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Determinants of regional fertility in China during the first years of reaching below-replacement fertility

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Abstract

China reached a stable below-replacement fertility in the middle of 1990s. The turn of this century saw the population development gap in various regions across China expanding, the total fertility rate (TFR) shrinking and remaining at a relatively lower level with the passage of time. Based on China's official statistics, the authors analyzed the characteristics of the total fertility rate at each stage of the population policy adjustment (1970s, 1982-2013, after 2013), in particular, in the regional aspect. The sub-stage of 1995-2010 – the first years of below-replacement fertility – were considered closely in sense of determinants of regional gaps in fertility. With the help of quantitative analysis, it can be proved that regional per capita GDP (wealth level) has significant links with fertility rate. The higher the per capita GDP, the lower the fertility rate. The authors concluded that the regional total fertility rates and per capita GDP were inversely related, and per capita GDP was the factor that had the greatest correlation with the regional total fertility rate. To increase the regional fertility rate, it is necessary not only to relax the family planning policy, but also to implement incentive policies related to human fertility and to strengthen social, economic, demographic, and cultural constructions.

Keywords

Determinant of fertility, total fertility rate, below-replacement fertility, per capita GDP, population policies, China.

JEL: J11, J13, R12, Y10.

Introduction

Population is one of the primary and most significant issues in society. Long-term balanced growth of population matters a lot to the development of a country and a nation, as well as to the political, economic and social stability of the country. A country with below-replacement fertility, as usual, cannot have growth of population without a high level of replacement migration. The study of factors affecting the regional fertility in such a country helps to understand the drivers of changes in fertility.

The family planning policy in China from 1971 to 1979 had the maximum effect on the decline in fertility. The total fertility rate (TFR) dropped from 5.7 to 2.6 children per woman. This was due to the fact that the family planning policy was weakened at the beginning of the demographic transition. Educated women reduced the fertility even earlier (Lavely & Freedman, 1990).

During the long-term "one family - one child" policy from 1982 to 2013, the TFR slowly decreased from 2.6 to 1.6 children per woman. The influence of this policy on fertility also takes place, but its strength corresponds to the period of completion of the demographic transition. Our research interest relates to the period when the TFR decreased to below-replacement fertility. This special period is important for understanding the factors contributing to the decline in fertility on the basis of regional data. The demographic transition is coming to an end, several types of policies have accelerated the transition. Fertility decreased below-replacement level at the beginning of 1990s. What other factors are acting at this historical moment to reduce fertility below the replacement level in the regional context? The differences in the regional fertility levels were still strong.

In the People's Republic of China (hereinafter referred to as "the PRC" or "China"), regional population growth is uneven (Krasova & Bao, 2016) and this situation has become increasingly significant in recent decades (Kalabikhina et al., 2020). The regional gap in the population development trends is related to such factors as social, economic, political, cultural and environmental. Before China implemented economic openness and reform in 1978, the Chinese government had encouraged childbirth. The country was in a period of planned economy. There were related political, social and cultural factors that encouraged childbirth. During this period, China's fertility rate was at a relatively high level. Since 1971, especially since 1982, China has been implementing a strict family planning policy. During this period, China's total fertility rate has been declining year by year and is currently at a relatively low level. Although China has been pursuing a "two-child policy" since 2013, the effect of increasing fertility is not obvious. After China's reform and opening up in 1978, the income divide between the western region, the eastern coast and middle China widened (Bazhenova, 2010). Since 1980, China's Gini coefficient has been on the rise. According to the data of the International Monetary Fund and the National Bureau of Statistics, China's Gini coefficient in 2016 was 46.5%, ranking 28th in the world, having increased by 15% during the period of 1990-2008 (Jain-Chandra et al., 2017). Hence, economic development has a close connection with population growth.

At the turn of this century, China's uneven social and economic growth (Appendix B, Figures B3, B4) increases the gap in population growth between various regions. Differences in China's population reproduction and settlement entwine national economic development and spatial distribution of wealth.

This paper analyzes the impact of demographic and economic determinants on the regional total fertility rate in China at the turn of this century. We are conducting a statistical analysis of China's total fertility rate dynamics since the inception of a strong demographic policy in the 1970s until the end of the 2010s. Then we consider the period 1995-2010 more closely. This is the period when the total fertility rate has steadily declined to below-replacement fertility. However, the regional total fertility rates were still clearly different in 1995. The regional dynamics of the total fertility rate was characterized by convergence in 1995-2010. Of interest is a set of factors that could influence the differentiation of regional fertility in this period. The paper also discusses the factors that resulted in different fertility rates in China at the turn of this century and the impact of local economic development on fertility. Then a conclusion is drawn and related suggestions (including a discussion of population policy) are put forward.

1. Literature review

One of the main issues when choosing explanatory variables for fertility in the regions of China — which has a stronger impact — is family planning policies or social and economic factors. Since 1971, a family planning policy has been carried out; then, since 1982, the country has been implementing a demographic policy "one family – one child," limiting fertility, which the PRC authorities proclaimed due to fears that the rapidly growing population would exhaust the land, water and energy resources of the country, hinder economic development and lead to poverty and underdevelopment of the PRC. The presence of a long-running anti-natalist policy expands the list of fertility factors, which, aside from a political impact, is one of the most complex processes in factor modelling. The decline in the birth rate in China is generally recognized as a result of a combination of socio-economic development and family planning policies (Winckler, 2002). The two forces interacted, most likely reinforcing one another: the level of social and economic development could be a precondition for family planning programs; fertility policies, in turn, could further strengthen existing social and family norms. Both socio-economic changes and population control policies have played a fundamental role in the decline of fertility in China, and in those places where family planning was most stringent, there have also been profound changes in the socio-economic structure (Tien, 1984).

A similar conclusion is made by Poston and Gu, who considered 28 regional entities in China using the country's 1982 census data (Poston & Gu, 1987). They believe that China's decline in fertility should not be seen solely as a result of population control policies. Skinner and co-authors, using the hierarchical regional space (HRS) spatial approach to study fertility change in China in the 1990s, highlight the following factors of regional fertility differentiation: levels of socio-economic development, implementation of family planning policies, changes in traditional family norms, and dissemination of abortion technologies selective on gender basis (Skinner et al., 2000).

Other researchers acknowledge that the declining TFR in China correlated with increasing incomes even before the one-child policy was implemented (Birdsall & Jamison, 1983). Also, researchers claim that in China, society's acceptance of the politically-sanctioned family size follows the gradient of socio-economic development: high acceptance rates are observed in most urban, industrialized regions while the lowest are observed among women living in poorer and less urbanized regions (Merli & Smith, 2002). Using data from the 2000 census, Cai (2010) compares the fertility levels at the district level of two provinces, Jiangsu and Zhejiang, which have similar levels of economic development but have different policies in the field of fertility. Cai finds that while the birth policy rules vary widely enough between these two provinces, the county-level fertility rates are still very similar. The author concludes that even if the decline in fertility was initiated by harsh government intervention, in recent years the persistently low fertility trend is mainly due to socio-economic factors rather than state intervention. In addition, many studies have shown that population policy accounted for only a small proportion of fertility variations and most of the decline in fertility was caused by an increase in the level of women's education and household income, as well as a shift in the concentration of labor from agriculture to industrial production and services (Schultz & Zeng, 1995; McElroy & Yang, 2000). On the one hand, decentralization of the demographic policy (Goodkind, 2011; Short & Zhai, 1999) suggests the impact of this factor on the regional fertility differentiation, on the other hand, the growing number of exclusions and exceptions for a number of population groups (Gu et al., 2007; Peng, 2008) allows us to focus on socio-economic factors of fertility.

Note that fertility is affected not only by demographic, but also by social policy, such as fiscal policy in the field of education and social protection (He et al., 2016), and distribution of funds for the education system (Chen & Miao, 2019).

The close relationship of urbanization with demographic changes has attracted some attention (Ge, 2015) when searching for fertility factors. It was noted that many countries have experienced demographic transition and have also achieved significant progress in urbanization (Sato & Yamamoto, 2005). Industrialization and urbanization, in turn, increase the cost of raising children and the involvement of women in the labor market, as well as promote the ideals of a small family, which ultimately affects reproductive motivation (Birdsall, 1983; Tien, 1984). It was in cities that demographic policy was more assertive. Urban centers were also centers of propaganda campaigns. In addition, health care and fertility control were more available in cities, and it was also easier to control the reproductive behavior of the population due to more compact living in urban areas compared to rural areas. All these factors together led to a more effective birth restriction in the cities of China (Bazhenova, 2010).

Even before the birth control policies began, urbanization and education were negatively correlated with fertility in marriage (Lavely & Freedman, 1990).

It is also important to note the spatial differences in the decline in infant mortality as an explanatory factor of differences in fertility: in regions where infant mortality is lower, the intervals between births are greater and the total fertility is lower (Zhang, 1990). In urban areas, infant mortality is generally lower, which, in turn, affects the decline in the desired number of children in the family. Thus, fertility reduction factors are more effective in urban areas, the level of education of a woman, her social status and activity definitely affect her reproductive behavior (Bazhenova, 2010). In general, higher incomes contribute to the reduction of infant mortality due to improved nutritional standards and contribute to the reduction of fertility by increasing the market value of women's time and, therefore, the alternative cost of childbearing. In addition, China's rapid economic growth and globalization led to the emergence of the idea of a "small family" among a significant part of the population of the PRC (Zheng et al., 2016).

Migration to cities reduces the likelihood of having children (Liang, 2018). A woman's migration status refers to whether she is a migrant or not, as well as her membership in the hukou household registration system (Guo & Gu, 2014). Thus, in 2005, non-migrant women with rural hukou (1.64 on average) had the highest TFR, and non-migrant women with urban hukou (Guo & Gu, 2014) had the lowest. In 2010, this trend continued. At the same time, in 2010, the highest coefficient for one child was observed among migrants living in the city, and for three children and above – in rural areas.

Economic factors often adversely affect the TFR. The literature indicates that, for example, there is a significant negative impact of rising real estate prices on TFR (Ge & Zhang, 2019). The high level of economic development, high level of education and autonomy for women (Wang et al., 2015) and high level of human development index (income, education and life expectancy) of the regions of China (Tao et al., 2017) negatively affected fertility in these regions.

However, an ethnographic study conducted by Zhang (Zhang, 2007) finds an inverse relationship between the TFR and the economic development level. In areas with high levels of economic development, affluent families tend to have more children because they can pay fines, while relatively poor rural families tend to have only one child due to fears of high costs.

Socio-cultural factors also matter. The link between gender equality and fertility is becoming unsustainable. The classical relationship is that the higher the level of education of women, the lower fertility rates. However, in modern Chinese society, gender equality (women's higher education and equal levels of education of spouses) can increase the likelihood of having a child (Zhao, 2019). Social interaction and the spread of cultural norms in relation to fertility are also important in addition to social and economic development (Bongaarts & Watkins, 1996). Increasingly, evidence suggests that the spread of ideas, norms and behaviors may not fully correspond to the spatial structures of socio-economic characteristics. Compared to rapid economic development and institutional change, changes in culture and norms can be slow. As a result, consideration of fertility reduction and differentiation factors includes both socio-economic and socio-cultural factors. Peng (2008), for example, draws attention to the dynamics of the implementation of local birth control policies in the context of common family norms: places with strong patrilineal norms (measured by family networks and the presence of ancestral temples – a temple or ancestral hall, also called a genealogical temple, is a Chinese temple dedicated to deified ancestors and forefathers of lineages or families in traditional Chinese religion) are particularly resistant to the anti-natalist family planning policies and show a high TFR despite such policies.

However, Hou Lee (Hou, 2018) believes that reproductive settings change depending on economic changes and/or family planning policies and play a secondary role in fertility dynamics.

The general conclusion from the above-mentioned literature is that socio-economic, socio-cultural, and demographic factors affect the regional total fertility rates during the entire period of decline in the TFR. The same story was investigated during the period of 1970th family planning or the 1982-2013 “only one child” policy. Population policies matter but the role of the previous ones may prevail. We are interested in fertility determinant in the below-replacement fertility period at the first 15 years. Assessing the impact of various factors on fertility in China in 1995-2010, we will focus on socio-economic and demographic factors, including economic development, urbanization, women’s education level, and mortality rates. This period is characterized by stable birth control policies. These were the last years of a strict demographic policy in China. The regional total fertility rates were still clearly different in 1995, and the regional dynamics of the total fertility rate was characterized by convergence in 1995-2010 within the framework of a steady below-replacement fertility after 1995.

2. Research methods and research data

2.1. Research methods

Literature analysis, which is the collection, sorting and screening of literature, was adopted to help comprehensively analyze the research topic and ensure the correctness of the literature. Thus, it is possible to identify the factors that affect the total fertility rate throughout China. This paper determines the stages of fertility changes using comparative statistical analysis comparing the changes in the Chinese regional TFRs. The basic econometric modeling method was adopted to make assumptions on the linking determinants of the regional total fertility rate (GDP per capita, urban population ratio, female education level, life expectancy at birth) at the turn of the century when population policy was stable and the TFR fell to a below-replacement level. The results were verified using regression analysis. Significant determinants linking regional fertility rates were analyzed using literature analysis, data comparison, and basic econometric modeling to draw a conclusion and identify countermeasures.

2.2. Research data

The information was compiled by data of the Population Division of the United Nations, the World Bank, the Statistical Yearbooks of the People's Republic of China: The World Bank Open Data,[1] China Statistical Yearbooks,[2] Fertility Estimates for provinces in China, 1975-2000, National Bureau of Statistics of China & East-West Center USA, 2007.[3]

3. Transformation of the regional fertility rate in China

Currently, China has an exceptionally low total fertility rate (TFR) — the national average is 1.6-1.7 (1994-2020). The TFR was very high throughout the 1960s, with a maximum of 6.385 births per woman in 1965 (Figure 1). This rate began to decline sharply in the 1970s and by the time the one-child policy was implemented, it was 2.747 births per woman (1979). The coefficient continued to decline further, in the 1990s it fell to values below the level of population reproduction, which is 2.1. Consistently, the demographic model of the PRC has transformed from high rates of birth (as well as mortality and population growth) to low.

In accordance with the regional division of the PRC, we calculated the averages of the TFR for 8 regions for the period from 1975 to 2010. In 1975, the region of East China had the lowest rate, in 2010, it was North-East China. The initial significant spread of regional indicators narrowed down over time to a range between 0.74 and 1.44 in 2010 (Figure 2).

One of the most affected regions due to population policies is the Northeast, where the TFR fell from 3-3.5 children per woman in 1975 to 0.5-0.7 in 2010 (China Statistical Yearbook, 2011). According to official statistics, already in 2005, an average of 49.5% of the population under the age of 30 were the only children in the family.

The change in the fertility rate in China can be divided into three stages in accordance with the change of population policy: the first stage, before 1978; the second stage, 1978-2012; the third stage, 2013-present.

1) The first stage, the 1970s. 1950s and 1960s were marked by economic recovery, social stability, improvement of people's living standards and medical service in China, and the population of China grew rapidly from 540 million in the early years of the founding of the Republic of China to 830 million in 1970. Until the late 1970s, China's economy followed a planned economic policy. Under the system of "low salary

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1 https://data.worldbank.org/

2 http://www.stats.gov.cn/english/Statisticaldata/AnnualData/

3 https://www.eastwestcenter.org/publications/fertility-estimates-provinces-china-1975-2000

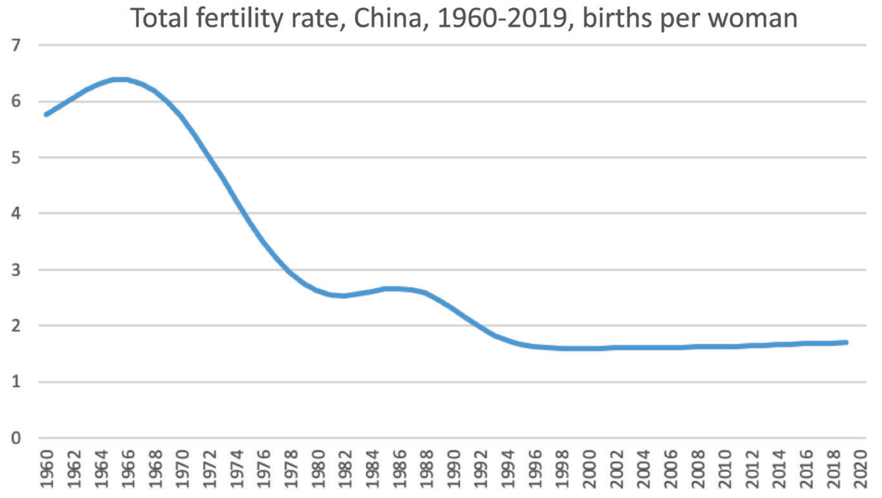

Figure 1. Fertility rate, total (births per woman) – China, 1960-2019. *Source:* Compiled by the authors based on World Bank Database.

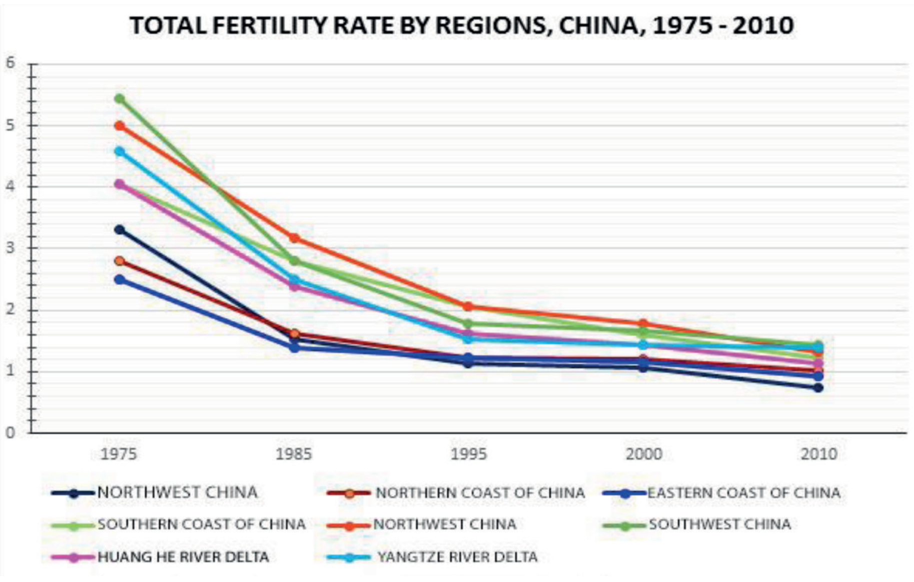

Figure 2. Dynamics of the TFR in 8 regions of China in 1975-2010. *Source:* Compiled by the authors based on Fertility Estimates for provinces in China, 1975-2000. National Bureau of Statistics of China. China Statistical Yearbook 2011.

and good welfare," the cost of raising children in China was relatively low. Fertility was encouraged by the government and illegal abortion was strictly prohibited (Peng, 1997). The Chinese Marriage Law of 1950 stipulates that the minimum age of marriage is 20 for men and 18 for women. During this period, although the total fertility rate in China declined year by year, it was at a relatively high level.

Table 1. Fertility rates in China and its regions

	1971	1975	1985	1995	2000	2010
All China	5,426	3,86	2,13	1,52	1,41	1,18
Beijing	2,991	2,04	1,17	1,06	0,97	0,71
Tianjin	3,061	2,59	1,22	1,13	1,05	0,91
Hebei	5,006	3,05	2,17	1,42	1,46	1,31
Shanxi	5,797	3,99	2,49	1,9	1,61	1,1
Inner Mongolia	5,414	4,25	2,35	1,37	1,18	1,06
Liaoning	4,036	2,96	1,22	1,16	1,09	0,73
Jilin	5,348	3,29	1,65	1,1	1,04	0,75
Heilongjiang	5,202	3,69	1,71	1,12	1,05	0,74
Shanghai	1,960	1,67	1	1,06	1,06	0,73
Jiangsu	4,054	2,84	1,57	1,23	1,12	1,04
Zhejiang	4,388	2,96	1,62	1,37	1,29	1,02
Anhui	6,168	4,07	2,52	1,62	1,4	1,49
Fujian	6,340	4,21	2,66	1,65	1,36	1,12
Jiangxi	6,359	6,13	2,9	1,71	1,61	1,29
Shandong	5,510	3,54	1,91	1,27	1,33	1,17
Henan	5,926	4,26	2,19	1,47	1,54	1,3
Hubei	5,773	3,81	2,28	1,45	1,27	1,35
Hunan	5,777	4,32	2,28	1,34	1,45	1,42
Guangdong	5,460	3,92	2,76	2,2	1,6	1,08
Guangxi	5,936	5,03	3,56	1,84	1,71	1,8
Hainan	-	4,02	3,02	2,32	1,81	1,51
Chongqing	-	4,79	1,6	1,42	1,26	1,18
Sichuan	6,348	4,68	1,68	1,44	1,3	1,09
Guizhou	6,789	7,1	3,43	2,27	2,11	1,75
Yunnan	6,013	5,63	3,74	1,97	1,92	1,41
Tibet	-	5	3,74	2,41	2,06	1,05
Shaanxi	5,229	3,68	2,55	1,7	1,39	1,06
Gansu	6,387	3,95	2,49	2,03	1,61	1,28
Qinghai	5,238	5,54	2,85	1,82	1,68	1,37
Ningxia	6,001	5,29	2,87	2,15	1,81	1,36
Xingang	5,754	5,25	3,9	1,85	1,73	1,52

Source: Female Fertility in China - A 1/1000 Population Survey, compiled by the China Population Information Center, New World Press, 1988 (for 1971). National Bureau of Statistics of China. China Statistical Yearbook 2011 (for 1975, 1985, 1995, 2000, 2010).

2) The second stage, 1982-2013. China has been promoting the family planning policy since the 1970s. In 1982, the "only one child" family planning policy was continued as China's main national policy. With each married couple having one child, the trend of rapid population growth was effectively brought under control. After the late 1970s, China adopted a policy of reform and opening up, and the Chinese economy moved from a planned economy to a market economy, which increased the cost of raising children. The Marriage Law of 1980 raised the minimum age of marriage to 22 for men and 20 for women, and the government advocated "late marriage and late childbearing." At this stage, the regional total fertility rate was declining year by year.

We can single out a sub-stage of fertility development after the mid-1990s. Since the mid-1990s, the TFR has decreased to below-replacement fertility level. It was relatively stable during the next 15 years (see Figure 1). Regional total fertility rates were still clearly different in 1995, while the regional dynamics of total fertility rates were characterized by convergence (see Figure 2).

Let's look at the fertility rate by province in 1995 (Figure 3) and 2010 (Figure 4).

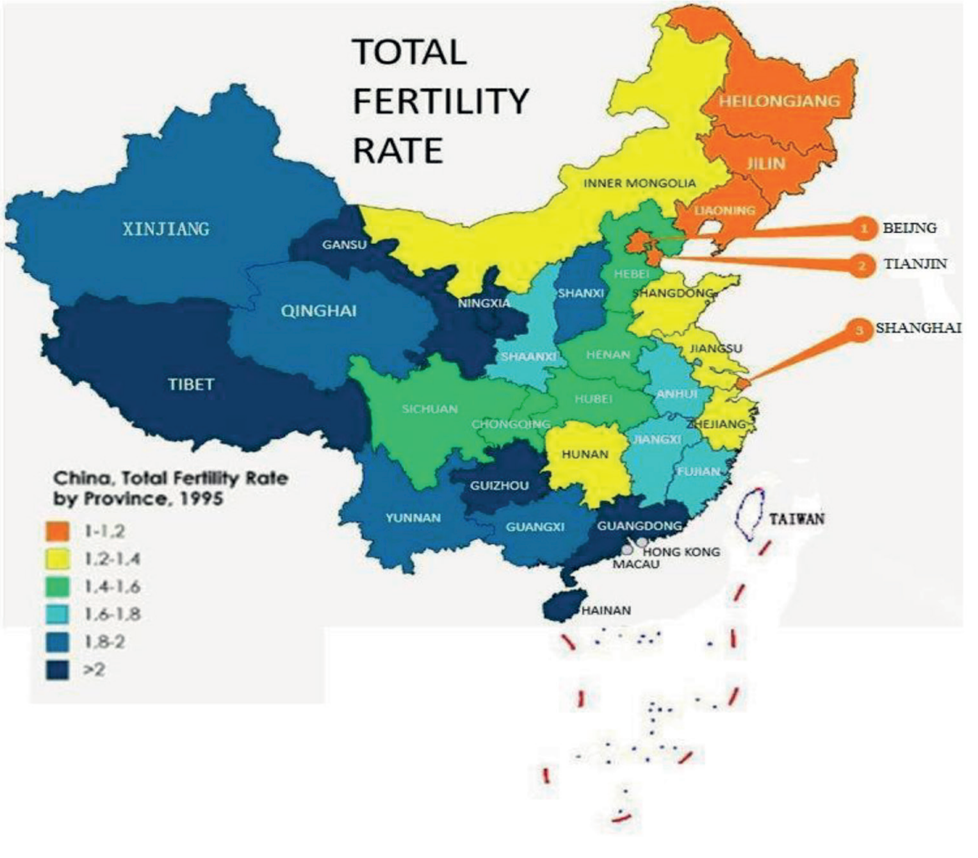

Figure 3. China, Total Fertility Rate by Province, 1995. *Source:* Compiled by the authors based on China Statistical Yearbook 1996.

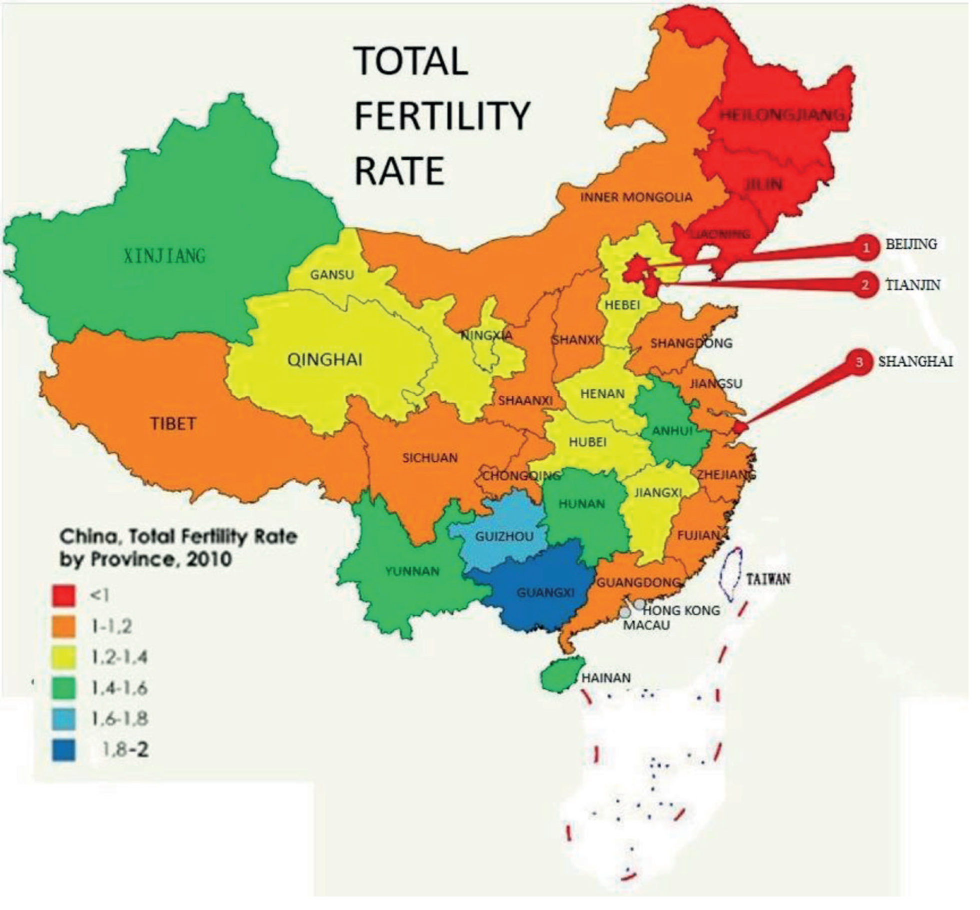

Figure 4. China, Total Fertility Rate by Province, 2010. *Source:* Compiled by the authors based on China Statistical Yearbook 2011.

In 1995, the most worrying situation was observed in North-East China, as well as in Beijing, Tianjin and Shanghai, where the total fertility rate did not exceed 1.2. By 2015, this indicator fell below 1 in these administrative divisions. It is important to note that already in 1995, almost nowhere in the PRC was there a level of the TFR sufficient for population reproduction, which is equal to 2.1. The TFR above this value was observed in only 5 administrative subdivisions out of 31 — the provinces of Guangdong, Hainan, Guizhou, as well as Tibet and Xinjiang. And by 2015, the PRC completely lacked a level of TFR sufficient for simple population reproduction.

3) The third stage, 2013-present. On November 15, 2013, the Third Plenary Session of the 18th CPC Central Committee issued the "Decision of the Central Committee of the Communist Party of China on Several Major Issues Concerning Comprehensively Deepening Reforms" and the "selective two-child" policy (each couple is allowed to give birth to two children, if one of the parents is an only child) was implemented. On October 29, 2015, the Fifth Plenary Session of the 18th CPC Central Committee decided to fully implement the "universal two-child" policy (each couple is allowed to give birth to two children).

The age structure and dependency ratio of the population since 2008 are as follows (Table 2):

Table 2. Demographic structure in China, 2008-2017

Index	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008
Total population at the end of the year (10 thousand)	139 008	138 271	137 462	136 782	136 072	135 404	134 735	134 091	133 450	132 802
Population aged 0-14 years (10 thousand)	23 348	23 008	22 715	22 558	22 329	22 287	22 164	22 259	24 659	25 166
Population aged 15-64 years (10 thousand)	99 829	100 260	100 361	100 469	100 582	100 403	100 283	99 938	97 484	96 680
Population aged 65 years and older (10 thousand)	15 831	15 003	14 386	13 755	13 161	12 714	12 288	11 894	11 307	10 956
Total Dependency Ratio (%)	39.2	37.9	37.0	36.2	35.3	34.9	34.4	34.2	36.9	37.4
Children's Dependency Ratio (%)	23.4	22.9	22.6	22.5	22.2	22.2	22.1	22.3	25.3	26.0
Aged Dependency Ratio (%)	15.9	15.0	14.3	13.7	13.1	12.7	12.3	11.9	11.6	11.3

Source: Data from the China National Bureau of Statistics. Data for 2015 make up 1% of the sample survey data; 2010 is the year of the national census; and other data is 0.1% of the sample survey data of each province in China.

As can be seen from the Table 2, the population aged 0-14 years increased after the implementation of the "two-child" policy in 2013, but the increase is small, which indicates that the population policy plays a certain role in the growth of the child population. The aged dependency ratio is constantly increasing, and the population ageing is worsening.

The "two-child" policy was carried out in China from 2013 to August 20, 2021. However, there were no incentive policies related to the population policy and the cost of raising children remained relatively high. During this period, the "two-child" policy played a certain role in the growth of the child population, but the effect was insignificant. The total fertility rate in all regions of China remained relatively low.

On August 20, 2021, the Chinese government amended the Law on Population and Family Planning, which advocates marriage and childbirth at appropriate age and promotes good prenatal and postnatal care. According to the amended law, each couple is allowed to have up to three children.

4. Research model and hypotheses

The next step of our research is a close examination of the determinants of the regional difference of the TFRs in the first 15 years of below-replacement fertility.

Indicators such as gross regional product (GRP) per capita, proportion of urban population, proportion of women with higher education, life expectancy at birth, net migration rate in the region, aged dependency ratio and infant mortality rates were chosen to build an econometric model. After multicollinearity tests, the model was implemented with explanatory variables such as per capita GRP; the proportion of women with higher education; life expectancy at birth; the proportion of urban population. We can emphasize that we now have data on the regional population policy. Both population policy and socio-cultural determinants are included in unexplained residuals in the model. The dependent variable is the total fertility rate.

The authors put forward the following hypotheses:

1) The growth of GRP per capita has a negative impact on the TFR;

2) An increase in the proportion of the urban population has a negative impact on the TFR;

3) An increase in the proportion of women with higher education has a negative impact on the TFR;

4) An increase in life expectancy at birth has a negative impact on the TFR.

To build quantitative models, data were collected on 31 regional subdivisions of the PRC at the provincial level for 3 periods: 1995, 2000 and 2010. The sample includes all regions of the PRC, except for special autonomous regions (Macau and Hong Kong), as well as Taiwan. The source of all data is the Statistical Yearbook of the People's Republic of China released by the National Bureau of Statistics of the PRC. Table 3 presents the indicators in the final database.

Basic regression model:

$$\ln TFRr = a_0 + a_1 GRPPCr + a_2 LEr + a_3 FEDUCr + a_5 URBr + REGr + e \quad .$$

Table 3. Descriptive statistics of dependent variables

Indicator (units)	Medium	Standard deviation	Minimum	Maximum	Symbol in models
Gross regional product per capita (RMB)	7545.9	16 183	15 411	74 573	GRPPC
Life expectancy at birth (years)	71.93	3.772	62.01	80.26	LE
Proportion of women with tertiary education among the total number of women over 18 years of age (%)	6.83	5.61	0.05	34.93	FEDUC

Table 3. Continued

Indicator (units)	Medium	Standard deviation	Minimum	Maximum	Symbol in models
Proportion of urban population (%)	41.31	17.48	13.45	89.3	URB
Dummy variable of the region:					reg_2
Northeast China (base variable)					reg_3
Northern Coast of China					reg_4
Eastern Coast of China					reg_5
Southern Coast of China					reg_6
Northwest China					
Southwest China					reg_7
Yellow River Delta					
Yangtze River Delta					reg_8

Each model also uses dummy variables for 7 regions of the PRC (North-East China is taken as the base comparison region) for a more detailed assessment of regional differentiation. The dummy variables added correspond to the regional subdivision described in Appendix 1 (for the 11th Five-Year Period 2006-2010).

All models used heteroscedasticity-resistant (robust) standard errors.

5. Data analysis and results

Table 4 presents the results of estimating regressions of the total fertility rate variable for all regressors using the pooled OLS approach.

Table 4. Results of regressions evaluation (robust standard errors are given in parentheses below the coefficients)

Dependent variable: ln_TFR				
Variables	(1)	(2)	(3)	(4)
const	1.546**	0.1444**	3.549**	0.4313**
	(0.1761)	(0.03376)	(0.4323)	(0.06092)
l_GRPPC	-0.1696**			
	(0.01852)			
FEDUC		-0.02676**		
		(0.003157)		

Table 4. Continued

Dependent variable: ln_TFR				
Variables	(1)	(2)	(3)	(4)
LE			-0.04901**	
			(0.005882)	
URB				-0.009496**
				(0.001038)
reg_2	0.2191**	0.3163**	0.2459**	0.2146**
	(0.05960)	(0.04594)	(0.05493)	(0.04149)
reg_3	0.2270**	0.2196**	0.2573**	0.2368**
	(0.04623)	(0.04953)	(0.04205)	(0.06581)
reg_4	0.5143**	0.4568**	0.5131**	0.4802**
	(0.06481)	(0.06574)	(0.08764)	(0.08335)
reg_5	0.4711**	0.5291**	0.2939**	0.3758**
	(0.03777)	(0.04699)	(0.06914)	(0.05048)
reg_6	0.4021**	0.4301**	0.3465**	0.3173**
	(0.08092)	(0.08946)	(0.07965)	(0.08722)
reg_7	0.2927**	0.3312**	0.2734**	0.2245**
	(0.04286)	(0.03907)	(0.06438)	(0.04649)
reg_8	0.3354**	0.3469**	0.3214**	0.2602**
	(0.02980)	(0.02962)	(0.03679)	(0.03845)
n	93	93	93	93
R^2	0.7672	0.7079	0.7299	0.6986
lnL	57.77	47.22	50.85	45.75

Note: *, **, *** denotes significance at 10%, 5% and 1% respectively.

With the dependent variable ln_TFR, the following modelling results are obtained:

- with per capita GRP growth of 1%, the TFR decreases by 0.17%
- if the proportion of women with higher education increases by 1%, the TFR decreases by 2.68%
- if life expectancy at birth increases by 1 year, the TFR decreases by 4.9%
- with an increase in the proportion of urban population by 1%, the TFR decreases by 1%.

Fixed and random effects models for each dependent variable were also tested. After conducting the linear constraint test, the Breusch–Pagan test and the Hausmann test in a model with the GRP (this time without dummy variables), we conclude that the fixed-effects model is better suited to describe the relationship between variables. So, we make a choice in its favor (the variable per capita GRP is significant at the 1% level). Accordingly, the presence of individual characteristics in regional fertility, constant in time (Appendix C, Table C1), is confirmed. However, among the rest of the models (with women's education, life expectancy or urban population), the random effects model is preferred (Appendix C, Tables C2, C3, C4), i.e. the probability that missing variables are one of the constituent errors.

The results suggest that when selecting GRP per capita as a variable of interest, the total fertility rate in Region 4 (Southern Coast of China) is 51% higher compared to Northeast China with a 95% probability. The fertility rate in Region 5 (Northwest China), all other things being equal, is 47% higher compared to Northeast China with a 95% probability. The total fertility rate in Region 8 (Yangtze River Delta) is 33% higher compared to Northeast China with a 95% probability. The North and East Coast regions of China showed a smaller spread. The results obtained support our arguments about significant regional inequality in fertility.

Preference of random effects for models with women's education, life expectancy or urban population suggests that there are no unambiguous patterns between regional fertility and regional indicators. A more complete set of socioeconomic and sociocultural factors is needed to identify a dependency. However, it can be argued that wealth levels are an important factor affecting the PRC's regional inequality in fertility. Based on the assumption that the current fertility trends remain unchanged, one can conclude that a 1% increase in GRP per capita will reduce the existing regional total fertility rates by 0.17%. The presence of fixed effects for the model with per capita GRP confirms the dependence of fertility on the regional distribution of wealth.

6. Conclusion and discussion

In conclusion, we would like to stress the limitations of our model. The first point is the quality of our data. Our dependent variables – the regional TFR – was extracted from a 1% sample survey data. Estimations of the level of fertility in the provinces vary in different sources (i.e., the 1975 TFRs of China Population Information Center and National Bureau of Statistics of China). In each case, we selected data from the National Bureau of Statistics of China. The other data were collected from 1% sample survey data, national census data, vital statistics, 0.1% of the sample survey data of each province in China.

The second point is our quantitative model. Our regression is simple and closer to correlation analysis. We do not have a strategy to avoid endogeneity (reverse causality). We didn't even have the opportunity to take lagged variables because of the data we used (we have only three points over a 15-year period). Thus, we can discuss the links between variables, but not the factors of regional fertility.

Given these limitations, we will focus on some results. We would like to present some points of discussion on fertility determinants in China, especially during the first decades of below-replacement fertility.

1) In 1970s, with China implementing the policy of reform and opening up, the country underwent a transformation from a planned economy to a market economy. Until 1978, when China carried out a policy of low salary and high welfare (Huang Aihe, the Long Evolution of Chinese Welfare, China Newsweek, December 25, 2006),

the childrearing cost was relatively low. From 1960 to 1978, fertility of the Chinese population maintained a relatively high level (see Figure 1). After the reform and opening up, China began to control population growth. The results of the study are based on data for the period from 1995 to 2010. During this period, China implemented a strict family planning policy "a couple with only one child." As seen from the comparison of China's population fertility rate chart (see Figure 1) and China's per capita GDP chart (Figure 5), after 1978, the relationship between China's population fertility rate and per capita GDP is reversed, and the relationship between China's population fertility rate and per capita GDP before 1978 is also roughly reversed. The actual data show that the relationship between population fertility rate and per capita GDP is reversed, as we think, regardless of the strictly controlled family planning policy or the not-so-strictly-controlled population policy.

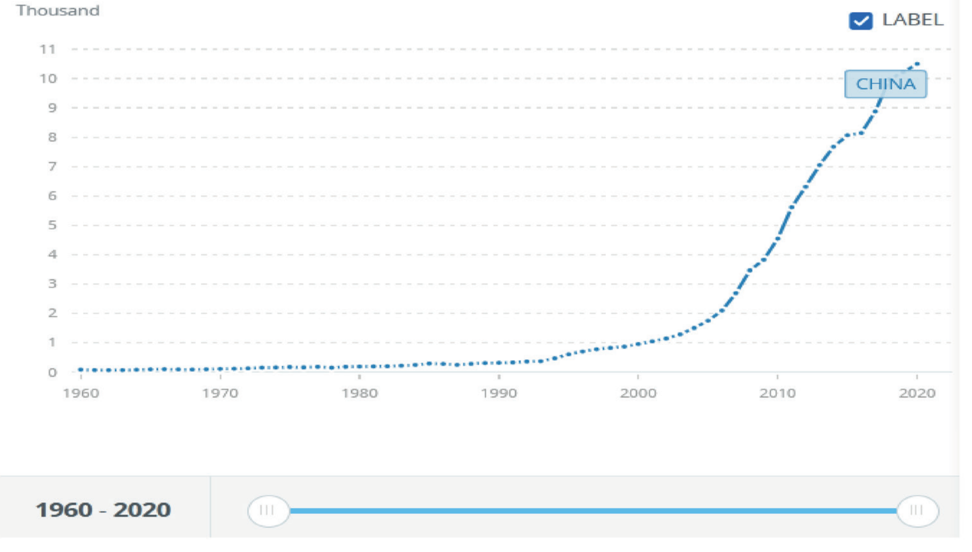

Figure 5. Per capita GPD, China, 1960-2020. *Source:* Compiled by the authors based on World Bank Database. https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=CN&start=1960&end=2020&view=chart

2) The result of the research is consistent with data at the regional level. It reveals that per capita GDP is an important factor for the local total fertility rate. Table 9 shows per capita GDP in each region at the end of the study period. According to Table 9 and Figure 3, a region with a high per capita GDP normally has a low total fertility rate; and vice versa. Northeast China registers the lowest rate and Tibet – comparatively low. Such trends attribute to many reasons. In general, the results of the research are in line with the data obtained.

Table 9. Per capita GDP in each province, city and autonomous region in 2010 (Yuan)

Region	Year 2010	Region	Year 2010	Region	Year 2010
Beijing	75,943	Anhui	20,888	Sichuan	21,182
Tianjin	72,994	Fujian	40,025	Guizhou	13,119
Hebei	28,668	Jiangxi	21,253	Yunnan	15,752
Shanxi	26,283	Shandong	41,106	Tibet	17,319
Inner Mongolia	47,347	Henan	24,446	Shaanxi	27,133
Liaoning	42,355	Hubei	27,906	Gansu	16,113
Jilin	31,599	Hunan	24,719	Qinghai	24,115
Heilongjiang	27,076	Guangdong	44,736	Ningxia	26,860
Shanghai	76,074	Guangxi	20,219	Xinjiang	25,034
Jiangsu	52,840	Hainan	23,831		
Zhejiang	51,711	Chongqing	27,596		

Source: Compiled by the authors based on China Statistical Yearbook 2011.

Low fertility rate in Northeast China. When China moved from its planned economy to a market economy after reform and opening-up, industry in Northeast China encountered huge challenges. In the 1990s, when a large number of enterprises and factories shut down, some people immigrated to developed areas along the eastern coast. With the effective implementation of family planning policy, the country's population growth was slow (Gu & Jia, 2015). Mostly young people of reproductive age migrated in search of work. According to the sixth National Census, the net population outflow in Liaoning province, Jilin province and Heilongjiang province was about 2 million, and the total fertility rate there was the lowest in 2010. Given the data, per capita GDP in these provinces is high, but the total fertility rate is low, which perfectly confirms the correctness of the research result.

Fertility rate in Tibet. Several factors brought about low per capita GDP and low total fertility rate in Tibet during the past decades. Firstly, urbanization there is speeding up, and the urbanization rate in 2010 was about 11.5% faster than that in 1990. Secondly, more and more people are receiving higher and secondary education (Bureau of statistics in Tibet, sample survey of 1% population on permanent residents in various regions/cities in 2015 in the Tibet Autonomous Region), to name just a few. In 1995, per capita GDP in Tibet was low, about 2,332.5 yuan, but the total fertility rate was high, about 3.32, which proves the correctness of the research results.

3) The results of this research are very convincing due to the fact that economic growth is associated with a low birth rate through several channels. First, the relative cost of raising children is growing. Secondly, people in economically developed zones postpone birth, which is the reason for the decrease in the conventional total fertility rate. Competition is high, work is a priority. Thirdly, there is a strain on the physical condition of the body. The higher the per capita GDP, the lower the rate will be, for in a region with a high per capita GDP, people often need more money to make a living, which leads to an increase in the child-raising cost. So, they gradually refuse to have

a baby (Yang, 2020). Also, such a region enjoys sound economic growth, so people are shouldering so much pressure that the probability of getting pregnant is declining and the number of spontaneous abortions is rising, which hinder an increase in the fertility rate (Xu et al., 2016).

4) Related policies can affect the regional total fertility rate. In 1975, when China was in a period of planned economy, population policies were conducive to the increase of the total fertility rate. However, cities with high per capita GDP, such as Shanghai, Beijing and Tianjin, had a low regional total fertility rate (1.67 in Shanghai, nearly 2.0 in Beijing and Tianjin), and other regions with lower per capita GDP had higher regional total fertility rate, which confirms the direct relationship between regional per capita GDP and the regional total fertility rate. Besides, the finding that per capita GDP has the greatest impact on the total fertility rate is also confirmed.

5) The practice of China's population policy and related policies have enriched the theory of population development. Before 1978, the population related policies and social and cultural factors caused an increase in the total fertility rate. The relatively low cost of raising children, specifically, was conducive to the increase of the total fertility rate. Even though the regional TFR decreased with the increase of per capita GDP, the regional TFR remained at a relatively high level. In 2013, China adopted the universal two-child policy. However, due to the lack of an incentive policy, the child-raising cost is very high and the total fertility rate has not significantly increased. The practice of China's population policy shows that in order to improve the total fertility rate, not only should a country relax its population policy, but also adopt incentive policies and strengthen social and cultural construction to reduce the cost of raising children.

6) Socio-cultural and economic factors can be more significant than population policy. For example, the population policy of China towards ethnic minorities does not contribute to an increase in their total fertility rates. In Guangxi Autonomous Region, per capita GDP is quite low but the fertility rate is comparatively high, which is hardly the result of the local policies towards ethnic minorities. There are 56 ethnic groups in China, of which 55 groups, with the exception of the Han nationality representing the overwhelming majority of the population, are always viewed as ethnic minorities. During the time when China carried out the one-child policy, every family from ethnic groups was allowed to have two children. The fertility rates of Guangxi autonomous region and Gansu province are presented in Table 10.

Table 10. Fertility rates of Guangxi Autonomous Region and Gansu Province in 1995-1996

Region	Total fertility rate	Population of ethnic minorities (thousand)	Total population (thousand)	Proportion of ethnic minorities in the total population
Gansu	>2	2,275.8	24,255.6	9.38%
Guangxi	1.8 -2	17,784	45,274	39.28%

Source: Compiled by the authors based on China Statistical Yearbook.

The data in Table 10 show that the proportion of ethnic minorities in the total population of Guangxi Autonomous Region was greater than that of Gansu Province, while the fertility rate in Guangxi was lower than that in Gansu Province. This shows that the two-child policy for ethnic minorities failed to improve the fertility rate of ethnic minorities when China was carrying out the one-child policy. The number of ethnic minorities in Southwest China is large, and the high fertility rate there is not caused by the two-child policy for ethnic minorities, but by the low per capita GDP in Southwest China.

7) The regional fertility rate affects the balanced development of the region's population, as well as national security and social stability. As China's economy continues to develop, people are striving for wealth and a better life. At present, due to the low fertility rate in China, a complete relaxation of family planning policy is greatly needed. Besides, an incentive policy in the field of fertility should be implemented to reduce birth and rearing costs. What's more, social and cultural construction should be reinforced. Special attention should be paid to the areas of low fertility to increase fertility, promote balanced development of the population, and ensure national security and social stability.

At the turn of the century, the period of stable below-replacement fertility, the regional fertility differentiation in the PRC is still relatively high. The leaders in terms of infertility are Southwest China (Yunnan, Guizhou and Guangxi provinces) and Northwest China (Xinjiang).

The authors analyze a number of socio-economic and demographic determinants in the last part of the family planning period in China at the turn of the century and draw the following conclusions. The regional fertility rate and per capita GDP are inversely related, and per capita GDP is the factor that has the greatest influence on the regional total fertility rate. According to the relevant literature, this rule also applies to China's fertility-promotion period before 1978.

In order to improve the regional fertility rate, it is necessary not only to relax the modern family-planning policy, but also to implement incentive policies related to human fertility, as well as to strengthen social, economic, demographic, and cultural structures.

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Appendix . Regional division of the PRC

In total, there are 34 provincial administrative subdivisions in China, including 23 provinces, 5 autonomous regions and 4 central subordination cities, as well as 2 special administrative regions – Aomen (Macau) and Xianggang (Hong Kong). Aomen, Xianggang and Taiwan Province are usually not included in the national census (Appendix A, Figure A1). Thus, the national census of China only includes 31 subdivisions.

Figure A1. China, Provincial-Level Administrative Divisions: Provinces, Autonomous Regions, Direct-Controlled Municipalities, Special Administrative Regions. *Source:* Compiled by the authors.

In order to implement the strategy of coordinated regional development, it is necessary to create in China a corresponding multilevel system and a framework of regional division to facilitate the implementation of targeted regional policies. According to China's 11th Five-Year Plan, the country is divided into eight regions:

1) North-East China: Liaoning, Jilin, Heilongjiang;
2) Northern Coast of China: Beijing, Tianjin, Hebei, Shandong;
3) Eastern Coast of China: Shanghai, Jiangsu, Zhejiang;
4) Southern Coast of China: Fujian, Guangdong, Hainan;
5) Northwest China: Gansu, Qinghai, Ningxia, Xinjiang, Tibet;
6) Southwest China: Chongqing, Sichuan, Guizhou, Yunnan, Guangxi;
7) Yangtze River Delta: Hubei, Anhui, Jiangxi, Hunan;
8) Yellow River Delta: Shanxi, Inner Mongolia, Henan, Shaanxi.

Appendix B. The ratio of urban/rural resident's income to the urban/rural national average, China, 1998, 2017

Figure A2. Regional division of the PRC. *Source:* Compiled by the authors.
Note: The administrative subdivision is based on China's 11th Five-Year Plan.

Figure B3. The ratio of urban/rural resident's income to the urban/rural national average, China, 2017. *Source:* Compiled by the authors based on China Statistical Yearbook 2018.

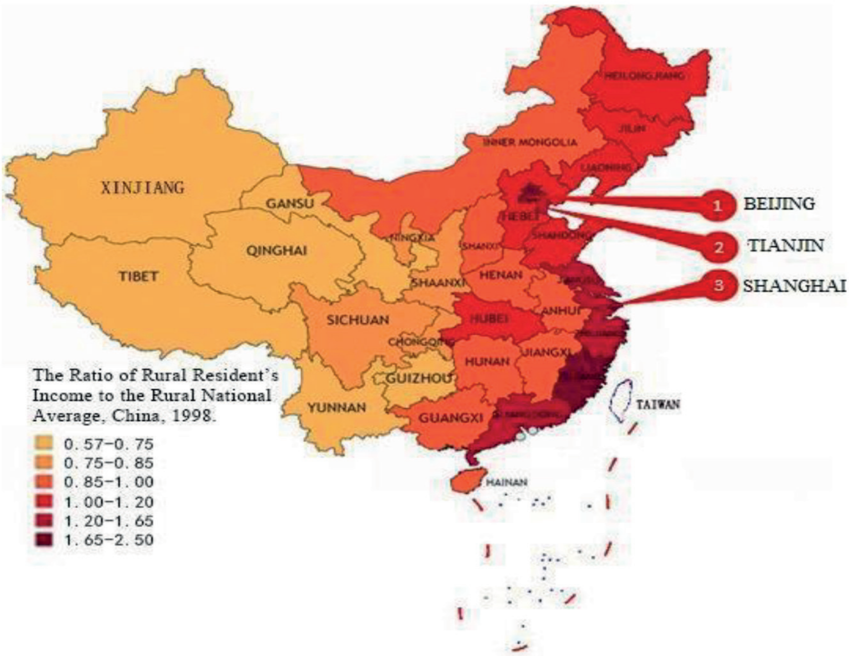

Figure B4. The ratio of urban/ rural resident's income to the urban/rural national average, China, 1998. *Source:* Compiled according to China Statistical Yearbook 1999.

Appendix C. Testing OLS, fixed and random effects models for some dependent variable. Total fertility rate. China

Table C1. Total fertility rate (TFR) and gross regional product (GRP) per capita, pooled ordinary least squares (OLS), fixed and random effects models

Dependent variable: ln_TFR			
Variables	**(1) pooled OLS**	**(2) fixed effects model**	**(3) random effects model**
const	2.158**	1.712**	1.816**
	(0.1961)	(0.1737)	(0.1756)
l_GRPPC	-0.2012**	-0.1526**	-0.1640**
	(0.02121)	(0.01891)	(0.01875)
n	93	93	93
R^2	0.4957	0.6432	-
Breusch-Pagan test	χ 2 (1) = 31.8249; p-value = 1.68712e-008 < 0.01 => random effects model is better than pooled OLS		
Hausman test	χ 2 (1) = 19.0675; p-value = 1.26174e-005 < 0.01 => fixed effects model is better than random effects model		
Robust test for differing group intercepts	Welch F(30, 21.9)=28.9513; p-value= P(F(30, 21.9)>28.9513)=7.39417e-012 < 0.01 => fixed effects model is better than pooled OLS		

Note: *, **, *** denotes significance at 10%, 5% and 1% respectively. Breusch-Pagan test. H0: Variance of observation – specific errors = 0. Hausman test. H0: pooled OLS estimates are consistent. Robust test for differing group intercepts. H0: The groups have common constants.

Table C2. Total fertility rate (TFR) and proportion of women with higher education (WEDUC), pooled OLS, fixed and random effects models

Dependent variable: ln_TFR			
Variables	**(1) pooled OLS**	**(2) fixed effects model**	**(3) random effects model**
const	0.5264**	0.5434**	0.5364**
	(0.04451)	(0.03381)	(0.04382)
WEDUC	-0.03166**	-0.03415**	-0.03313**
	(0.004571)	(0.004951)	(0.004458)
n	93	93	93
R^2	0.4290	0.5080	-
Breusch-Pagan test	χ 2 (1) = 30.2508; p-value = 3.79628e-008 < 0.01 => random effects model is better than pooled OLS		
Hausman test	χ 2 (1) = 0.454167; p-value = 0.500363 > 0.01=> random effects model is better than fixed effects model		
Robust test for differing group intercepts	Welch F(30, 21.9)= 23.3285; p-value = P(F(30, 21.9) > 23.3285) = 7.1344e-011< 0.01 => fixed effects model is better than pooled OLS		

Note: *, **, *** denotes significance at 10%, 5% and 1% respectively.

Table C3. Total fertility rate (TFR) and life expectancy at birth (LE), pooled OLS, fixed and random effects models

Dependent variable: ln_TFR			
Variables	**(1) pooled OLS**	**(2) fixed effects model**	**(3) random effects model**
const	4.108**	4.253**	4.201**
	(0.03304)	(0.4795)	(0.05410)
LE	-0.05280**	-0.05482**	-0.03313**
	(0.004706)	(0.006667)	(0.004458)
n	93	93	93
R^2	0.5402	0.6378	-
Breusch-Pagan test	χ 2 (1) = 34.4173; p-value = 4.44755e-009 < 0.01 => random effects model is better than pooled OLS		
Hausman test	χ 2 (1) = 0.0816182; p-value = 0.775116 > 0.01=> random effects model is better than fixed effects model		
Robust test for differing group intercepts	Welch F(30, 21.9)= 6.55366; p-value = P(F(30, 22.0) > 6.55366) = 1.24597e-005 < 0.01 => fixed effects model is better than pooled OLS		

Note: *, **, *** denotes significance at 10%, 5% and 1% respectively.

Table C4. Total fertility rate (TFR) and proportion of urban population (URB), pooled OLS, fixed and random effects models

Dependent variable: ln_TFR			
Variables	**(1) pooled OLS**	**(2) fixed effects model**	**(3) random effects model**
const	0.7691**	0.9189**	0.8240**
	(0.05588)	(0.08942)	(0.06222)
URB	-0.01110**	-0.05482**	-0.01243**
	(0.001235)	(0.002163)	(0.002163)
n	93	93	93
R^2	0.5127	0.5121	-
Breusch-Pagan test	χ 2 (1) = 20.7117; p-value = 5.339e-006 < 0.01 => random effects model is better than pooled OLS		
Hausman test	χ 2 (1) = 3.13119; p-value = 0.0768076 > 0.01=> random effects model is better than fixed effects model		
Robust test for differing group intercepts	Welch F(30, 21.9)= 6.27007; p-value = P(F(30, 22.0) > 6.27007) = 1.83744e-005 < 0.01 => fixed effects model is better than pooled OLS		

Note: *, **, *** denotes significance at 10%, 5% and 1% respectively.