

The Changing Trends and International Comparison of Chinese Women's Fertility Pattern under Low Fertility Level

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Abstract: Using data from Chinese national population censuses and 1% population sampling surveys from 2000 to 2020, by analyzing the age-specific fertility contribution rate curve, the Mean age at birth, the Standard deviation in Mean age at birth in different years, and comparing with the transformation process of fertility pattern in developed countries, this paper analyses the changing trends in Chinese women's fertility pattern under low fertility level. The results find that under low fertility level, the growth rate of Chinese women's Mean age at birth turns from fast to slow, the dispersion of fertility pattern rises first and then falls, and the distribution of child-bearing age is overall postponed. Compared with developed countries, the transformation of Chinese women's fertility pattern started late, changed quickly, and fluctuated greatly, from significantly lagging behind the general transformation process of fertility pattern in developed countries to rapidly approaching the average level of fertility pattern in developed countries. The adjustment of Chinese fertility policy has had a significant impact on the fertility pattern, leading to a turning point in the changing trends of the fertility pattern after 2010. With the development of economy and society and the continuous adjustment of fertility policy, the future fertility pattern of Chinese women may show trends that women's child-bearing age will continue to rise, but the dispersion of fertility pattern will slightly decline in fluctuations.

Keywords: Fertility Pattern, Mean Age at Birth, Standard Deviation, Changing Trends.

1. Research Background

Under the joint influence of the family planning policy and economic and social development, China completed Demographic Transition in the late 1990s and entered a stage of low fertility level. The fertility pattern is a time distribution function of the fertility process, manifested as the age distribution of women's fertility behavior per unit time. Both the fertility pattern and fertility level are statistical characteristics of women's fertility behavior during a specific period, and there is a close relationship between them. With the completion of Demographic Transition, Chinese women's fertility pattern has also transformed gradually from "early, many, dense" to "late, few, sparse".

Since 2000, the fertility desire of the child-bearing age groups in China has gradually decreased, and the fertility level has shown a continuous downward trend. By 2010, the total fertility rate of China has dropped to around 1.6 according to World Bank data, while according to Chinese national population census, it has dropped to 1.18, entering lowest low fertility level. Faced with the new demographic situation, China has begun to continuously adjust its fertility policy and gradually released birth restrictions, especially with the implementation of the comprehensive two child policy in 2016, which has caused significant fluctuations in fertility level.

The changes in the fertility desire of the child-bearing age group, as well as the adjustment of national fertility policy, have a direct impact on the time of fertility behaviors, leading to further changes in women's fertility pattern. By analyzing the changing trends of Chinese women's fertility pattern from 2000 to 2020, especially the similarities and differences in the changing trends of fertility pattern between different birth order, we can show the characteristics of Chinese women's fertility behavior under low fertility level from another

perspective, deeply understand the impact of fertility policy adjustments on fertility pattern, and thus better judge Chinese women's future fertility pattern.

2. Research Methods and Data Sources

There are two main analysis paths in the existing research of fertility pattern. One is to draw the fertility curve by using the age-specific fertility rate (ASFR). Through analyzing the skewness, kurtosis, area and other attributes of the fertility curve, the characteristics of the fertility pattern in a specific period can be described directly. For example, British demographer Brass W proposed The Brass-Gompertz Relational Fertility Model, this Model use Gompertz function to fit the curve of fertility rate, in which the β parameter represent the width and dispersion tendency of the fertility curve, but this method is very sensitive to the selection of the standard fertility model, and the results are difficult to interpret and compare.

The other is based on the characteristic that the fertility pattern is approximate to normal distribution, to describe the characteristics of the fertility model by calculating specific indicators, and to reflect the changing trends of the fertility pattern by comparing the changes of indicators in different periods. For example, the Mean age at birth, the median of fertility age distribution is used to describe the central tendency of the fertility pattern, the Standard deviation in mean age at birth is used to describe the dispersion tendency of the fertility pattern. However, there are two shortcomings in this type of study. Firstly, the existing studies often only use one kind of indicator to describe the fertility pattern, making it difficult to comprehensively reflect the characteristics of the fertility pattern. Secondly, insufficient attention has been paid to the impact of Chinese fertility policy adjustments on fertility pattern.

Based on existing research, this paper uses the method

proposed by Song Jian et al. for calculating the age-specific fertility contribution rate of child-bearing age. By calculating the probability distribution of age-specific fertility rates, the age-specific fertility rate is transformed into the age-specific fertility contribution rate (AFSCR), and the age-specific fertility contribution curve is plotted. Then, this paper analyzes the distribution characteristics and changing trends of fertility pattern by calculating and comparing indicators such as the Mean age at birth (MCB) and the Standard deviation in mean age at birth (sdMCB) in different periods. The specific calculation formula is as follows:

$$H_i(x) = \frac{f_i(x)}{TFR^i(x)}, \text{ 且 } \sum_x^i H_i(x) = 1.$$

$$MAB_i = \sum_x^i \bar{x} H_i(x), \text{ 且 } sdMAB_i = \sqrt{\sum_x^i H_i(x) (MAC_i - \bar{x})^2}.$$

Among them, $f_i(x)$ represents the fertility rate of women in x -year and i -th birth during a specific period, $TFR^i(x)$ represents the total fertility rate in i -th birth. $H_i(x)$ represents the proportion of the fertility rate of women in x -year and i -th birth in the total fertility rate of the same birth order, which is the fertility contribution rate of women in x -year and i -th birth during this period. The \bar{x} represents the mean age of child-bearing within the age range $[x, x + 1)$, this paper assume that it is approximately $x + 0.5$.

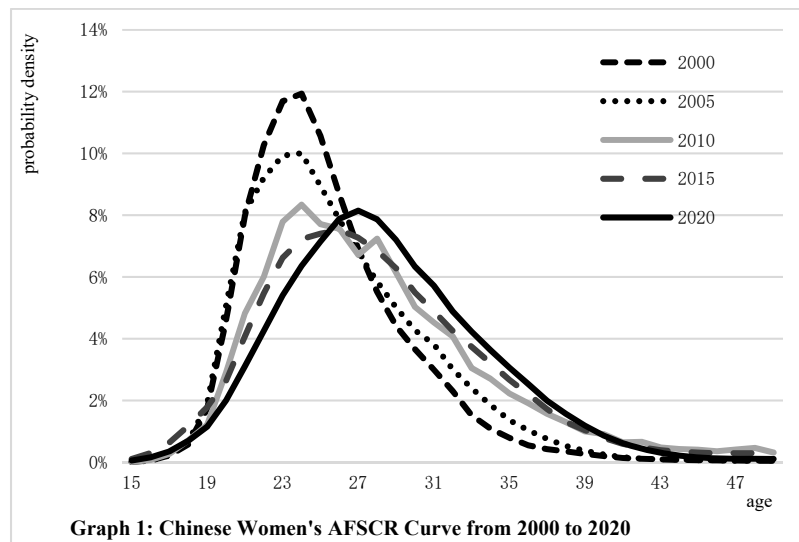
There are two main sources of research data used in this paper. Among them, the Chinese data are from national population censuses of 2000, 2010, 2020 and 1% population sampling surveys in 2005 and 2015 published by the National

Bureau of statistics. By analyzing the period characteristics and changing trends of the overall fertility pattern and birth order-specific fertility pattern, this paper explores the changing trends of Chinese women's fertility pattern under the low fertility level. (Because of three-birth and more birth of Chinese women only account for relatively low proportion in total fertility and seriously restricted by the family planning policy, there have been many false reports and omissions in relevant statistical data. Therefore, this article only explores the changes in the fertility pattern of first-birth and second-birth.)

The data of other countries are from the Human Fertility Database (HFD), which includes the multi-year population data of 33 countries and regions dominated by developed countries. According to the research needs, this paper selects the age-specific fertility data of 7 countries (France, Germany, Denmark, Sweden, Czech Republic, Austria, Japan) from 1970 to 2020 for analysis, and compares the changing trends of China's fertility pattern with this countries', further grasp the change process of current Chinese women's fertility pattern, and explore the future trend of Chinese women's fertility pattern.

3. Analysis on the changing Trends of Chinese women's fertility pattern

3.1. The overall changing trends in fertility pattern of all Chinese women



Graph 1: Chinese Women's AFSCR Curve from 2000 to 2020

As shown in Graph 1, from 2000 to 2020, Chinese Women's AFSCR Curve shows the characteristics of change: kurtosis from high to low, skewness from left to right, and curve shape from centralized to dispersive and broad. The Chinese women's fertility pattern shows changing trends that the growth rate of the Mean age at birth turns from fast to slow, the dispersion of fertility pattern rises first and then falls, and the distribution of child-bearing age is overall postponed.

In 2000, the Chinese women's AFSCR Curve showed an obvious peak characteristic and positive skew distribution; the Mean age at birth was 25.87 years old, and the Standard deviation in mean age at birth was 4.2 years. According to the characteristics of Normal distribution, it can be seen that in 2000, nearly 70% of women's child-bearing age were between 21.67 and 30.07 years old (the Mean age at birth plus or minus one Standard deviation); the distribution of women's child-

bearing age was centralized, and the child-bearing age was relatively early; most women's child-bearing behavior was completed before the age of 30.

From 2000 to 2010, the kurtosis of the AFSCR Curve rapidly decreased; the degree of positive skewness begun to weaken; the curve shape shifted to the right and a secondary peak gradually appeared. The Mean age at birth rapidly increased to 28.44 years old, which was 2.57 years later than in 2000; The Standard deviation in mean age at birth expanded to 5.91 years, the time interval for women's child-bearing behavior in a centralized way widened significantly, the dispersion tendency of fertility pattern increased significantly, and child-bearing behavior over the age of 30 has begins to become a social norm.

From 2010 to 2020, the kurtosis of the AFSCR Curve first decreased and then increased, and the curve shape further

shifted to the right and resumed single-peaked form. During this period, the women's child-bearing age further increased, but the growth rate slowed down. In 2020, the Mean age at birth reached 28.98 years, only 0.54 years later than in 2010; the Standard deviation in mean age at birth reduced to 5.32 years, 0.59 years less than that in 2010, and the dispersion tendency of women's child-bearing age decreased slightly.

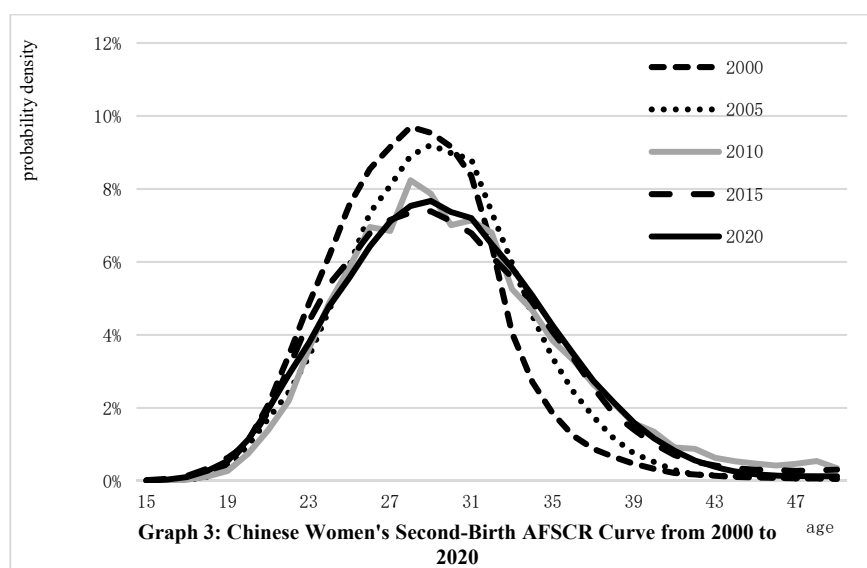
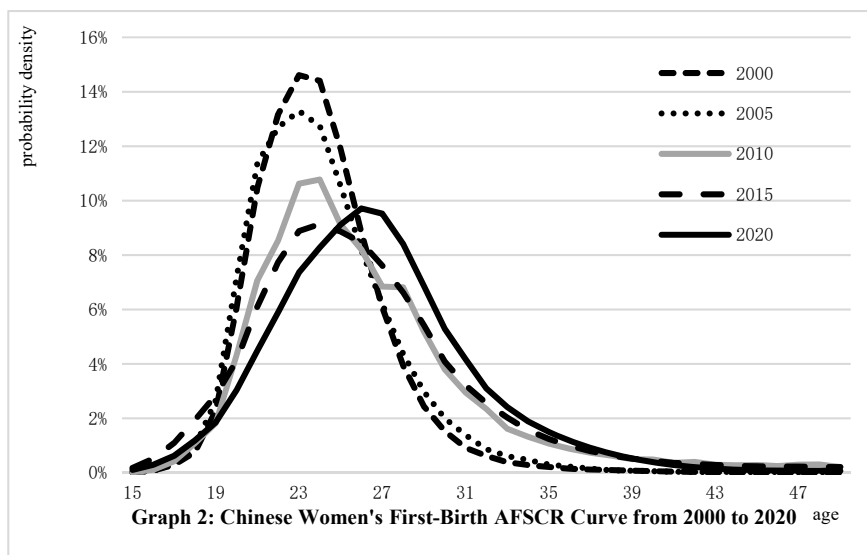
On the perspective of the overall changing trends of

AFSCR Curve, from 2000 to 2020, the fertility contribution rate of women aged 25 to 29 remained around 36%, while the fertility contribution rate of women aged 20 to 24 decreased from 46.46% in 2000 to 21.12% in 2020, and the fertility contribution rate of women aged 30 to 39 increased from less than 14% in 2000 to over 35% in 2020, and the distribution of women's child-bearing age was overall postponed.

Table 1. Changes in main indicators of Chinese women's fertility pattern from 2000 to 2020

Time	Fertility pattern of all women		Fertility pattern of First-birth		Fertility pattern of Second-birth	
	MAB(year)	sdMAB(year)	MAB ₁ (year)	sdMAB ₂ (year)	MAB ₂ (year)	sdMAB ₂ (year)
2000	25.87	4.2	24.50	3.14	28.80	4.21
2005	26.41	4.64	24.59	3.43	29.79	4.43
2010	28.44	5.91	26.65	5.27	30.83	5.56
2015	28.48	5.82	26.63	5.37	30.21	5.44
2020	28.98	5.32	27.22	4.77	30.33	5.21

3.2. The changing trends in Chinese women's fertility pattern of different birth order



Fertility behavior has significant progressive characteristics. First-birth is the start of women's fertility

behavior, and the fertility pattern of first-birth will directly affect the subsequent fertility behavior of women and the

overall fertility level of society.

As shown in Graph 2, from 2000 to 2020, the changing trends of Chinese women's first-birth fertility pattern was substantially consistent with that of all Chinese women. The kurtosis of first-birth AFSCR Curve rapidly decreased between 2000 and 2015, and rebounded in 2020. The degree of positive skewness of the curve weakened continuously, and the curve shape tended to flatten and gradually shifted to the right.

The Mean age at birth of first-birth showed an alternating trend of stagnation and increase (see Table 1). In 2000, the Mean age at birth of first-birth was 24.5 years old, and the changes in 2005 were relatively small compares to 2000. Then in 2010, it significantly increased to 26.65 years old, and the level in 2015 was also at the same with 2010. In 2020, it further increased to 27.22 years old. It can be seen that the postponement of the first-birth child-bearing age was the main reason for the overall postponement in the Mean age at birth of Chinese women.

The dispersion of first-birth's fertility pattern also showed a changing tendency that increased first and then decreased, but the range of change was larger. In 2000, The Standard deviation in mean age at birth of first-birth was 3.14 years, it meant that nearly 70% of women's child-bearing age were between 21.36 and 27.61 years old. The distribution of women's childbearing age was relatively centralized and tended to have children earlier. From 2000 to 2015, the Standard deviation continued to increase, reaching 5.37 years in 2015, an increase of 2.23 years compared to 2000, and in 2020, the Standard deviation slightly decreased to 4.77 years, nearly 70% of women's child-bearing age were between 22.46 and 31.99 years old.

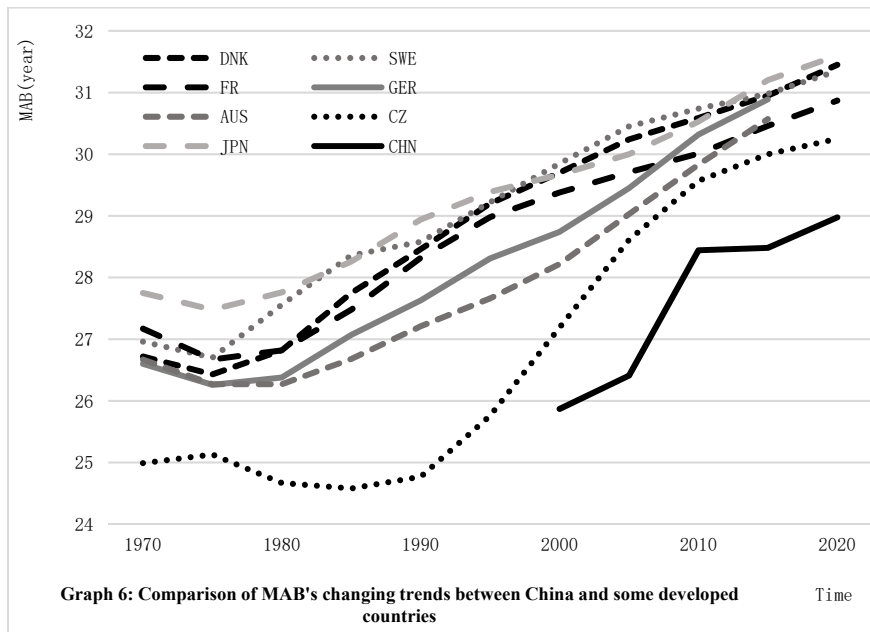
In a long time, the second-birth was the core content of China's fertility policy. Under the "only child" family planning policy, the behavior of second-birth has been strictly

restricted. Since 2013, the key measure of China's fertility policy adjustment has been to continuously loosen policy restrictions on second-birth, providing greater freedom to give birth for the child-bearing age groups. Due to the strong influence of the national fertility policy, there was a significant difference in the changing trends between the fertility pattern of first-birth and second-birth.

As shown in Graph 3, the second-birth AFSCR Curve was more similar to the standard Normal distribution. From 2000 to 2020, the position of second-birth AFSCR Curve generally remained unchanged, but the kurtosis of curve continued to decrease, the curve shape tended to be flat, and the change degree of the curve shape was significantly lower than first-birth AFSCR Curve. Both the Mean age at birth of second-birth and the dispersion of second-birth's fertility pattern showed a trend of increase first and then decrease (see Table 1).

In 2020, the Mean age at birth of second-birth reached 30.33 years old, which was only 1.53 years older than that in 2000, significantly lower than the growth rate of the Mean age at birth of first-birth, and compared with 2010, it decreased by 0.6 years, which was opposite to the trend of the Mean age at birth of first-birth during the same period, and the interval between woman's first-birth and second-birth decreased from 4.18 years in 2010 to 3.1 years in 2020. The Standard deviation in mean age at birth of second-birth was 5.21 years in 2020, which was 1 year larger than that in 2000, but 0.35 years smaller than that in 2010. In all periods, the Standard deviation in mean age at birth of second -birth was higher than that of first-birth, and women's choice for second-birth age was more diversified.

4. International Comparison of Chinese Women's Fertility Pattern

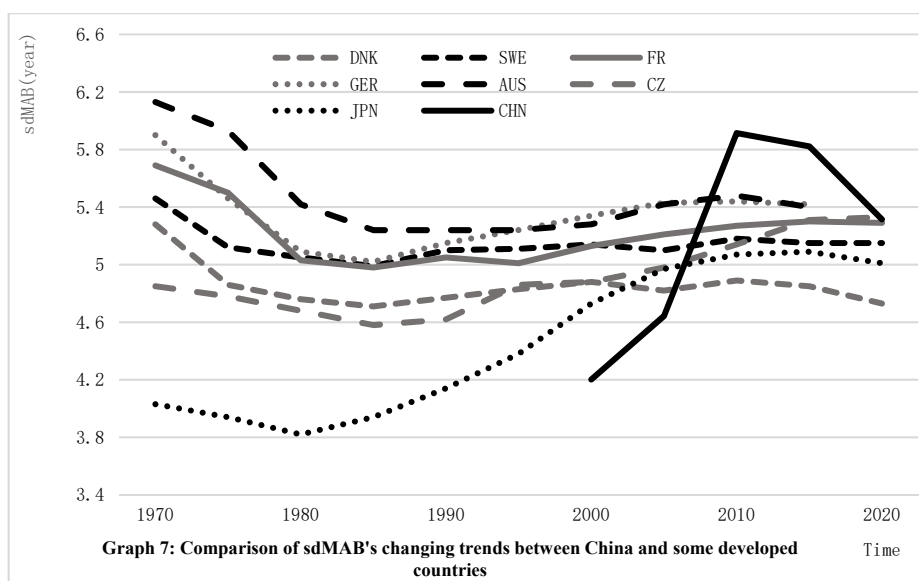


Graph 6: Comparison of MAB's changing trends between China and some developed countries

In the first half of the 20th century, European countries generally achieved a Demographic Transition from "high fertility rate, high mortality rate, and high growth rate" to "low fertility rate, low mortality rate, and low growth rate". After the Second World War and the subsequent "baby boom", the low fertility level of developed countries has been

stabilized again. Since the 1970s, under the low fertility level, the total fertility rate of developed countries has begun to decline further from the replacement level. The population development presented a new change called "The Second Demographic Transition" by some demographer. The fertility patterns of countries have also presented new features, which

can be summarized as two trends:



Firstly, the Mean age at birth continued to rise stably. Around the 1980s, the Mean age at birth in developed countries gradually entered an upward range and continued to increase at a rate of approximately one year per decade (see Graph 6). By 2020, the Mean age at birth in most developed countries had exceeded 30 years old and remained stable in growth.

Second, the dispersion of fertility pattern has gradually stabilized. From 1970 to 2000, the changing processes of the Standard deviation in Mean age at birth in developed countries were different, but the direction of changes were relatively uniform. After a period of increase or decrease, the Standard deviation in Mean age at birth in most developed countries has finally stabilized in about five years. Between 2000 and 2020, the Standard deviation in Mean age at birth in developed countries fluctuated slightly, and the dispersion of fertility pattern has generally remained unchanged (see Graph 7).

Compared with developed countries, China's Demographic Transition started relatively late, but the transformation speed was fast. In less than thirty years, it completed the nearly century long Demographic Transition process of developed countries, entering a stage of low fertility level at the end of the 20th century, and soon began to show the characteristics of "The Second Demographic Transition". The changing trends of Chinese women's fertility pattern shows similar characteristics of starting late and changing fast to the Demographic Transition, but there is a significant progressive difference between the two.

In 2000, the total fertility rate of China had dropped to 1.22, significantly lower than the replacement level. However, the Mean age at birth of Chinese women was less than 26 years old, with the Standard deviation in Mean age at birth of 4.2 years. The two indicators were not only significantly lower than the average level of relevant indicators in most developed countries during the same period, but also lower than the level of most developed countries in the 1970s. The process of change in women's fertility pattern significantly lagged behind Demographic Transition.

From 2000 to 2010, influenced by multiple factors such as economic and social development, the transformation of marriage and fertility culture, and the continuation of family

planning policy, the fertility pattern of Chinese women showed accelerating trends of change. The Mean age at birth and the Standard deviation in mean age at birth rapidly increased, and the range of change far exceeded that of developed countries in the same period. Especially, the Standard deviation in Mean age at birth of Chinese women reached 5.91 years in 2010, an increase of 1.71 years compared to 2000, surpassing the change range in most developed countries over the past 40 years. That also reflects that in the process of Chinese accelerating modernization, the mismatch among the national fertility policy, individual fertility desire and social fertility culture has become increasingly apparent. Under the mutual constraints of policy constraints with fertility demands, and mutual influences of traditional fertility culture with modern fertility values, the heterogeneity of women's child-bearing age has greatly enhanced, and the dispersion of fertility pattern has significantly increased.

From 2010 to 2020, with the continuous adjustment of Chinese fertility policy and gradually released policy restrictions on number of births, the changing trends of Chinese women's fertility pattern gradually approached the change mode of developed countries. The Mean age at birth of Chinese women continued to increase, but the growth rate slowed significantly. By 2020, the Mean age at birth of Chinese women was close to 29 years old, still lower than the average level of most developed countries. The changing trends of the Standard deviation in Mean age at birth of Chinese women has shifted from a rapid rise to a gradual decline, and the dispersion of fertility pattern has gradually moved closer to the average level of developed countries. The changing trends of this period also reflects that with the adjustment of fertility policy, Chinese women's fertility pattern has shifted from an unconventional change driven by the family planning policy to a more normal changing path.

5. Conclusions

First, from 2000 to 2020, the Chinese women's fertility pattern shows changing trends that the growth rate of the Mean age at birth turns from fast to slow, the dispersion of fertility pattern rises first and then falls, and the distribution of child-bearing age is overall postponed. The changing

trends of first-birth fertility pattern is substantially consistent with that of all women, and the postponement of the first-birth is the main reason for the overall postponement of child-bearing age. The adjustment of the national fertility policy has had a significant impact on the change of the second-birth fertility pattern. The Mean age at birth and the Standard deviation in mean age at birth of second-birth both shown a downward trend since 2010.

Secondly, compared to the changing process of women's fertility patterns in developed countries under low fertility level, the transformation of Chinese women's fertility pattern has shown characteristics of late start, rapid change, and great fluctuation. Before 2000, the Mean age at birth and the Standard deviation in mean age at birth of Chinese women were significantly lower than those of developed countries during the same period. From 2000 to 2020, the Mean age at birth of Chinese women experienced a growth process from high-speed to low-speed, but in 2020, it was still significantly lower than the average level of developed countries. The Standard deviation in mean age at birth of Chinese women has gone through a process from significant increase to gradual decrease, gradually tending towards and stabilizing at the average level of developed countries.

Thirdly, as a whole, the changes of Chinese women's fertility pattern are the result of a combination of factors such as economic and social development, improvement of the education system, adjustment of fertility policy, and transformation of fertility culture. Among them, the general increase in the years of education and the popularization of urban lifestyles constitute the fundamental driving force to postpone women's child-bearing age, while the adjustment of national fertility policy has greatly affected the changing trends of fertility pattern, leading to a turning point in the changing trends of the fertility pattern after 2010. After 2013, with the gradual release of the policy restrictions on the number of births, women with the desire to have multiple children no longer need to postpone their child-bearing time to comply rules on birth interval or bypass policy restrictions, which reduces the phenomenon of women giving birth at an elder age, advances the child-bearing time of second-birth generally, narrows the birth interval. And then, the trend of postponement in women child-bearing age was suppressed in a certain extent, and the central tendency of the distribution of women's child-bearing time was enhanced.

Fourthly, from the perspective of future changing trends, in the context of the continued extension of residents' education level and the continuous improvement of urbanization level, the child-bearing age of Chinese women will maintain an upward trend in the future. Meanwhile, with the implementation of the "comprehensive three child" policy, women's autonomy in child-bearing has further improved, the phenomenon of child-bearing at the age of 40 and above has continued to decrease. Therefore, in the future, there is a possibility of further reduction of both the birth interval and the Standard deviation in mean age of Chinese women, and the dispersion of fertility pattern will slightly decline in fluctuations.

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