971 to 2016. This is a considerably lower estimate than the usual 400 million prevented births, and is consistent with Whyte, Feng, and Cai (2015) discussion. We implement a placebo study to check the validity and robustness of the results that support our main conclusions.

Our results are consistent with the conjecture that the population control policy cannot fully explain the decrease in the birth rate in China (Y. Cai 2010; Feng, Cai, and Gu 2012; Whyte, Feng, and Cai 2015; Zhang 2017). As supporting evidence, we calculate China's counterfactual birth rate year by year since 1971 in the absence of the coercive population control policy using the SCM and find this effect is very weak after the late 1980s.

[2] They are Albania, Brazil, Colombia, Costa Rica, Jamaica, North Korea, South Korea, Lebanon, Malaysia, Panama, Paraguay, South Africa, Thailand, Turkmenistan, Uzbekistan, and Venezuela.

The remainder of the paper is arranged as follows. In section 2, we introduce background information on the Chinese population control policy and its potential influences. In section 3, we describe the data used in this paper. In section 4, we present the econometric methods that are applied in this paper, namely the SCM and the placebo study. In section 5, we present the main empirical results. The last section presents the concluding remarks and related discussions.

2. CHINA'S POPULATION CONTROL POLICY AND ITS INFLUENCES

2.1 The Evolution of China's Population Control Policy

2.1.1 Later, Longer, and Fewer Policy (1971–78)

Due to the Great Famine between 1959 and 1961, as well as the Chinese people's low material standard of living, in 1971, top leaders began to focus on population control policies, starting with a loud and widespread propaganda slogan: "One isn't too few, two are just fine, and three are too many." Afterward, several provinces[3] set up the Birth Planning Leadership Group, a branch of the Revolutionary Committee (Babiarz et al. 2018). In 1973, China presented its first nationwide population control policy named *Wan Xi Shao,* or "Later, Longer, and Fewer" (LLF).[4] It was during this period of time when China's fertility rate dropped sharply.

This achievement rely on a combination of persuasion, voluntary compliance, but also required strict enforcement by the government (Whyte, Feng, and Cai 2015). Policy enforcers were sent to villages to keep a record of pregnancy information in a bid to prevent out-of-quota births. Couples who had already had two children were required to use contraceptive methods (intrauterine devices, for example) or get sterilized. Over-quota babies would be

[3] Gansu, Jilin, Guangxi, and Sichuan were among the first provinces that launched this campaign.

[4] This policy literally encourages couples to give birth to babies at later ages ("later"), with longer spaces between births ("longer"), and fewer lifetime births ("fewer"). However, the persuasive campaign has clear guidelines. It required new couples to get married at ages older than 23 for the female and 25 for the male. The first and second births should be spaced at around four years, and a couple could have no more than two children.

denied household registration (or *hukou*) and thus would lose their rightful access to education, food coupons, etc. In the urban areas, female workers in factories were pressured to get abortions if they became unexpectedly pregnant or else they could face severe punishment, including losing their jobs (Whyte, Feng, and Cai 2015).

2.1.2 The One Child Policy (1979–83)

Although China's total fertility rate dropped sharply to a comparatively low level of 2.753 children per woman after the implementation of the LLF policy, it did not stop the One Child Policy (henceforth OCP) from being launched. Taking the population control policy as a method to stimulate economic growth, the successor of the late Chairman Mao, Deng Xiaoping, supported the OCP (Whyte, Feng, and Cai 2015; Zhang 2017). [5]

The OCP stipulated that each couple, in both rural and urban areas, was only allowed to give birth to one child except under extenuating circumstances, but with differential treatment across different regions and ethnic groups. Compared with the ethnic minorities, the Chinese Han faced much stricter restrictions. Han couples[6] were generally allowed to have only one child whereas minorities exempt from the OCP could have two or more children (Park and Han 1990; Qian 1997). As part of the enforcement mechanisms, financial sanctions were introduced during this period to help enforce the policy and suppress fertility rates. In addition, reports on the number of forced abortions and female sterilizations more than doubled from 1978 to 1979 (Banister 1987; Whyte, Feng, and Cai 2015).

2.1.3 The One-and-a-half Child Policy (1984–2012)

The OCP's implementation has been difficult in practice. The government's power to impose the OCP in rural areas was weak, in particular for couples with only one daughter. Furthermore, the phenomenon of neglect and infanticide among female offspring started to

[5] According to the suggestions offered by the group of scientists headed by Song Jian at that time, the optimal population for China in 2080 should be 700 million or fewer based on a scientific projection that takes China's limited natural resources into account. To achieve this goal, a two-children-per-couple policy is not enough and the number of children should be reduced to one (Whyte, Feng, and Cai 2015)

[6] In couples where both of the parties are Chinese Han.

appear after the OCP came into effect (Banister 1987). Taking these situations into account, on April 13, 1984, the central government issued Central Document No.7, allowing for greater flexibility on the regulations imposed by the OCP and adjustment based on local economic conditions (Qian 2017). The most significant amendment was that couples in rural areas with only one daughter were permitted to have a second child,[7] the so-called "one-and-a-half-child policy." Couples in urban areas, however, were not affected by this amendment to the OCP. In the late 1980s, the central government coupled the fertility rate to the promotion of local officials, making the population control target evaluative (Suárez-Serrato, Wang, and Zhang 2019). This caused a significant increase in fine rates[8] to households that did not comply with the policy. The strengthened implementation of the one-and-a-half-child policy dramatically decreased the fertility rate beginning the early 1990s, as figure 1 shows.

2.1.4 Two Child Policy (2013 afterwards)

With the total fertility rate below the replacement level[9] for more than two decades, the Chinese government gradually started to lift the ban on permitted births in regions with imminent labor supply shortages and diminishing demographic dividends (F. Cai 2010; Feng 2011). By 2007, almost all regions in China allowed couples to have two children if both parents came from a single-child household. On December 28, 2013, the third plenary session of 18th Communist Party of China (CPC) Central Committee expanded the conditional two child policy, allowing for couples to have two children as long as one parent was a single child. Two years later, this conditional two child policy was amended to a universal version that permits all the couples to have a second child. The two child policy, especially the universal version, created a boom of second babies. As the statistics show, the number of second babies born in 2016 and 2017 were 7.21 million and 8.83 million, respectively, accounting for 40.36 percent and 51.24 percent of the new births each year (National Bureau of Statistics of China 2017, 2018). However, the two child policy didn't increase China's

[7] As an exception, people from rural areas in Beijing, Tianjin, Shanghai, Jiangsu, Chongqing, and Sichuan, were not allowed to have a second child, no matter the gender of the first child.
[8] The fine rate is defined as the total fine amount divided by one year's worth of household income. Provinces or cities including Beijing, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Hubei, Guangdong, Yunnan, Ningxia, and Xinjiang dramatically increased this rate at the end of the 1980s.
[9] Generally, this number is 2.1 children per woman (Wilson 2004).

overall fertility rate because the number of couples that decided not to have children increased sharply at the same time, partly due to the increasing cost of living, which decreased people's willingness to become parents.

2.2 Influences of China's Population Control Policy on the Fertility Rate

Opinions about the influences of the Chinese population control policy on the fertility rate are mixed. Many believe China's OCP has significantly curbed the fertility rate in the country (Huang 2017; De Silva and Tenreyro 2017; Mauldin 1982; Wang and Zhang 2018), while others hold the view that the OCP may have only had a limited short-term effect on fertility around 1979, but little or no additional effect in the long run (Y. Cai 2010; Alkema et al. 2011; Zhang 2017). Other factors may also reshape people's reproductive behavior, such as socioeconomic factors (Alfano 2017; Anukriti 2018; Schultz 1973) and women's empowerment (Duflo 2012; Upadhyay et al. 2014).

One myth in line with the population control policy's impact on the birth rate is how many prevented births can be attributed to the population control policy worldwide. The most often-cited number, yet broadly criticized, is 400 million prevented births from the early 1970s to the late 1990s (Y. Cai 2010; Feng, Cai, and Gu 2012; Whyte, Feng, and Cai 2015). This claim originated from the Chinese government, which states that the population control policy not only fueled China's dramatic economic boom but also made great contributions to global well-being. It is also suggested that the efforts imposed by the Chinese population control policy helped address the negative consequences of global climate change, but many scholars are skeptical about this. The original estimate of prevented births came from a project sponsored by the Chinese government in the late 1990s (Yang, Shengli, and Jinsheng 2000). Feng, Cai, and Gu (2012) and Whyte, Feng, and Cai (2015) point out that the estimate of 400 million prevented births was calculated using a simplistic extrapolation method, projecting what the birth rate would have been by the end of the 1990s had China's birth rate followed the trajectory of decline between 1950 and 1970. This was an overgenerous evaluation that did not take China's rapid economic growth into account.

3. DATA

The data we use comes from the World Bank (2016). The World Bank dataset collects rich information about country-level economic and development indicators, including birthrate, infant mortality rate, percentage of women in the total population, the percentage of total population (by gender) who are 20–24 and 25–29 years of age, GDP per capita (constant 2010 US dollars), and GDP growth rate. The dataset covers the years from 1960 to 2016 so that we can build our panel data with 213 countries over 57 years.

Because the SCM needs strongly balanced panel data, we restrict the World Bank (2016) sample to countries with no missing observations across all variables included in our research with two exceptions. In the raw dataset collected from World Bank indicators, Hong Kong's infant mortality rate is missing while China's infant mortality rate is missing from 1960 to 1968. We retain Hong Kong in the donor pool for the fact that it's one of the geographically closest regions that share socioeconomic characteristics with China. Hence, we fill the missing observations by using supplementary data from the Hong Kong Monthly Digest of Statistics (Census and Statistics Department 2017) and also replace China's missing data from 1960 to 1968 with data gathered from Knoema (2019).

We exclude the observations from South Korea since this country also carried out a population control policy in the early 1970s. This reduces our sample to 17 Asian countries and 51 developing countries. Because China experienced the Great Famine from 1959–61, which caused abnormally low birth rates in these years, we exclude the observations for those years in the sample. Our final sample contains 935 country-year observations for 17 Asian countries and 2,805 country-year observations for 51 developing countries. The sample's summary statistics can be seen in table 1 and the birth rate trend for China and the selected Asian donor-pool countries can be seen in figure 2.

Table 1: Pre-policy Characteristics of China and Donor Pools

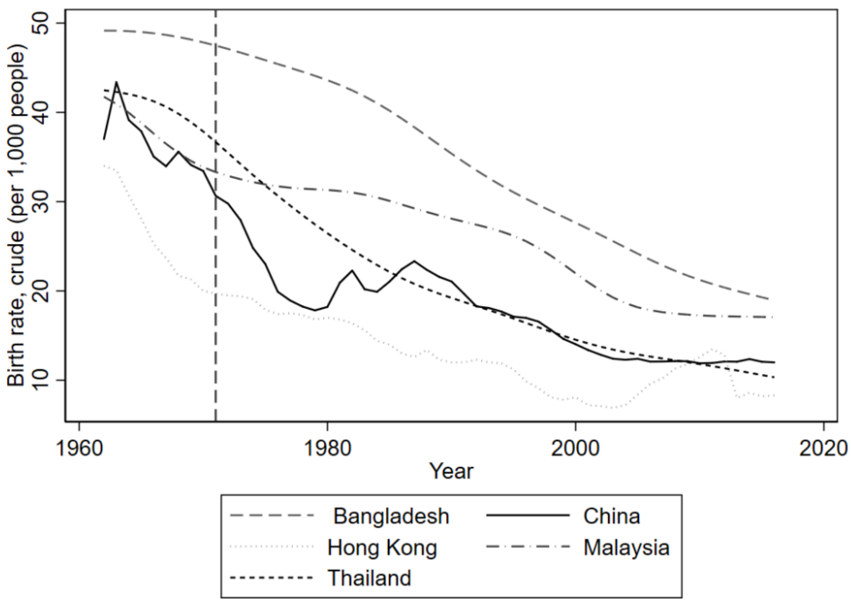
	China			Donor pool	
	Real	Synthetic A	Synthetic D	Asian	Developing
Crude birthrate (per 1,000 people), 1963	43.37	40.27	42.07	38.99	44.25
Crude birthrate (per 1,000 people), 1971	30.65	31.92	32.59	34.97	41.58
Females as a percentage of the total population	48.60	48.82	49.00	49.25	49.92
Infant mortality rate (per 1,000)	107.46	79.27	63.75	93.23	112.94
Men:*					
Percentage aged 20–24	7.65	7.40	7.63	8.10	8.22
Percentage aged 25–29	7.02	6.93	6.60	7.14	6.99
Women:*					
Percentage aged 20–24	7.31	7.06	8.08	8.01	8.17
Percentage aged 25–29	6.52	6.47	6.95	7.02	7.00
GDP per capita (2010 US$)	178.87	2,645.55	2,857.29	3,094.67	1,672.42
GDP Growth Rate (percent)	7.75	6.73	7.58	6.12	4.89

Note: Percentage aged 20–24 and 25–29 is the total number of men (women) in that age group divided by the total number of men (women) in the population. GDP per capita is measured in constant 2010 US dollars. Synthetic A represents the estimated results of the SCM using Asian countries/regions as the donor pool while the Synthetic D stands for the developing-country donor pool. See section 4.1 for details.

Source: Data comes from World Bank (2016). *

Figure 2 demonstrates that all the selected countries in Asia are experiencing a decreasing fertility rate trend in the absence of a strict population control policy. Thailand is quite notable, as its fertility converged with China beginning in the mid-1980s. Thailand also conducted a series of national family planning programs, like the distribution of nonmedical contraceptives, training midwives to prescribe the birth control pill as an effort to broaden its availability, etc. Unlike the Chinese compulsory population control policy, Thailand's family planning program was to a greater degree voluntary and persuasive, which also improved the economic well-being of both the women and their family members (Kalwij 2016).

Figure 2. Birth Rate of China and Selected Donor-Pool Countries/Regions (1962–2016)



Source: World Bank (2016)

Hong Kong is now a special administrative region in southern China. It became a colony of the British Empire after the First Opium War in 1842. In 1950, British Hong Kong established the Family Planning Association, which provided health services related to family planning advice, sex education, and birth control. It also launched the "Two Is Enough" campaign through persuasive education in the 1970s. But most demographers believe the birth rate decline is the result of economic development that fostered the growth of new individualistic aspirations and personal independence, consequently causing changes in marital structure (Yip and Lee 2002). Hong Kong is special in our study, as it is now part of China's territories and shares many similar characteristics in reproductive behavior with other Chinese regions.

In Malaysia, family planning programs were incorporated as part of the national development plans until the late 1960s. The programs were mainly aimed at promoting the use of health facilities, expanding the population's access to information on reproductive health and use of contraceptive methods (Lee, Ong, and Smith 1973), rather than directly setting birth limits.

Singapore experienced a similar situation with its family planning program. It was first started by a group of volunteers and later became the Family Planning Association of Singapore, offering health services like contraception and marital counseling. The Dominican Republic also offered these services, with voluntary surgical contraception available (Santiso-Galvez, Ward, and Bertrand 2015).

Overall, compared with other Asian and developing countries/regions, China is special in its compulsory limits for each couple and coercion in the imposition of the population control policy, whereas the family planning programs in other countries only offer voluntary health services to lower the birth rate. Ross and Stover (2001) offers supporting evidence to this conclusion, as China is the only country with a family planning program effort index score[10] higher than 80. Therefore, China provides an excellent opportunity for studying the population control policy on its birth rate (Chen and Fang 2018) since this policy is recognized as the most stringent in the world (Cleland et al. 2006).

4. EMPIRICAL STRATEGY

The aim of this paper is to decompose the birth rate decrease into the effects imposed by China's population control policy and those caused by economic development. We use other Asian and developing counties/regions as the donor pool and synthesize a counterfactual China before the population control policy's intervention and then compare the birth rates between the real and synthetic China to evaluate the impact caused by the population control policy. After that, we conduct a placebo study to check the validity of the method and confirm the robustness of our conclusions.

[10] The family planning index was developed to measure the level of effort that goes into family planning programs and to track how this changes over time. It collects information regarding policies, services, evaluation, and access, and was originally proposed by Lapham and Mauldin (1972).

4.1 Synthetic Control Method (SCM)

The core idea behind SCM is to synthesize a "twin" China using other countries and regions that share similar cultureal and socioeconomic characteristics before the imposition of the population control policy. The synthetic China is constructed by combining the information of the donor countries using a set of estimated weights, based on how similar those countries were to China during the preintervention period. The synthetic China then can be regarded as the counterfactual (synthetic control unit) to real China (treated unit). Then the effect of the population control policy on the birth rate can be compared by looking at the difference between the "real" and "synthetic" China after the policy intervention. To obtain the weight for each of the countries and regions in the donor pool, we follow the methodology proposed by Abadie, Diamond, and Hainmueller (2010).

Let F_{it}^{N} be the birth rate that would be observed for country/region i at time t in the absence of the population control policy, for units i=1,2,3…J+1, and time periods t=1, 2,3…T. Let T_0 denote the number of preintervention periods and $1 \leq T_0 < T$. Let F_{it}^{I} be the birth rate that would be observed for unit i at time t if unit i is exposed to the intervention in periods $T_0 + 1$ to T. A key hypothesis is that this policy cannot be expected before its implementation, which is valid in our research, as China's important policies are usually kept confidential before their official announcement. Since during the preintervention period all the units have not been affected by the policy yet, we have:

$$F_{it}^{I} = F_{it}^{N}, \mathrm{i} = 1,2,3 \dots \dots \mathrm{J} + 1, \mathrm{t} = 1,2,3 \dots \dots T_0 \qquad (1)$$

Let $\alpha_{it} = F_{it}^{I} - F_{it}^{N}$ be the effect for unit i at time t, and D_{it} be an indicator that takes a value of one if unit i is exposed to the policy at time t, and zero otherwise. Then the relationship between F_{it}^{I} and F_{it}^{N} can be expressed as:

$$F_{it}^{I} = F_{it}^{N} + \alpha_{it} D_{it} \qquad (2)$$

Without loss of generality, if we assume $i = 1$ for China, and that the policy has been in place for any period $t > T_0$, then the treatment D_{it} becomes:

$$D_{it} = \begin{cases} 1 & if\ i = 1\ and\ t > T_0, \\ 0 & otherwise. \end{cases} \tag{3}$$

In this framework, α_{it} represents the impact of the policy intervention, at any point $t > T_o$, which is defined as:

$$\alpha_{1t} = F_{1t}^{I} - F_{1t}^{N}, \mathrm{t} > T_0 \tag{4}$$

Since China is under the policy intervention from period $T_0 + 1$ to t, the observed birth rate is F_{1t}^{I}. We then need to estimate F_{1t}^{N} before we get α_{1t} for $\mathrm{t} > T_0$. Suppose F_{1t}^{N} can be estimated by the following model:

$$F_{1t}^{N} = \delta_t + \theta_t Z_i + \lambda_t \mu_i + \varepsilon_{it} \tag{5}$$

where δ_t is an unknown common factor with constant factor loadings across units; Z_i is a combination of covariates that aim to control for pretreatment characteristics; Z_i is composed of the percentage of women, the infant mortality rate, the percentage of men between ages 20–24 and 25–29, the percentage of women between ages 20–24 and 25–29, GDP per capita, and the GDP growth rate; θ_t is a vector of unknown parameters; λ_t is a vector of unobserved common factors; μ_i is a vector of unknown factor loadings; and ε_{it} is the error term.

To synthesize a "twin" China, we first generate a weight vector $\mathrm{W} = (w_2, \dots \dots w_{J+1})'$ such that $w_i \geq 0$ for $i = 2 \dots \dots J + 1$ and $\sum_{i=2}^{J+1} w_i = 1$. W represents a weighted average of control countries and regions. The value of W is calculated based on the following equations:

$$\sum_{j=2}^{J+1} w_j F_{jt} = \delta_t + \theta_t \sum_{j=2}^{J+1} w_j Z_j + \lambda_t \sum_{j=2}^{J+1} w_j \mu_j + \sum_{j=2}^{J+1} w_j \varepsilon_{it} \quad (6)$$

Suppose there exists $\left(w_2^* \ldots \ldots w_{J+1}^*\right)$ such that:

$$\begin{cases} \sum_{j=2}^{J+1} w_j^* F_{j1} = F_{11} \\ \sum_{j=2}^{J+1} w_j^* F_{j2} = F_{12} \\ \ldots \ldots \\ \sum_{j=2}^{J+1} w_j^* F_{jT_0} = F_{1T_0} \\ \sum_{j=2}^{J+1} w_j^* Z_j = Z_1 \end{cases} \quad (7)$$

If $\sum_{t=1}^{T_0} \lambda_t{}' \lambda_t$ is nonsingular then,

$$F_{1t}^N - \sum_{j=2}^{J+1} w_j^* F_{jt} = \sum_{j=2}^{J+1} w_j^* \sum_{s=1}^{T_0} \lambda_t \left(\sum_{t=1}^{T_0} \lambda_t{}' \lambda_t \right)^{-1} \lambda_s' (\varepsilon_{js} - \varepsilon_{1s}) - \sum_{j=2}^{J+1} w_j^* \left(\varepsilon_{jt} - \varepsilon_{1t}\right) \quad (8)$$

Thus, we can get the estimator as follows:[11]

$$\widehat{\alpha_{1t}} = F_{1t}^I - \sum_{j=2}^{J+1} w_j^* F_{jt}, t = T_0 + 1 \ldots \ldots \mathrm{T} \quad (9)$$

[11] For more details, please refer to Abadie, Diamond, and Hainmueller (2010, 2015).

4.2 Robustness

As China is an East Asian country that may share similar cultural and economic development patterns with other nearby countries/regions,[12] we use the SCM results of the Asian donor pool as the basis of our analysis.[13] To check the validity of the results, we use two different groups of countries/regions as the donor pool. The first is the developing countries/regions while the second is a combination of the Asian and developing countries/regions.

Furthermore, we conduct an in-space placebo test as described in Abadie, Diamond, and Hainmueller (2015). For this procedure, we estimate the treatment effects using countries from the list of control countries, but excluding China from the analysis. In principle, if the estimated treatment effects are larger for the control units compared to the effect estimated for China, then we would conclude that the population policy treatment is not related to the observed changes in the fertility rate. To evaluate this effect, we use root mean squared prediction error (henceforth RMSPE), as suggested by Abadie, Diamond, and Hainmueller (2015):

$$\text{RMSPE} = \left(\frac{1}{T_0}\sum_{t=1}^{T_0}\left(F_{1t} - \sum_{j=2}^{J+1} w_j^* F_{jt}\right)^2\right)^{1/2} \tag{11}$$

The ratio of the pre- and postintervention RMSPE can then be used to evaluate the placebo test by comparing the relative size of the predicted outcomes before and after the hypothetical treatment effects.

Finally, to check whether the results are dominated by one of the weight-assigned countries/regions, a leave-one-out sensitivity test is conducted. We remove one of the selected countries/regions from the donor pool and reestimate the model to construct the "synthetic China."

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[12] A preference for sons, for example, does or did exist in East Asian countries, including China, India, and South Korea. Japan is a country that's also experiencing a very low fertility rate.

[13] A robustness check using the real data from China would confirm the correctness of categorizing them in this way.

5. MAIN RESULTS

5.1 Empirical Results for Synthetic China

Table 2, panel A displays the weights of each country/region in the synthetic control estimation for China using Asian countries as its donor pool. The SCM algorithm uses data from Bangladesh, Hong Kong, Malaysia, and Thailand with corresponding weights of 0.341, 0.492, 0.026, and 0.141 as the synthetic control. The lion's share is distributed to Hong Kong, which makes sense in that Hong Kong was a part of China before it became a colony of Britain and may share more similar characteristics in reproductive behavior.

Table 2. Synthetic Control Weights for China Using Asian Countries and Regions as the Donor Pool

Country/Region Name	Synthetic Control Weight
Panel A: Asian Countries	
Bangladesh	0.341
Hong Kong SAR, China	0.492
Malaysia	0.026
Thailand	0.141
RMSPE	1.810
Panel B: Developing Countries	
Dominican Republic	0.557
Singapore	0.443
RMSPE	2.510
Panel C: Asian and Developing Countries	
Dominican Republic	0.575
Hong Kong SAR, China	0.425
RMSPE	2.460

Note: The synthetic control weight is the country weight assigned by the data-driven SCM (Abadie, Diamond, and Hainmueller 2010). Only countries with a positive estimated weight are shown. See appendix 1 for the full list of potential donor countries.

If we change the donor pool to developing countries/regions, the synthetic China then becomes a combination of the Dominican Republic and Singapore, with the weights of 0.557 and 0.443, respectively (table 2, panel B). If all the Asian and developing countries are assigned to the donor pool, the synthetic China would be constructed by Hong Kong and the Dominican Republic, with the corresponding weights of 0.425 and 0.575 (table 2, panel C).

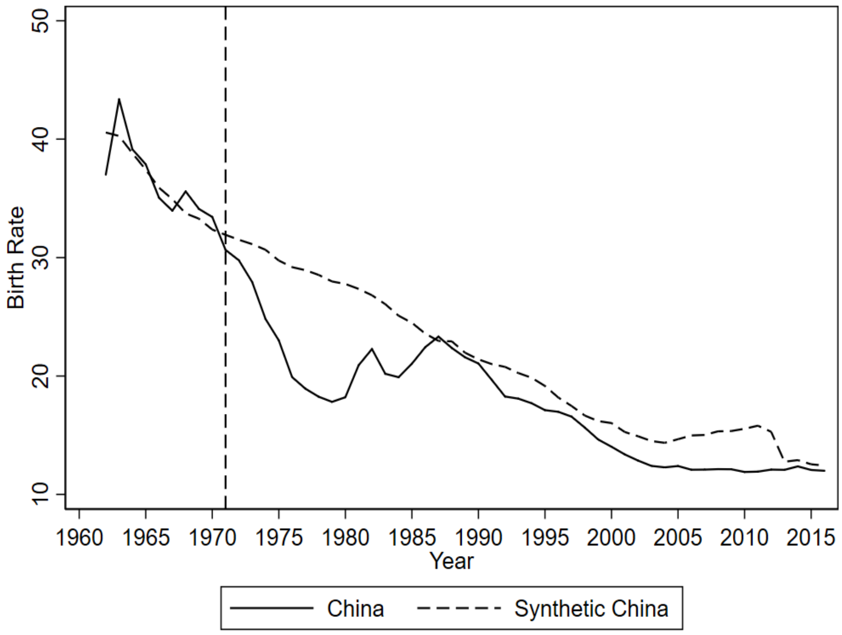
For the three different donor pools, the calculated preintervention RMSPEs (the average of the squared discrepancies between the real and synthetic China's birth rate during 1963–71) are 1.81, 2.51, and 2.46, respectively. This indicates that the Asian donor pool synthesizes better than the rest. In 2017, the first year after the universal two child policy came into effect, there were all together 1.62 million second babies, a number that fits better with the estimated prevented births if we use the Asian countries as the donor pool.[14] Nevertheless, we still report the results based on the donor pool of developing countries/regions as a robustness check. After all, both of the RMSPEs are quite small, which means that the SCM is able to offer a good fit for China's birth rate prior to the implementation of the LLF policy using the donor-pool countries and regions. Therefore, our synthetic China is to a large degree reliable, so we can use the estimated weights to form a counterfactual China after the population control policy is enacted.

Figures 3–5 show China's real birth rate trajectory and that of counterfactual China using the Asian countries/regions, developing countries/regions, and a combination of them as the donor pool. The yearly difference and ratio between real and counterfactual birth rates for the first two donor pools are also reported in table 3. No matter the donor pool we choose, the synthetic China almost reproduces the real birth rate in the preintervention period and there's a significantly widened gap between them after the policy intervention, as can be observed from figures 3–6.[15] However, this influence weakened after the late 1980s as the gap between synthetic and real China gradually narrowed. For the years after 2013 (when the conditional two child policy was enacted), the effect is very small, ranging from 0.0446 percent to 0.0684 percent, equivalent to 0.62 million to 0.94 million prevented births for the corresponding years (figure 3 and table 3).

[14] A total of 2.97 million births were prevented from 2013 to 2016 with the Asian donor pool whereas this number would be 20.18 million with the developing-country donor pool.

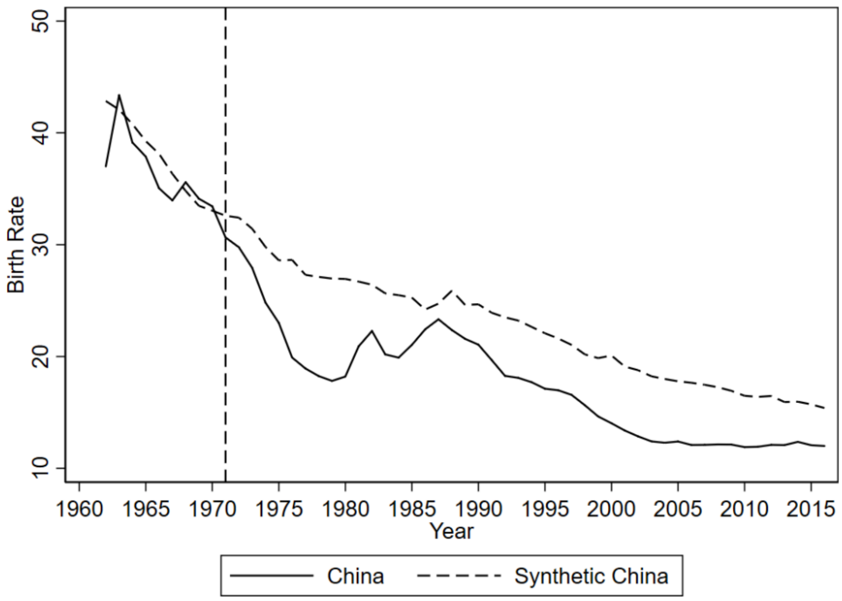
[15] We only report the gaps between the real and synthetic China for the Asian and developing countries/regions donor pool in figure 6 because the results of a combination of the two donor pools is a scenario that falls between them. Thereafter, we mainly focus on the results using Asian and developing countries/regions as the donor pool in the analysis.

Figure 3. Birth Rate for Real and Synthetic China Using Asian Countries/Regions as the Donor Pool



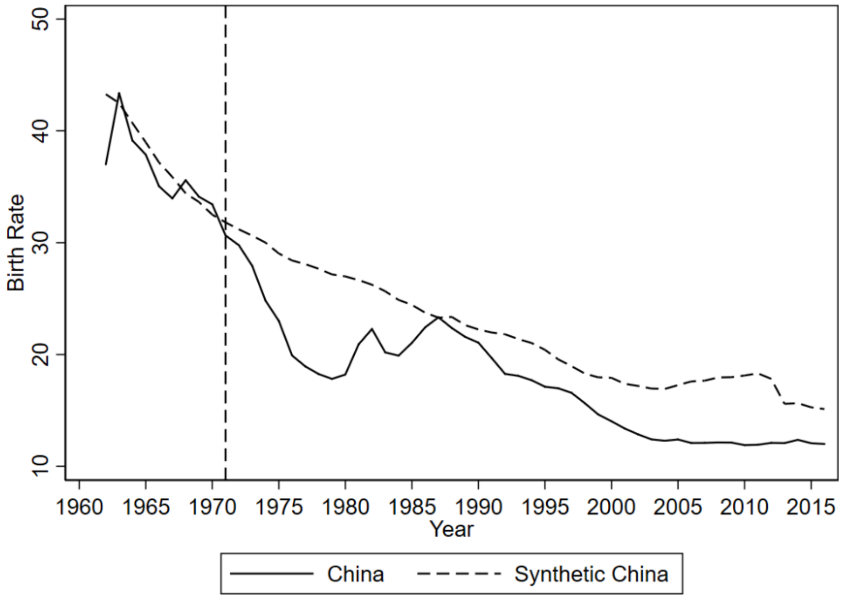
Note: The infant mortality rate for Hong Kong comes from the Census and Statistics Department (2017), using an OLS regression to impute missing values. China's infant mortality rates for 1962–68 are from Knoema (2019). The RMSPE is 1.81 for this figure.

Figure 4. Birth Rate for Real and Synthetic China Using Developing Countries/Regions as the Donor Pool



Note: The RMSPE is 2.51 for this figure.

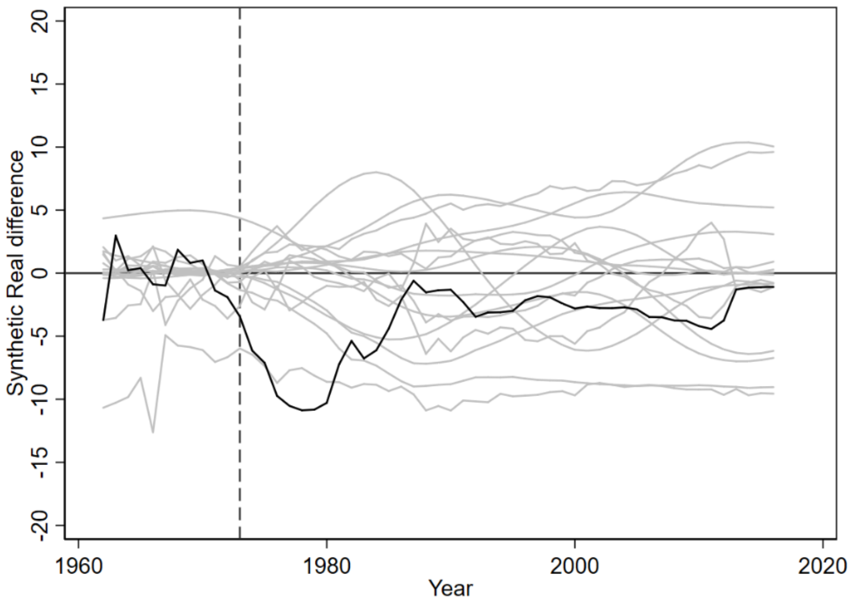
Figure 5. Birth Rate for Real and Synthetic China Using Asian and Developing Countries/Regions as the Donor Pool



Note: The RMSPE is 2.46 for this figure.

Figure 6. Yearly Birth Rate Difference between Real and Synthetic China (Synthetic-Real) Using Asian (panel a) and Developing Countries (panel b) as Donor Pools

a) Donor Pool: Asian countries



b) Donor Pool: Developing countries

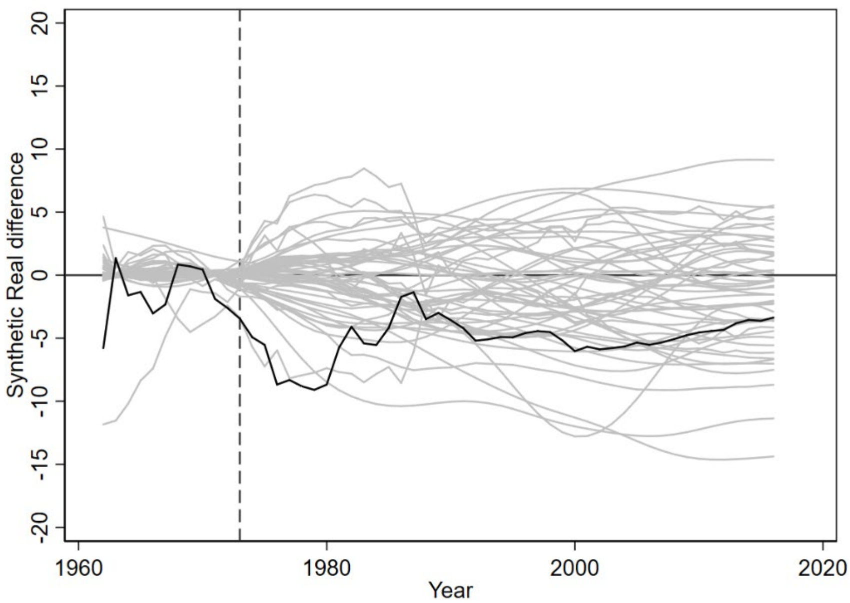


Table 3. SCM Estimators Using Asian and Developing Countries/Regions as the Donor Pool

Year	Population	SCM Estimates									
		Asian Countries/Regions					Developing Countries/Regions				
		Real Birth Rate (‰)	Counterfactual Birth Rate (‰)	Birth Rate Difference (%)	Ratio (%)	Prevented Births	Real Birth Rate (‰)	Counterfactual Birth Rate (‰)	Birth Rate Difference (%)	Ratio (%)	Prevented Births
		(1)	(2)	(2)-(1)	(1)/(2)		(3)	(4)	(4)-(3)	(3)/(4)	
1971	852.29	30.65	31.92	0.1270	96.02	1.1180	30.65	32.59	0.1940	94.05	1.7092
1972	871.77	29.77	31.51	0.1737	94.49	1.5636	29.77	32.42	0.2650	91.83	2.3873
1973	892.11	27.93	31.14	0.3205	89.71	2.9514	27.93	31.43	0.3498	88.87	3.2222
1974	908.59	24.82	30.66	0.5843	80.94	5.4770	24.82	29.80	0.4978	83.30	4.6614
1975	924.2	23.01	29.75	0.6742	77.34	6.4224	23.01	28.60	0.5589	80.46	5.3173
1976	937.17	19.91	29.19	0.9284	68.20	8.9621	19.91	28.64	0.8728	69.52	8.4208
1977	949.74	18.93	28.94	1.0007	65.42	9.7869	18.93	27.30	0.8374	69.33	8.1765
1978	962.59	18.25	28.53	1.0285	63.96	10.1908	18.25	27.12	0.8868	67.30	8.7746
1979	975.42	17.82	27.99	1.0166	63.67	10.2015	17.82	26.97	0.9150	66.07	9.1725
1980	987.05	18.21	27.78	0.9566	65.56	9.7121	18.21	26.94	0.8728	67.60	8.8536
1981	1000.72	20.91	27.36	0.6447	76.43	6.6331	20.91	26.70	0.5790	78.32	5.9528
1982	1016.54	22.28	26.82	0.4541	83.07	4.7435	22.28	26.42	0.4141	84.33	4.3242
1983	1030.08	20.19	26.07	0.5877	77.45	6.2158	20.19	25.65	0.5459	78.72	5.7715
1984	1043.57	19.90	25.09	0.5195	79.30	5.5607	19.90	25.49	0.5586	78.08	5.9819
1985	1058.51	21.04	24.50	0.3456	85.89	3.7501	21.04	25.27	0.4228	83.27	4.5914
1986	1075.07	22.43	23.59	0.1156	95.10	1.2733	22.43	24.20	0.1771	92.68	1.9512
1987	1093.00	23.33	22.96	-0.0366	101.59	-0.4096	23.33	24.73	0.1401	94.34	1.5696
1988	1110.26	22.37	22.93	0.0561	97.56	0.6370	22.37	25.89	0.3516	86.42	4.0078
1989	1127.04	21.58	21.97	0.0387	98.24	0.4459	21.58	24.61	0.3032	87.68	3.5032
1990	1143.33	21.06	21.41	0.0347	98.38	0.4057	21.06	24.67	0.3606	85.38	4.2274
1991	1158.23	19.68	21.01	0.1329	93.67	1.5726	19.68	23.91	0.4235	82.29	5.0252
1992	1171.71	18.27	20.77	0.2502	87.95	2.9943	18.27	23.50	0.5234	77.73	6.2804
1993	1185.17	18.09	20.25	0.2164	89.31	2.6183	18.09	23.21	0.5123	77.93	6.2156
1994	1198.50	17.70	19.85	0.2149	89.17	2.6279	17.70	22.65	0.4945	78.16	6.0640
1995	1211.21	17.12	19.16	0.2042	89.35	2.5212	17.12	22.08	0.4957	77.55	6.1399

1996	1223.89	16.98	18.19	0.1210	93.35	1.5083	16.98	21.61	0.4633	78.56	5.7952
1997	1236.26	16.57	17.47	0.0902	94.84	1.1344	16.57	21.04	0.4470	78.76	5.6445
1998	1247.61	15.64	16.66	0.1019	93.88	1.2934	15.64	20.19	0.4548	77.47	5.7915
1999	1257.86	14.64	16.20	0.1556	90.39	1.9889	14.64	19.86	0.5218	73.72	6.6962
2000	1267.43	14.03	16.03	0.1999	87.53	2.5747	14.03	20.09	0.6057	69.85	7.8343
2001	1276.27	13.38	15.27	0.1893	87.60	2.4537	13.38	19.10	0.5717	70.06	7.4381
2002	1284.53	12.86	14.91	0.2054	86.23	2.6782	12.86	18.78	0.5918	68.48	7.7474
2003	1292.27	12.41	14.51	0.2101	85.52	2.7549	12.41	18.23	0.5825	68.06	7.6666
2004	1299.88	12.29	14.36	0.2071	85.58	2.7314	12.29	17.99	0.5702	68.31	7.5479
2005	1307.56	12.40	14.67	0.2265	84.55	3.0057	12.40	17.78	0.5384	69.73	7.1675
2006	1314.48	12.09	14.98	0.2894	80.69	3.8617	12.09	17.65	0.5564	68.48	7.4453
2007	1321.29	12.10	15.02	0.2924	80.54	3.9227	12.10	17.47	0.5375	69.24	7.2279
2008	1328.02	12.14	15.33	0.3189	79.20	4.3012	12.14	17.25	0.5110	70.38	6.9052
2009	1334.74	12.13	15.36	0.3227	78.99	4.3746	12.13	16.94	0.4806	71.62	6.5253
2010	1341.00	11.90	15.55	0.3650	76.53	4.9721	11.90	16.49	0.4588	72.17	6.2558
2011	1347.35	11.93	15.81	0.3878	75.47	5.3087	11.93	16.39	0.4463	72.78	6.1133
2012	1354.04	12.10	15.29	0.3191	79.13	4.3872	12.10	16.47	0.4372	73.46	6.0183
2013	1360.72	12.08	12.76	0.0684	94.64	0.9432	12.08	15.93	0.3848	75.84	5.3212
2014	1367.82	12.37	12.90	0.0530	95.89	0.7350	12.37	15.96	0.3589	77.51	4.9884
2015	1374.62	12.07	12.55	0.0479	96.19	0.6664	12.07	15.72	0.3653	76.77	5.1015
2016	1382.71	12.00	12.45	0.0446	96.42	0.6243	12.00	15.40	0.3399	77.93	4.7732
Total Prevented Births						164.196					268.306

Note: Birth rate difference refers to the difference between the birth rate of synthetic and real China. Prevented births = $\frac{Population \times BR\ Difference}{(1 - Counterfactual\ Birth\ Rate)}$ measures the total number of people who were not born due to the population control policy (in millions).

Source: The population data are from the National Bureau of Statistics of China (in millions).

Notably, in 1987, the birth rate difference between real and synthetic China is somewhat negative, indicating to some degree that the population control policy increased the birth rate. This can be partly explained by the anxiety caused by public policy uncertainty, which may prompt couples to have children earlier than expected (Feng, Cai, and Gu 2012).

Specifically, the difference in birth rates between synthetic and real China started to increase after 1971 and peaked in 1978 at 1.03 percent, indicating that the OCP may have had a short-term effect on fertility before 1979, but little or no additional long-run effects (Zhang 2017). In other words, the majority of the prevented births were attributed to the LLF policy rather than the OCP, which in the long run had little effect on China's birth rates.

With the SCM, we can obtain China's counterfactual birth rate in the absence of the population control policy year by year. Using this indicator, we can subsequently estimate the prevented births for year i as this equation holds:

$$CBR_i = \frac{PB_i + NB_i}{PB_i + TP_i}, i = 1971,\ 1972 \ldots \ldots 2016 \quad (12)$$

where CBR_i is the counterfactual birth rate for year i obtained from the SCM; PB_i is the prevented births for year i; NB_i refers to the newborn babies for year i; and TP_i is China's total population for year i. We relate NB_i and TP_i using RBR_i:

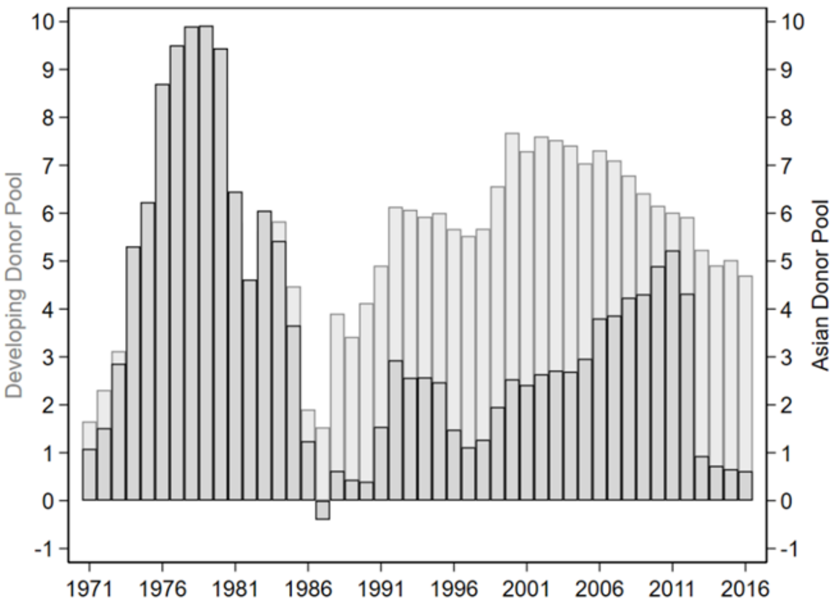
$$RBR_i = \frac{NB_i}{TP_i}, i = 1971,\ 1972 \ldots \ldots 2016 \quad (13)$$

where RBR_i is the real birth rate for year i. Then it's easy to get:

$$PB_i = \frac{TP_i \times (CBR_i - RBR_i)}{1 - CBR_i}, i = 1971,\ 1972 \ldots \ldots 2016 \quad (14)$$

Overall, the total prevented births due to the implementation of the population control policy from 1971 to 2016 range from 164.2 million to 268.3 million (table 5) based on the SCM with Asian and developing countries/regions as the donor pool, which is far fewer than the assumed 400 million.[16] The corresponding annual numbers are displayed in figure 7 and table 5.

Figure 7. Prevented Births after the Implementation of the LLF Policy



Note: The light gray bars represent the estimators using the developing countries/regions as the donor pool while the dark gray represents the Asian countries/regions. Both the units are in millions of people.

5.2 Placebo Study

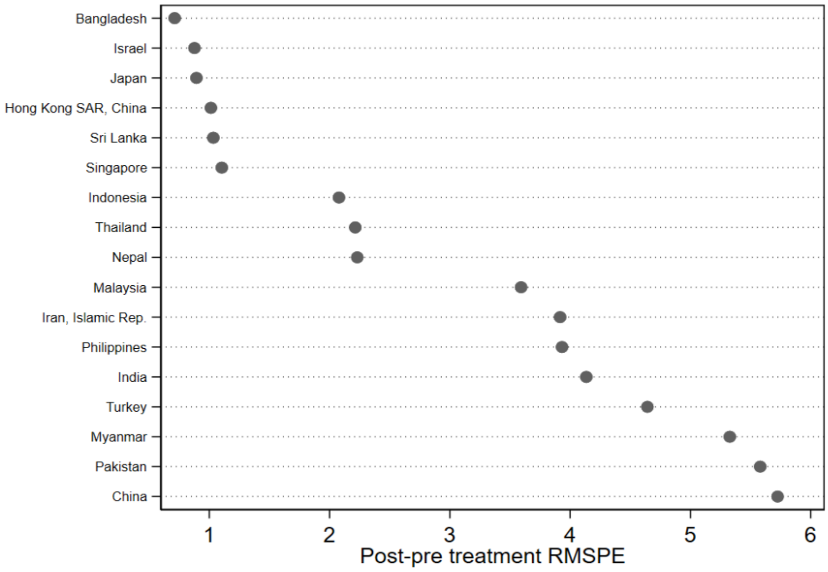
Figure 8 plots the post- and preintervention RMSPE ratios for China and all other control units in our sample. If we choose the time window from 1963 to 1980, China stands out with the largest post-/pretreatment RMSPE ratio, whereas it only ranks at 11 if we change the time window to 1963–2016. For China, the postintervention gap is about 5.72 times larger than the preintervention gap. Based on the shorter time window, if we were to pick a country/region at

[16] The original calculation of the number of prevented births came from an internal study sponsored by China's National Population and Birth Planning Commission in the late 1990s (see Whyte, Feng, and Cai [2015] for discussion). In our results, if we limit the time range from 1971 to 2000, the total number of prevented births are 116.5 million (Asian countries donor pool) and 164.1 million (developing-country donor pool), around 30 percent to 40 percent of the assumed 400 million births.

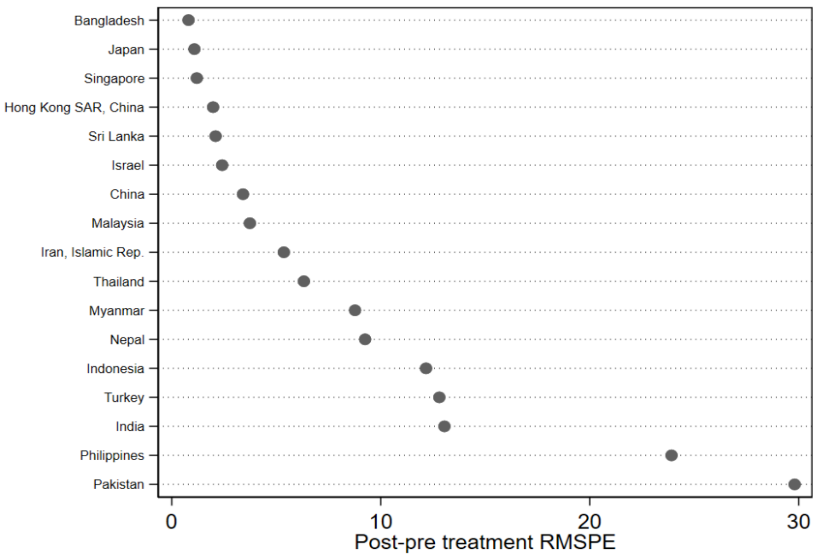
random from the sample, the possibility of obtaining a ratio as high as China's would be $1/17 \cong 0.059$, suggesting a marginally significant impact imposed by the population control policy in the short term. However, this possibility would be $10/17 \approx 0.582$ if we change the time window to a longer period, providing evidence that the population control policy had little or no additional effect on China's birth rate in the long run.

Figure 8. In-space Placebo Distributions Under the Intervention of Population Control Policies with Different Time Windows

(a) 1963–80



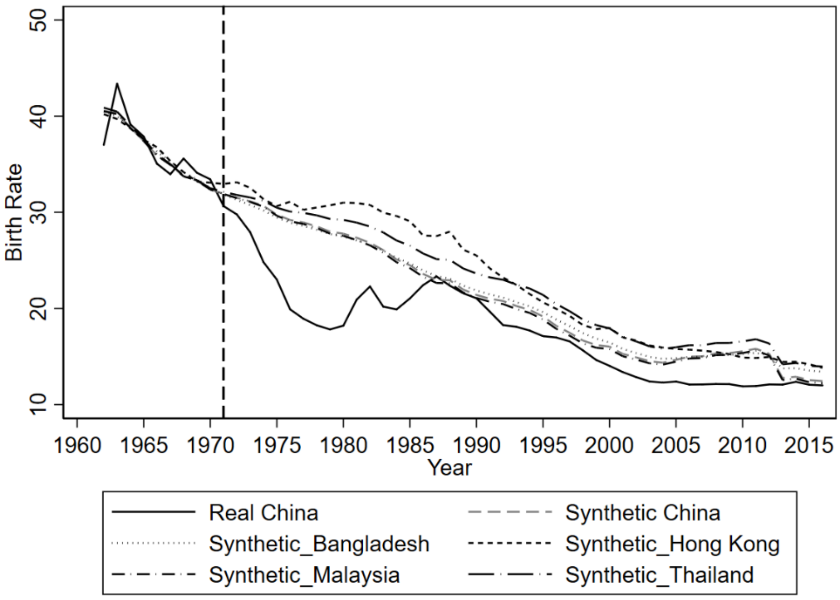
(b) 1963–2016



According to the Asian donor pool, synthetic China can be constructed by the weighted average of four countries/regions, namely Bangladesh, Hong Kong, Malaysia, and Thailand. To verify whether the results are manipulated by a particular country/region, we conduct the leave-one-out test. This procedure needs four iterations for each donor pool. The results are displayed in figure 9 and the corresponding weights in different conditions are presented in table 4. The black solid line refers to the actual value of China's birth rate, whereas the gray dashed line refers to the original synthetic China constructed by all control units in the Asian donor pool. The dashed line in black stands for the leave-one-out estimate if we remove one selected country/region from the donor pool.

Generally, all the leave-one-out estimates are well fitted in the preintervention period. They are very close to our previous synthetic and real estimates before the policy intervention. But we observe a widened gap between the leave-one-out estimates and the original synthetic if Hong Kong is excluded during the postintervention period. Since Hong Kong may share more similar characteristics with Mainland China in multiple dimensions, it is not surprising to find that Hong Kong has the highest weight in the original synthetic China. Given the fact that the estimates using the Asian donor pool are the lower bound in this paper, a widened gap in the placebo study with Hong Kong excluded in figure 9 would not influence the validity of our previous results.

Figure 9. Leave-One-Out Distribution of the SCM



Notes: "Real China" refers to the actual value of China's birth rate, while "synthetic China" refers to the original synthetic control estimate. "Synthetic Bangladesh" refers to the synthetic control estimate excluding Bangladesh; other countries/regions are likewise denoted. The black solid line refers to the actual value of China's birth rate, whereas the gray dashed line refers to the original synthetic China constructed by all control units in the Asian donor pool. Other black dashed lines are the leave-one-out synthetic China.

Table 4. Synthetic Control Weight for Leave-One-Out Robustness Check Using Asian Countries/Regions as the Donor Pool

Country/Region Name	Synthetic Bangladesh	Synthetic Hong Kong	Synthetic Malaysia	Synthetic Thailand
Bangladesh	-	0	0.338	0.322
Hong Kong SAR, China	0.253	-	0.494	0.425
India	0	0	0	0
Indonesia	0.123	0	0	0
Iran, Islamic Republic	0.054	0.346	0	0
Israel	0	0	0	0
Japan	0	0	0	0
Malaysia	0.328	0	-	0.254
Myanmar	0	0.233	0	0
Nepal	0	0	0	0
Pakistan	0	0	0	0
Philippines	0	0	0	0
Singapore	0	0.421	0	0
Sri Lanka	0	0	0	0
Thailand	0.242	0	0.167	-
Turkey	0	0	0	0
RMSPE	1.84	1.88	1.80	1.83

Note: The synthetic control weight is the country weight assigned by the data-driven SCM (Abadie, Diamond, and Heinmuller 2010). "Synthetic Bangladesh" refers to the synthetic control estimate excluding Bangladesh; other countries/regions are named likewise.

6. CONCLUSION AND DISCUSSION

Although a large body of literature has paid attention to the consequences of China's population control policy (Y. Cai 2010; Chen, Li, and Meng 2013; Ebenstein 2010; Ebenstein and Leung 2010; Feng, Cai, and Gu 2012; Whyte, Feng, and Cai 2015; Zhang 2017), few studies have investigated the potential impact of the population control policy on the birth rate and disentangled its effect from socioeconomic factors. This paper fills the gap by evaluating the year-by-year effects of the population control policy with the economic development variables controlled using SCM.

We find that the population control policy had a large and negative effect on China's birth rate soon after the implementation of the LLF policy, while little effect could be observed in the long run. Based on different scenarios, the cumulative prevented extra births may fall in the range of 164.2 million to 268.31 million from 1971 to 2016. Because the effect has been fairly weak in recent years, canceling this policy may not help reverse the trend of a declining and aging Chinese population.

Our findings may have other implications. The Chinese population control policy has been blamed for its impact on the imbalanced sex ratio at birth, with declining rates against women. Most extant literature concludes that there are three main contributors to China's imbalanced sex ratio at birth: they are China's strict population control policy (Ebenstein 2010; Jayachandran 2017), the long-persistent preference for sons (Das Gupta et al. 2003; Ebenstein and Leung 2010), and the development and improvement of technology that allows the determination of a child's sex before birth (Chen, Li, and Meng 2013). The strict population control policy was once heavily criticized for the phenomenon of "missing girls" in China. However, for 2013–16, the population control policy's effect on the birth rate was fairly small, but the sex ratio at birth was still imbalanced, standing at around 1.15 male births per 1 female birth (World Bank 2016). According to the literature, the sex ratio at birth should have returned to a normal level if the policy had little effect on the birth rate. For this reason, the causal effect of the Chinese population control policy on the imbalanced sex ratio at birth needs further investigation.

The second implication is for policymakers, especially for those in countries with a large population like India. To curb the population growth rate, China made great efforts to enforce strict population policies, incurring huge social costs. But the policy may only have contributed to a small part of the birth rate decline. To facilitate population governance, like controlling the population growth rate, more could be done apart from imposing population control policies, such as improving females' access to education and increasing their labor force participation rate.

The third implication is related to retirement and China's pension systems. Currently, Chinese parents with more children can receive more financial transfers from their children and are less likely to work past retirement age (Oliveira 2016). With fewer children in the future, aged parents would have to rely more on their pension instead of intergenerational support from their children. This would cause a dilemma in which more aged people want to draw from their pension while fewer young laborers are paying into it. The Chinese government has to pay more attention to the reform of the pension system (Zhang 2017), given that the aging of China's population is inevitable in spite of the population control policy's cancellation. China may also have to postpone the usual retirement age to solve this problem.

REFERENCES

Abadie, Alberto, Alexis Diamond, and Jens Hainmueller. 2010. "Synthetic control methods for comparative case studies: Estimating the effect of California's tobacco control program." *Journal of the American Statistical Association* 105(490): 493–505.

———. 2015. "Comparative politics and the synthetic control method." *American Journal of Political Science* 59(2): 495–510.

Abadie, Alberto, and Javier Gardeazabal. 2003. "The economic costs of conflict: A case study of the Basque Country." *American Economic Review* 93(1): 113–32.

Alfano, Marco. 2017. "Daughters, dowries, deliveries: The effect of marital payments on fertility choices in India." *Journal of Development Economics* 125(March): 89–104.

Alkema, Leontine, Adrian E. Raftery, Patrick Gerland, Samuel J. Clark, François Pelletier, Thomas Buettner, and Gerhard K. Heilig. 2011. "Probabilistic projections of the total fertility rate for all countries." *Demography* 48(3): 815–39.

Anukriti, S. 2018. "Financial incentives and the fertility-sex ratio trade-off." *American Economic Journal: Applied Economics* 10(2): 27–57.

Babiarz, Kimberly Singer, Paul Ma, Grant Miller, and Shige Song. 2018. "The Limits (and Human Costs) of Population Policy: Fertility Decline and Sex Selection in China under Mao." NBER Working Paper No 25130. Cambridge, MA: National Bureau of Economic Research.

Banister, Judith. 1987. *China's Changing Population*. Stanford, CA: Stanford University Press.

Bbaale, Edward, and Paul Mpuga. 2011. "Female education, contraceptive use, and fertility: evidence from Uganda." *Consilience: The Journal of Sustainable Development* (6): 20–47.

Bhat, P. N. Mari. 2002. "Returning a favor: Reciprocity between female education and fertility in India." *World Development* 30(10): 1791–1803.

Boldrin, Michele, and Larry E. Jones. 2002. "Mortality, fertility, and saving in a Malthusian economy." *Review of Economic Dynamics* 5(4): 775–814.

Cai, Fang. 2010. "Demographic transition, demographic dividend, and Lewis turning point in China." *China Economic Journal* 3(2): 107–19.

Cai, Yong. 2010. “China’s below-replacement fertility: government policy or socioeconomic development?” *Population and Development Review* 36(3): 419–40.

Census and Statistics Department. 2017. “Hong Kong Monthly Digest of Statistics, July 2017.” Accessed on January 15, 2019. Available at: https://www.statistics.gov.hk/pub/B10100022017MM07B0100.pdf

Chen, Yi, and Hanming Fang. 2018. “The Long-Term Consequences of Having Fewer Children in Old Age: Evidence from China’s ‘Later, Longer, Fewer’ Campaign.” NBER Working Paper No. 25041. Cambridge, MA: National Bureau of Economic Research.

Chen, Yuyu, Hongbin Li, and Lingsheng Meng. 2013. “Prenatal sex selection and missing girls in China: Evidence from the diffusion of diagnostic ultrasound.” *Journal of Human Resources* 48(1): 36–70.

Cleland, John, Stan Bernstein, Alex Ezeh, Anibal Faundes, Anna Glasier, and Jolene Innis. 2006. “Family planning: the unfinished agenda.” *The Lancet* 368(9549): 1810–27.

Das Gupta, Monica, Jiang Zhenghua, Li Bohua, Xie Zhenming, Woojin Chung, and Bae Hwa-Ok. 2003. “Why is son preference so persistent in East and South Asia? A cross-country study of China, India and the Republic of Korea.” *The Journal of Development Studies* 40(2):153–87.

De Silva, Tiloka, and Silvana Tenreyro. 2017. “Population control policies and fertility convergence.” *Journal of Economic Perspectives* 31(4): 205–28.

Duflo, Esther. 2012. “Women empowerment and economic development.” *Journal of Economic Literature* 50(4):1051–79.

Ebenstein, Avraham. 2010. “The ‘missing girls’ of China and the unintended consequences of the one child policy.” *Journal of Human Resources* 45(1): 87–115.

Ebenstein, Avraham, and Steven Leung. 2010. “Son preference and access to social insurance: evidence from China’s rural pension program.” *Population Development Review* 36(1): 47–70.

Feng, Wang. 2011. “The future of a demographic overachiever: Long-term implications of the demographic transition in China.” *Population and Development Review* 37(S1): 173–90.

Feng, Wang, Yong Cai, and Baochang Gu. 2012. “Population, policy, and politics: How will history judge China’s one-child policy?” *Population and Development Review* 38: 115–29.

Huang, Wei, Xiaoyan Lei, and Ang Sun. 2015. “When Fewer Means More: Impact of One-Child Policy on Education of Girls.” IZA Discussion Paper 9301. Bonn. Germany: Institute of Labor Economics (IZA).

Huang, Wei. 2017. “How does the one child policy impact social and economic outcomes?.” IZA World of Labor: 387. Bonn. Germany: Institute of Labor Economics (IZA).

Jayachandran, Seema. 2017. “Fertility decline and missing women.” *American Economic Journal: Applied Economics* 9(1): 118–39.

Kalwij, Adriaan. 2016. “The effects of setting up a National Family Planning Program in local communities on women’s contraceptive experiences and fertility in rural Thailand.” *Asian Population Studies* 12(2): 156–76.

Knoema. 2019. “China-Infant Mortality rate.” Database. McLean, VA: Knoema Corporation. Accessed January 15, 2019. Available at: http://knoema.com/atlas/China/topics/Demographics/Mortality/Infant-mortality-rate.

Lalive, Rafael, and Josef Zweimüller. 2009. “How does parental leave affect fertility and return to work? Evidence from two natural experiments.” *The Quarterly Journal of Economics* 124(3): 1363–1402.

Lapham, Robert J., and W. Parker Mauldin. 1972. “National Family Planning Programs: Review and Evaluation.” *Studies in Family Planning* 3(3):29–52.

Lee, Eddy, Michael Ong, and Thomas Edward Smith. 1973. “Family planning in West Malaysia: the triumph of economics and health over politics.” In T. E. Smith (ed.), *The politics of family planning in the third world.* London: George Allen and Unwin.

Mauldin, W. Parker. 1982. “The determinants of fertility decline in developing countries: An overview of the available empirical evidence.” *International Family Planning Perspectives* 8(3): 116–21.

Morgan, S. Philip. 2003. “Is low fertility a twenty-first-century demographic crisis?” *Demography* 40(4): 589–603.

National Bureau of Statistics of China. 2017. “Press conference on the operation of the national economy in 2017.” Beijing: National Bureau of Statistics of China. February 28. Available at: http://www.stats.gov.cn/english/PressRelease/201702/t20170228_1467503.html

———. 2018. “Press conference on the operation of the national economy in 2018.” Beijing: National Bureau of Statistics of China. February 28. Available at: http://www.stats.gov.cn/english/PressRelease/201801/t20180118_1574943.html

Oliveira, Jaqueline. 2016. "The value of children: Inter-generational support, fertility, and human capital." *Journal of Development Economics* 120(May): 1–16.

Park, Chai Bin, and Jing-Qing Han. 1990. "A minority group and China's one-child policy: the case of the Koreans." *Studies in Family Planning* 21(3): 161–70.

Qian, Nancy. 2017. "The effect of China's one child policy on sex selection, family size, and the school enrolment of daughters." WIDER Working Paper 2017/159 Helsinki: UNU-WIDER.

Qian, Zhenchao. 1997. "Progression to second birth in China: A study of four rural counties." *Population Studies* 51(2): 221–28.

Ross, John, and John Stover. 2001. "The family planning program effort index: 1999 cycle." *International Family Planning Perspectives* 27(3): 119–29.

Santiso-Galvez, Roberto, Victoria M. Ward, and Jane T. Bertrand. 2015. *Family Planning in Dominican Republic. The Achievements of 50 Years.* Chapel Hill, NC: MEASURE Evaluation.

Suárez-Serrato, Juan Carlos, Xiao Yu Wang, and Shuang Zhang. 2019. "The Limits of Meritocracy: Screening Bureaucrats Under Imperfect Verifiability." *Journal of Development Economics* 140(September 2019): 223–41.

Schultz, T. Paul. 1973. "Explanation of birth rate changes over space and time: A study of Taiwan." *Journal of Political Economy* 81(2, Part 2): S238–74.

United Nations. 2014. *United Nations Report on Developing Nations, 2014*. New York: United Nations. Accessed January 27, 2019. Available at: http://www.un.org/en/development/desa/policy/wesp/wesp_current/2014wesp_country_classification.pdf .

Upadhyay, Ushma D., Jessica D. Gipson, Mellissa Withers, Shayna Lewis, Erica J. Ciaraldi, Ashley Fraser, Megan J. Huchko, and Ndola Prata. 2014. "Women's empowerment and fertility: a review of the literature." *Social Science & Medicine* 115: 111–20.

Wang, Xuebo, and Junsen Zhang. 2018. "Beyond the Quantity–Quality tradeoff: Population control policy and human capital investment." *Journal of Development Economics* 135(November): 222–34.

Whyte, Martin King, Wang Feng, and Yong Cai. 2015. "Challenging myths about China's one-child policy." *The China Journal* 74: 144–59.

Wilson, Chris. 2004. "Fertility below replacement level." *Science* 304(5668): 207–9.

World Bank. 2016. *World Development Indicators.* Washington, DC: The World Bank Group.

Yang, Kuifu, Chen Shengli, and Wei Jinsheng (eds). 2000. *China's Birth Planning: Benefits and Inputs* (in Chinese). Beijing: China Population Press.

Yip, Paul S. F., and Joseph Lee. 2002. "The impact of the changing marital structure on fertility of Hong Kong SAR (Special Administrative Region)." *Social Science & Medicine* 55(12): 2159–69.

Zhang, Junsen. 2017. "The evolution of China's one-child policy and its effects on family outcomes." *Journal of Economic Perspectives* 31(1): 141–60.

APPENDIX 1. List of Potential Donor Countries: Asian Countries and Developing Countries

Asian Countries

Bangladesh
Hong Kong SAR, China
India
Indonesia
Iran, Islamic Republic
Israel
Japan
Malaysia
Myanmar
Nepal
Pakistan
Philippines
Singapore
Sri Lanka
Thailand
Turkey

Developing Countries

Algeria
Bangladesh
Benin
Bolivia
Botswana
Brazil
Burkina Faso
Cameroon
Central African Republic
Chile
Colombia
Democratic Republic of the Congo
Cote d'Ivoire
Dominican Republic
Ecuador
Egypt, Arab Republic
Fiji
Ghana
Guatemala
Guyana
Honduras
India
Indonesia
Kenya
Lesotho
Liberia
Malaysia
Mauritania
Mexico
Nepal
Nicaragua
Pakistan
Panama
Papua New Guinea
Paraguay
Peru
Philippines
Rwanda
Senegal
Sierra Leone
Singapore
Sri Lanka
Sudan
Thailand
Togo
Trinidad and Tobago
Turkey
Uruguay
Zambia
Zimbabwe