ACCSCIENCE PUBLISHING

International Journal of Population Studies

RESEARCH ARTICLE

Fertility by parity in China in the context of changing fertility policy

Supplementary File

Supplementary information 1

Description of the calculation of PPTFR:

x : Age reached during the year.
r : Number of children already born.
$q(x,r)$: The probability of a birth at parity r and x age.
$N(x,\mathrm{r})$: The number of women aged x, of parity r at the beginning of the year, thus at risk of having a child of order $r+1$, given that x varies from 15 to 50 and r from 0 to 5. (In the initial paper (Rallu and Toulemon, 1994) the highest order was set as 10. Given the low fertility level in China, there are extremely low proportions of orders higher than 5, indicating the estimates for order 5 or higher would have little effect on aggregate fertility. Thus, we take the order 5 as the high end.)

$N(x)=\sum N(x,\mathrm{r})=N$: number of women at each age, supposed constant.

Let $N(15,0)=1000$ (1)

For $x\geq 16, r=0$

$$N(x,0)=N(15,0)\prod_{15\leq y<x}\left[1-q(y,1)\right] \tag{2}$$

For $x\geq 16, r\geq 1$

$$N(x,\mathrm{r})=\sum_{15\leq y<x}\left\{N(y,r-1)q(y,r)\right\}\prod_{y<z<x}\left[1-q(z,r+1)\right] \tag{3}$$

Equation (1) corresponds to the initial population: at age 15, at the beginning of year, no woman has had a child. Equation (2) represents the "survivors" of the parity-1 fertility schedule: the women aged x who have no children at the beginning of year are those who have had no births at previous ages. Equation (3) defines the women aged x having r children as women who have had a child of order r at an age younger y than x, and who have had no children since. If $x\leq 15+r$, then $N(x,\mathrm{r})=0$.

The population at age 50 $N(50,\mathrm{r})$ gives the ultimate parity distribution of the synthetic cohort. They permit the constructing of the usual indicators:

For $1\leq r\leq 5$

$$PPTFR(r)=\frac{1}{N}\sum_{s\geq r}N(50,s) \tag{4}$$

$$PPTFR=\sum_{r}PATFR(r)=\frac{1}{N}\sum_{r}rN(50,r) \tag{5}$$

Equation (4) defines period fertility for each birth order r as the proportion of women who, having lived their entire life under "current conditions," have borne at least r children, that is, one child or order r . Equation (5) represents the summary index of parity-age-specific fertility, expressed in children per woman.

Supplementary information 2

Description of the decomposition of cohort fertility changes attributable to changing parity-progression ratios:

The cohort fertility level is measured by the cohort cumulative fertility rate ($CCFR$). For each birth cohort analyzed, the CCFR can be defined as the sum of parity-specific. $CCFR_i$

$$CCFR = \sum_i CCFR_i \tag{1}$$

Where $CCFR_i$ is the average number of children of birth order i born to women from a given cohort.

The parity progression ratios to first births and to higher birth orders are given as:

$$PPR_{0,1} = CCFR_1 , \tag{2}$$

$$PPR_{i-1,i} = \frac{CCFR_i}{CCFR_{i-1}} , \quad i > 1 , \qquad 3)$$

It also holds that:

$$CCFR_i = \prod_{j=1}^{i} PPR_{j-1,j} \tag{4}$$

The difference between CCFR in initial cohort $c1$ and $c2$ is expressed as:

$$CCFR^{c2} - CCFR^{c1} = \sum_i \left[\left(\frac{CCFR_i^{c2}}{CCFR_i^{c1}} - \frac{CCFR_{i+1}^{c2}}{CCFR_{i+1}^{c1}} \right) \sum_j CCFR_j^{c1} \right] \tag{5}$$

The relationship between completed cohort fertility rate and parity progression ratios is expressed as:

$$\begin{aligned} CCFR &= PPR_{0,1} + PPR_{0,1} * PPR_{1,2} + PPR_{0,1} * PPR_{1,2} * PPR_{2,3} \\ &+ PPR_{0,1} * PPR_{1,2} * PPR_{2,3} * PPR_{3,4} + PPR_{0,1} * PPR_{1,2} * PPR_{2,3} \\ &* PPR_{3,4} * PPR_{4,5} + \cdots + PPR_{0,1} * PPR_{1,2} * PPR_{2,3} * PPR_{3,4} \\ &* PPR_{4,5} * PPR_{5,6} * PPR_{6,7} * PPR_{7,8} * \frac{PPR_{8,9+}}{(1 - PPR_{8,9+})} \end{aligned} \tag{6}$$

It should be noted that in the initial research, the author combined data on fourth and further births together, computing an indicator of progression rate from third and higher-order births to the fourth and higher births (Zeman, Beaujouan, Brzozowska, *et al.*, 2018). In this study, we extend that the birth order to ninth due to progression rate in higher orders is large in earlier period of China. Correspondingly, data on ninth and further births were combined together, an indicator of progression rate from eighth and higher-order births to the ninth and higher births was computed.

Under the condition of fixed $PPR_{1,2}$ and higher, the completed cohort fertility rate is computed as:

$$\begin{aligned} CCFR_{fixPPR1+}^{c1,c2} &= PPR_{0,1}^{c2} + PPR_{0,1}^{c2} * PPR_{1,2}^{c1} + PPR_{0,1}^{c2} * PPR_{1,2}^{c1} \\ &* PPR_{2,3}^{c1} + PPR_{0,1}^{c2} * PPR_{1,2}^{c1} * PPR_{2,3}^{c1} * PPR_{3,4}^{c1} * PPR_{4,5}^{c1} \\ &+ PPR_{0,1}^{c2} * PPR_{1,2}^{c1} * PPR_{2,3}^{c1} * PPR_{3,4}^{c1} * PPR_{4,5}^{c1} * PPR_{5,6}^{c1} \\ &* PPR_{6,7}^{c1} * PPR_{7,8}^{c1} * \frac{PPR_{8,9+}^{c1}}{1 - PPR_{8,9+}^{c1}} \end{aligned} \tag{7}$$

Completed cohort fertility rate under the condition of fixed $PPR_{2,3}$ and higher is computed as:

$$\begin{aligned} CCFR_{fixPPR2+}^{c1,c2} &= PPR_{0,1}^{c2} + PPR_{0,1}^{c2} * PPR_{1,2}^{c2} + PPR_{0,1}^{c2} * PPR_{1,2}^{c2} \\ &* PPR_{2,3}^{c1} + PPR_{0,1}^{c2} * PPR_{1,2}^{c2} * PPR_{2,3}^{c1} * PPR_{3,4}^{c1} + PPR_{0,1}^{c2} \\ &* PPR_{1,2}^{c2} * PPR_{2,3}^{c1} * PPR_{3,4}^{c1} * PPR_{4,5}^{c1} + PPR_{0,1}^{c2} * PPR_{1,2}^{c2} \\ &* PPR_{2,3}^{c1} * PPR_{3,4}^{c1} * PPR_{4,5}^{c1} * PPR_{5,6}^{c1} * PPR_{6,7}^{c1} * PPR_{7,8}^{c1} * \frac{PPR_{8,9+}^{c1}}{1 - PPR_{8,9+}^{c1}} \end{aligned} \tag{8}$$

Using these results, we compute the contribution of changes in each parity-progression ratio $dPPR_{t-1,i}^{c1,c2}$, to the overall change in completed cohort fertility rate.

$$dPPR_{0,1}^{c1,c2} = CCFR_{fixPPR1+}^{c1,c2} - CCFR^{c1} \tag{9}$$

$$dPPR_{1,2}^{c1,c2} = CCFR_{fixPPR2+}^{c1,c2} - CCFR_{fixPPR1+}^{c1,c2} \tag{10}$$

$$dPPR_{2,3}^{c1,c2} = CCFR^{c2} - CCFR_{fixPPR2+}^{c1,c2} \tag{11}$$

Supplementary information 3

Table S1. TFR and PPTFR in China, 1949–2020.

Year	TFR					PPTFR			
	1982 fertility survey	1988 fertility survey	1997 and 2001 fertility survey	2017 fertility survey (adjective)	Census/ population sample survey (adjective)	1982 fertility survey	1988 fertility survey	1992 fertility survey	2017 fertility survey
1949	6.14								
1950	5.81								
1951	5.70								
1952	6.47								
1953	6.05								
1954	6.28								
1955	6.26					6.33			
1956	5.85					5.98			
1957	6.41					6.37			
1958	5.68					5.83			
1959	4.30					4.27			
1960	4.02					3.63			
1961	3.29					2.83			
1962	6.02					5.78			
1963	7.40					7.16			
1964	6.08					6.52			
1965	6.96					5.96			
1966	6.17					5.75			
1967	5.23					4.98			
1968	6.33					5.68			
1969	5.64					5.41			
1970	5.71					5.43			
1971	5.34					5.08			
1972	4.86					4.73			
1973	4.45					4.37			
1974	4.08					4.14			
1975	3.51					3.73			
1976	3.18					3.47			
1977	2.78					3.23			
1978	2.68	2.77				3.16	2.94		
1979	2.73	2.81				3.20	2.91		
1980	2.25	2.31				2.70	2.47	2.57	
1981	2.65	2.61			2.61	2.65	2.57	2.53	
1982		2.86					2.67	2.59	
1983		2.41					2.31	2.39	
1984		2.33					2.26	2.28	
1985		2.17					2.16	2.28	
1986		2.40			2.41		2.36	2.43	

(Cont'd...)

Table S1. ***(Continued).***

Year	TFR					PPTFR			
	1982 fertility survey	1988 fertility survey	1997 and 2001 fertility survey	2017 fertility survey (adjective)	Census/ population sample survey (adjective)	1982 fertility survey	1988 fertility survey	1992 fertility survey	2017 fertility survey
1987		2.57					2.48	2.50	
1988								2.29	
1989					2.25			2.25	
1990			2.29					2.10	
1991			1.77					1.76	
1992			1.59					1.66	
1993			1.52						
1994			1.41						
1995			1.45		1.43				
1996			1.36		1.55				
1997			1.27		1.46				
1998			1.34		1.46				
1999			1.29		1.45				
2000			1.45	1.66	1.66				1.51
2001				1.62	1.62				1.51
2002				1.58	1.57				1.52
2003				1.54	1.55				1.48
2004				1.54	1.55				1.63
2005				1.56	1.58				1.62
2006				1.52	1.54				1.65
2007				1.52	1.54				1.69
2008				1.52	1.53				1.70
2009				1.48	1.49				1.69
2010				1.46	1.47				1.66
2011				1.62	1.62				1.63
2012				1.79	1.79				1.75
2013				1.61	1.61				1.61
2014				1.73	1.74				1.69
2015				1.51	1.53				1.53
2016				1.73	1.76				1.73
2017				1.64	1.68				1.69
2018					1.49				
2019					1.48				
2020					1.30				