Birth Seasonality of China in 1960-2017: Steps toward a convergence from a divergence

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Short abstract

Little research on birth seasonality has been done for China ,especially for the period after the implementation of family planning policies. We present an analysis of birth seasonality in China since 1960 by using various national representative data and demonstrate the difference between parities, urban and rural residence and mother's ethnicity across periods. Unlike the European and American birth seasonal models, China have a unique and significant feature of birth seasonality, with a peak in autumn and winter (October to February) and a trough in spring and summer (March to August). Since 1990, as a result of the implementation of family planning policy and the expansion of women's use of modern methods of contraception, seasonal birth patterns have changed dramatically and the average monthly birth amplitudes have gradually decreased. People's self-control is a key factor in explaining seasonal changes. In addition, the pronounced seasonality of first birth is robust, while the second birth and the third follow a less obvious seasonal pattern over time, indicating that higher order of births were more affected by self-driven intervention related to family planning policy. Furthermore, we confirmed the Chinese culture and the holiday effects as well as the family planning policies could alter people's reproductive behavior and contribute the shaping of birth timing of Chinese people.

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1 Introduction

Medical and biological studies have confirmed the close relationship between birth season and infant development and adult health. The birth season is correlated with the early development of the baby, but also related to adult development and health. For example, studies focusing on developed countries such as Australia, Israel, and the United States have revealed that winter-born babies in these countries score higher on cognitive tests and are heavier and heavier than those born in summer [1][2]. Another study found that American summer-born babies are often at a disadvantage in education when they become children[3][4]. More studies have shown that the seasonal dependence of early human developmental mechanisms may play a very important role in the risk of getting a disease in a person's later life: for example, a study based on electronic patient records in New York patients found that 55 diseases are related to the person's birth month[5] . British and Polish adults born in winter have a higher risk of Addison disease (primary adrenal insufficiency) than adults born in summer[6].

Human populations often exhibit seasonal variation in reproduction. Most European countries show seasonal variation that usually peak in the spring and are the lowest during the last quarter of the year. In contrast, most US states show patterns with high numbers of births during the summer and autumn, and low numbers of births during spring. Some countries, such as Israel, Australia, New Zealand and South Africa, show almost no seasonal variation in birth rates[7][8]. Seasonal birth patterns are relatively stable within a defined geographic area. Better understand the birth seasonality could contribute to the promotion of public health planning and the annual birth projections.

Seasonality of births has been extensively studied in North America, Europe, and East Asia but much less so in China setting. The existing research on birth seasonality in China has focused on small populations and/or short time and earlier periods, such as 1980s and 1990s. We will use a variety of data sources to analyze the birth seasonality of China in 1960-2017 and identify possible similarities and differences between the Chinese model and the US and European fertility season patterns. We aim to document birth seasonality in China in more detail than previously achieved considering the rapid socio-economic development and family planning policies alternations in recent decades. We use birth data from the national survey and birth registration system to

systematically document, test, and compare birth seasonality in China. We also examine the stability of birth seasonality over five decades. When possible, we disaggregate the data by parity, by urban or rural residence, by some socio-economic status to assess whether birth month is correlated with various aspects of family background.

2 Data source

We use the data from the National Fertility and Family Planning Sample Survey in 1988 and two untapped data sources—1) the 120 Counties Monitoring System (120 CMS) and 2) the Birth Registration System (BRS) to examine the trends of birth seasonality in 1960-2017. The National Fertility and Family Planning Sample Survey in 1988 has a sample of 2.16 million women in reproductive age. The 120 CMS data provided a complete coverage of births in 117 sites in 28 provinces with a total population of 128.4 million (9.4% of total China population), with only three provinces, Zhejiang, Yunnan and Tibet, not represented. The sites were selected to cover both urban and rural as well as more and less economically developed areas across China. The more recent BRS covers total China population and was established via the National Family planning data-sharing platform in 2014.

Each data source will contribute birth data for different years. Among them, the data of the national birth control sampling survey in 1988 will be used to obtain information about the birth from 1960 to 1986. The 120 CMS and the BRS will provide birth data for 1987-2014 and 2015-2017 respectively. To verify the reliability of birth patterns for each data source and consistency with other data sources, we compared birth monthly distribution with national statistical yearbooks and other publications. The comparison confirms the consistency of the monthly distribution pattern in the relevant year, and minimizes the estimation of the seasonal variation in birth due to the data itself.

3 Methods

In this paper, monthly birth rates are converted to birth amplitudes and the amplitude is defined as the percent deviation from the annual monthly mean, indexed at zero or 100. Other parameters of interest include peak and trough amplitudes and months and the shape of the birth distribution. We followed the methods in He and Earn (2007) to de-trend and scale the monthly birth data. The following equations were used:

The monthly number of births for month j in year i, represented by X_{ij}. Equation 1 represents the average number of births. Equation 2 defines the scaling factor, C_{ij}， , used to correct for the variation in month lengths. In equation 3, we define the scaled, month-length-corrected monthly amplitude Y_{ij}. Finally, equation 4 represents the average monthly amplitude over the periods, $Z_{j,}$ which was computed by averaging the monthly amplitudes across years Z_j（$N_{yr} = 10$）. We also calculated the maximum amplitude, defined as the maximum difference between the monthly amplitude and the mean.

$$\bar{X}_i = \frac{1}{12}\sum_{j=1}^{12} X_{ij} \quad (1)$$

$$C_{ij} = \frac{(\text{Days in year } i)/12}{\text{Days in month } j \text{ of year } i} \quad (2)$$

$$Y_{ij} = \frac{C_{ij}X_{ij} - \bar{X}_i}{\bar{X}_i} \quad (3)$$

$$Z_j = \frac{1}{N_{yr}}\sum_{j=i}^{i+9} Y_{ij} \quad (4)$$

4 Primary results

4.1 The differential in the birth seasonality by periods

The birth seasonal pattern in China differs from the European model and the American model. Overall, the monthly distribution is uneven and fluctuating. The birth in autumn and winter is significantly higher than that in spring and summer. The standardized number of births in October-December is 15-30% more than the average monthly number of birth for all the periods while births in April-June is about 10-20% less than the monthly average.

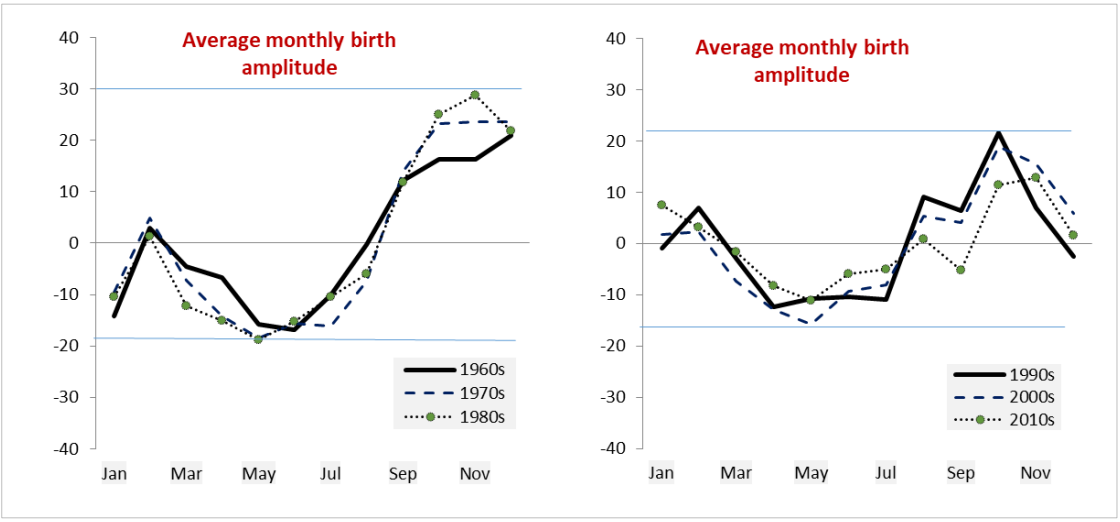


Figure1 Average monthly birth amplitude by periods

If we count back 9 months away from the month of births, we arrive with the seasonal distribution of the conception month (see the x-axis below Figure 1). The peak season of pregnancy is in December, January-May, and the trough is from June to October(Figure1). The theoretical explanation for this is that traditional Chinese culture has a strong influence on the seasonality of birth. The Chinese New Year is usually in January-February, indicating the existence of the similar "holiday effect" in China as the Christmas effect in western countries. The proportion of people who are pregnant during the May 1st (Labor's Day with one-week holiday for Chinese) and Spring

Festival is extremely high. According to the 1982 national 1% Fertility and Fecundity survey, the average female marriage peak month in the country from 1946 to 1981 was mainly concentrated in January, February, October to December[9]. The seasonal pattern of marriage timing (the same calculation method) is found that May, December, and January-February are the peak wedding periods, which is consistent with the seasonal pattern of pregnancy events.

Although the seasonality of birth in China has always maintained a clear pattern of winter peaks and summer troughs, it has gradually evolved over time. Specifically, the seasonal patterns of the 1960s, 1970s, and 1980s were similar, with a birth peak from October to December and a second birth peak in February with a birth amplitude of 30% while the birth trough is concentrated in May/June with a negative amplitude deviation up to 20%. Since the 1990s, the deviations of birth peak and trough are reduced respectively to around 10-20% and 10%. Not only does the amplitude changed, but the curve tends to be relatively even distribution with more births occurred in other months such as in August.

We further compare the period average monthly amplitude and the annual average monthly amplitude (see Figure 2). It was found that the average amplitudes in the 1960s, 1970s, and 1980s were around 15%, 13.9%, 15.1%, and 15.4%, respectively, but that of 1990s, 2000s and 2010s has fallen to 9%, 9.2% and 7.5%, further suggesting that the seasonal pattern of birth is gradually weakening.

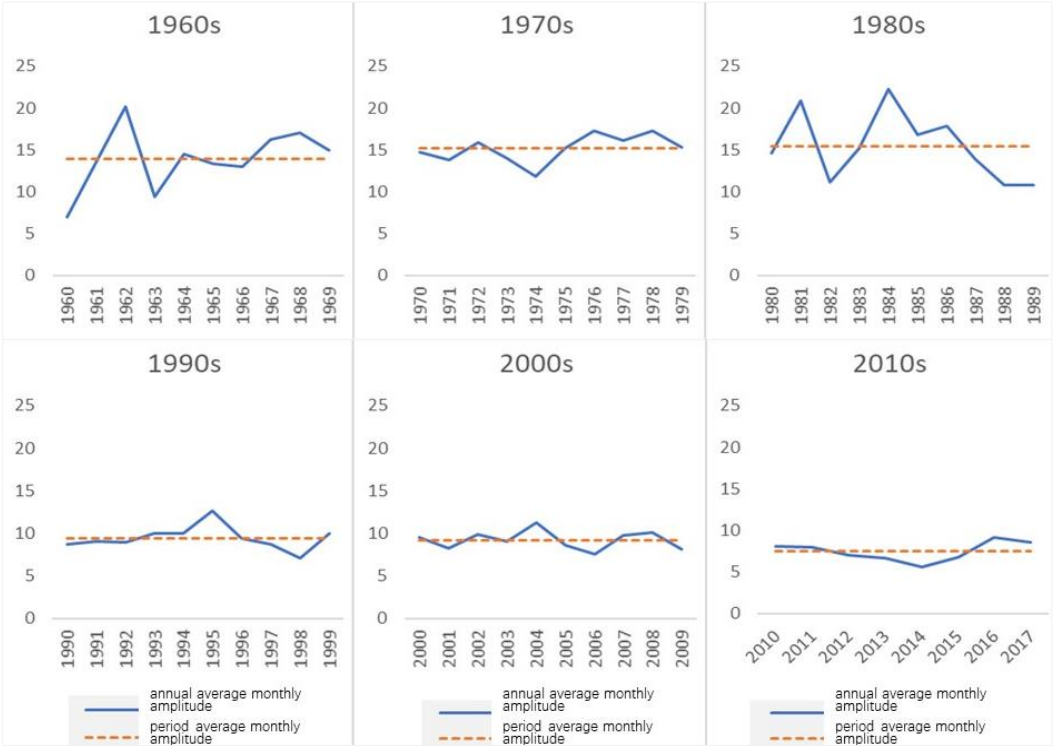


Figure2 Average annual and period monthly birth amplitude

Taking the changes in China's population and family planning policies into consideration, we find that the seasonal patterns of births are relatively stable, and the variation between years is relatively slight within a relatively stable family planning policy context (such as the 1970s, 1990s, 2000-2009), , while the fertility policy is changed frequently (the 1980s, 2014-2017), the seasonal patterns changed greatly, and the variation between years is large, revealing a certain degree of correlation between the seasonal pattern and the changes in the family planning policy.

It is also related to the level of contraception and long-term contraception in each period. The contraceptive level was lower in the 1960s (the total contraceptive rate was 4.3%), and in the 1970s (the total contraceptive rate was 30.8%), when people were mainly giving birth on a much more natural base. The seasonal pattern of birth across these periods were similar to each other due to fewer intentional intervention. However, with the implementation and popularity of the long-acting medical-controlled contraceptive measures such as intrauterine devices and sterilization in the 1980s, the contraceptive rate of married women has risen rapidly under the influence of national one-child policy supported by contraceptive use requirement. The total contraceptive rate has reached more than 85% with the long-acting contraceptive rate has been stable at around 77%. Since the 1990s, the comprehensive contraceptive rate has been higher than 90%. It could explain partially the weakening pattern of birth seasonality after 1990s.

4.2 Seasonal differentials by birth parity

The birth seasonal pattern by birth order has experienced the process of convergence, differentiation and re-convergence, among which the magnitude of the birth deviation in each period also changed. In the 1960s, the birth season patterns for all birth order were similarly following the October-February birth peak, and the summer birth trough. Since the 1970s, with the establishment of the National Family Planning Leading Group on July 16, 1973 and the implementation of the “Later, Longer, and Fewer” family planning policy in December of the same year, the government started to lower the number of second child and above with providing contraceptive methods by free. Although the seasonality of first child has remained relatively stable, the birth season pattern of higher birth orders began to appear slightly different. The amplitude of the birth in peak season for the second and the third births decreased, and that in the trough season also weakened. This trend even aggravated in the 1980s and in 1990s. In the context of strict implementation of family planning in the 1990s, the seasonal distribution of the second and the third births was completely the same, and there were three concentrated birth peaks in February, August and October, with an amplitude of about 10%. The differentiation of the high birth order seasonal pattern continued until 2009. Since 2010, the seasonal patterns of births of children have once again converged. However, compared with the monthly birth shift in the 1960s, there has been a sharp decline. Since 2010, the average monthly amplitude has not exceeded 10%. The seasonality of births has been weakened, and the monthly distribution has become more and more Evenly (Figure 3).

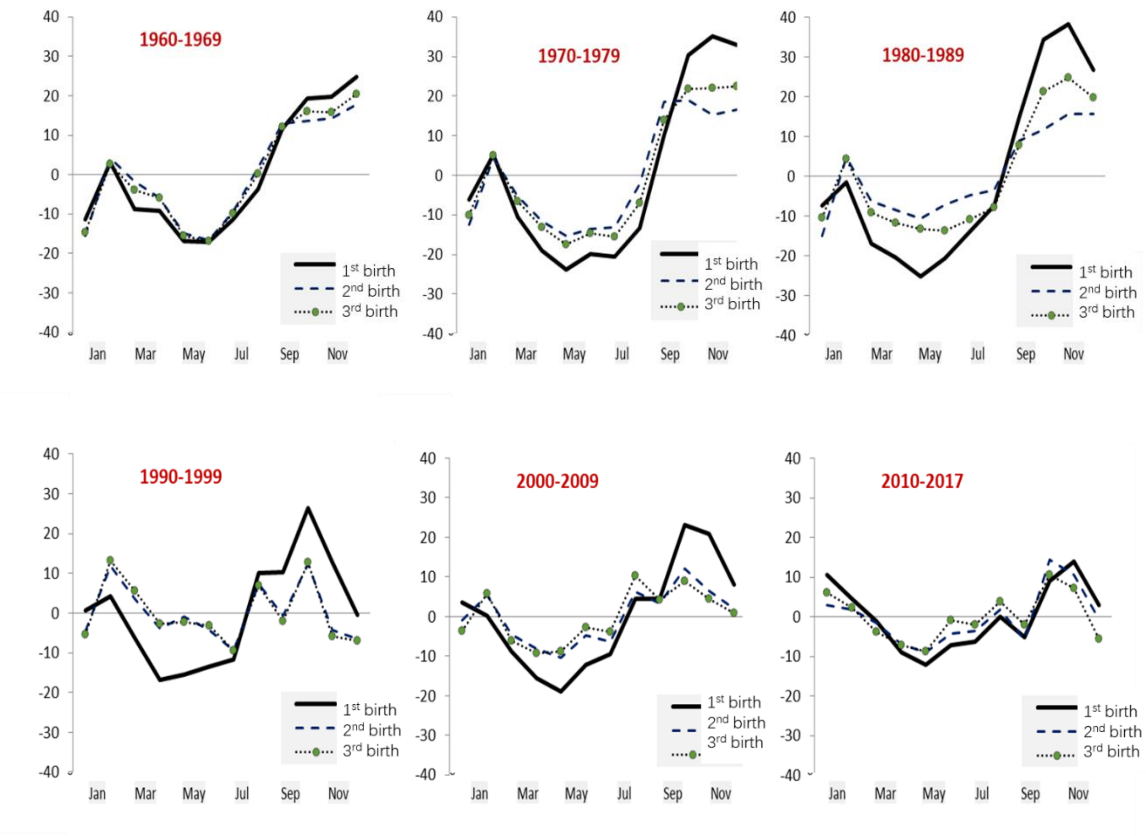


Figure3 Average monthly birth amplitude by periods and by parity

4.3 Seasonal differentials by birth parity and by ethinic groups

Due to the variables in the data source, the comparison between residence has to refer to the period in 1980 to 2014. We again captured the same trajectory for the divergence between first birth and the second birth at the earlier periods, and the convergence in the recent 2010s. The urban area displayed a fast convergence pace than rural, the seasonal pattern has came to same curve since 2000s while it was only happened in rural after 2000.

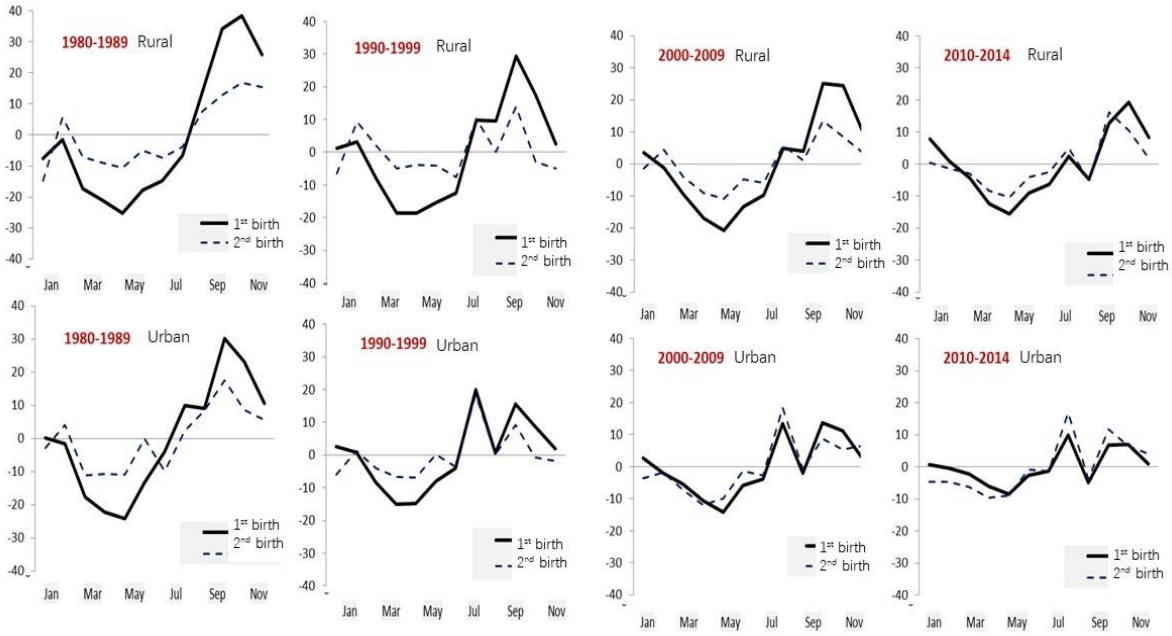
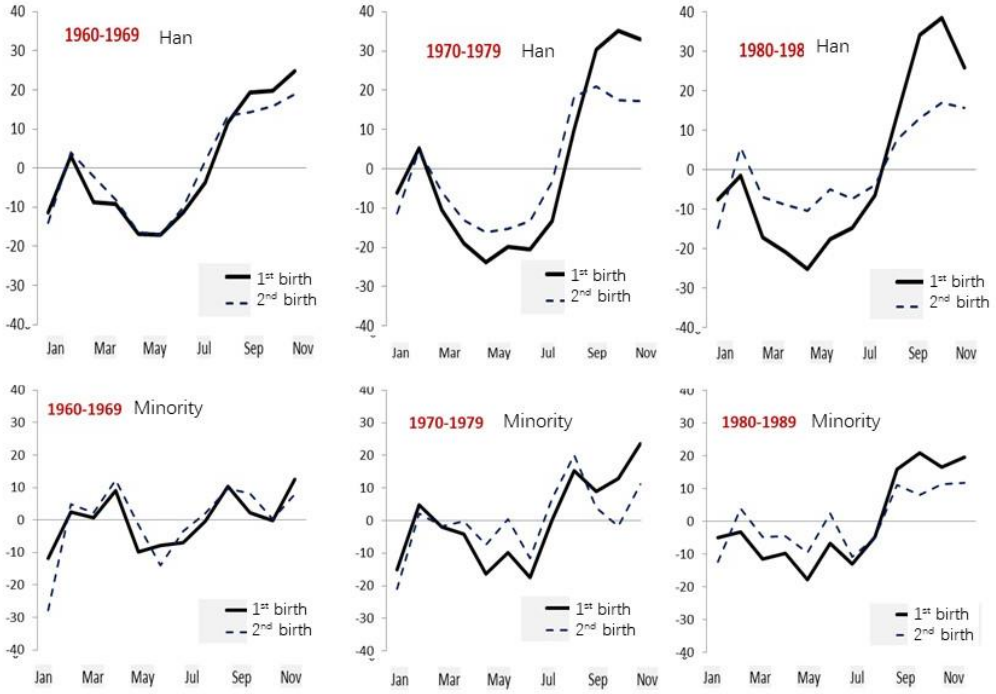


Figure3 Average monthly birth amplitude by periods and by residence

The seasonal birth pattern of the ethnic minorities kept quite remarkable stable across most of the periods and exhibited more birth peak month over a year (Figure 4), probably because that the ethic groups are entitled to have more births and even without limitation for the number of children they could have and that they mainly resident in tropical and subtropical area.



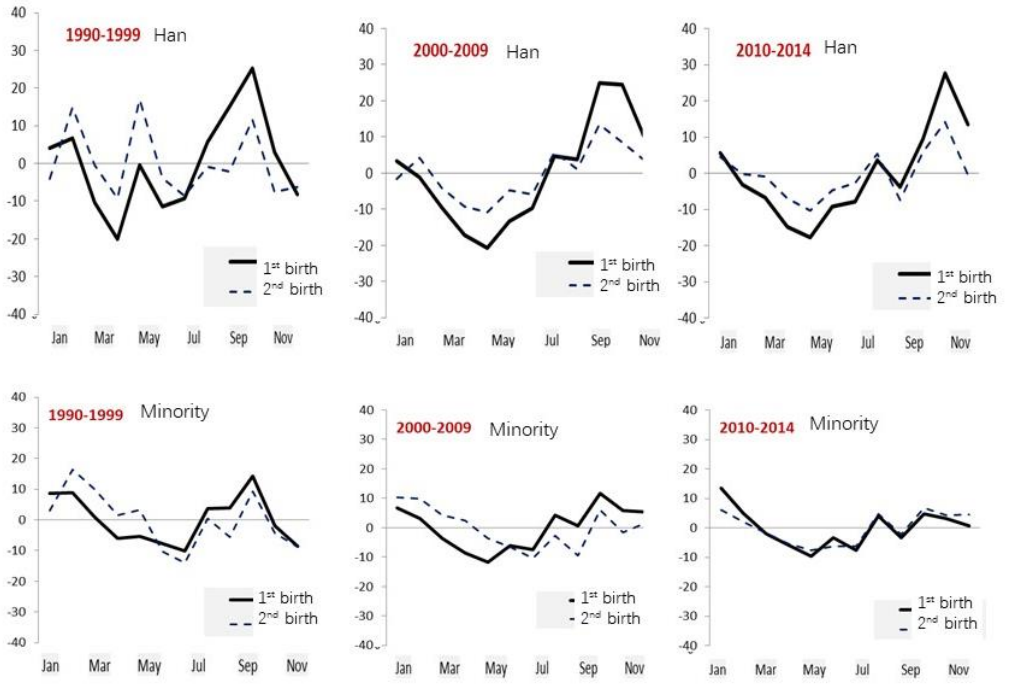


Figure4 Average monthly birth amplitude by periods and by ethnic group

4.4 The sensetive reaction to family planning policy changes

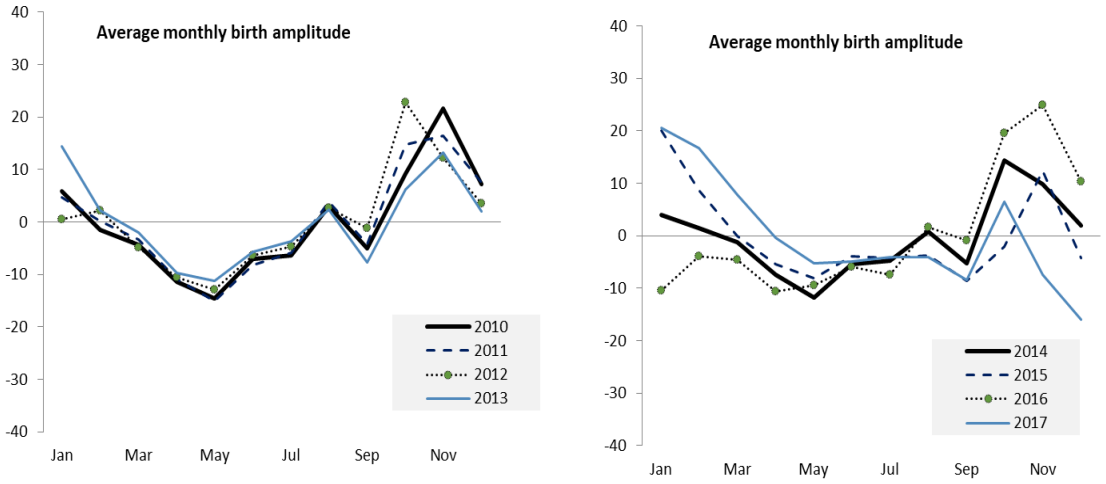


Figure5 Average monthly birth amplitude before and after recent family planning policy changes

Before the recent selective two child policy in 2014 and the universal two child policy in 2016, the birth seasonality since 2010-2013 is dominated by a peak in October to November and the amplitude difference for other months is too slightly differ to be ignore. However, after the consecutive policy changes since 2014, the seasonal birth curve evolved drastically year by year with more birth happened in the months used to be the trough, such as March, April, and the differential of monthly average amplitude across years increased, implying people's promote response to these new policy changes.

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