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Descriptive Finding

Trends in cohort fertility among Chinese women

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Contents

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Abstract

BACKGROUND
China's continuous decline in births has attracted scholarly and policy attention. However, total fertility rates are affected by tempo effects and may not accurately reflect the underlying fertility level.

OBJECTIVE
We examine cohort trends in childlessness and the number of children ever born (CEB) among Chinese women, focusing on fertility postponement, recuperation, and the effects of structural changes.

METHODS
Using nationally representative data, we calculate age-specific childlessness proportions and the number of CEB by cohort. We analyze fertility postponement and recuperation, and employ decomposition techniques to assess how age-parity-specific progression ratios, urban–rural composition, and educational structure contribute to cohort fertility differences.

RESULTS
Childlessness has increased across cohorts, while CEB has declined. The rise in childlessness is stronger among urban and more educated women, whereas the decline in CEB is greatest among rural and less educated women. Fertility postponement has intensified, while recuperation has weakened. Decomposition shows that increased childlessness is primarily driven by reduced first-birth progression at younger reproductive ages, while the decline in CEB is largely attributed to shifts in women's urban–rural and educational composition.

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CONCLUSIONS
Childlessness has risen and fertility levels have declined, with differences across urban–rural and educational groups. These patterns highlight the need to consider social and structural factors in policies aimed at supporting fertility.

CONTRIBUTION
This study provides a systematic cohort-based analysis of childlessness and fertility trends in China, providing valuable empirical evidence on cohort fertility.

1. Introduction

China's number of annual births has dropped dramatically, from 12 million in 2020 (OLG 2022) to just 9.02 million in 2023 (NBS 2024), and the total fertility rate (TFR) declined from 1.3 in 2020 to approximately 1.0 in 2023. Since the period fertility indicator is biased due to the tempo effect, some studies have attempted to examine China's fertility change with cohort indicators – for example, using national and provincial proportions of childlessness based on 2020 population census data (Jiang et al. 2023) or data for Shanghai specifically (Chen 2023), or looking at the number of children ever born (CEB) for women aged 45–49 (Yang, Jiang, and Sánchez-Barricarte 2022) or for women in the seven northern provinces using the 2017 China Fertility Survey (Wang, Ma, and Li 2019).

Both the proportion of childlessness and the number of CEB are influenced by birth postponement and recuperation, but the extent of the effect remains unclear. In some cases, although women are delaying their first births, cohort fertility has remained stable or declined only slightly due to strong recuperation in second and higher-order births (Sobotka et al. 2011; Castro 2015; Nitsche and Brückner 2021). In other cases, postponement has led to a marked decline in cohort fertility, as recuperation at later reproductive ages has been insufficient (Beaujouan, Zeman, and Nathan 2023; Hwang 2023). In these contexts, the postponement of marriage and childbearing is associated with a reduction in the number of births and a higher incidence of childlessness (Lee et al. 2020; Yang, Jiang, and Sánchez-Barricarte 2022; Kwon and Sohn 2023).

The increase in the childlessness proportion and the decline in the CEB number result from shifts in the fertility trajectory. Changes in parity progression ratios are a key factor contributing to fertility decline, both for period fertility indicators (Andreev, Shkolnikov, and Begun 2002) and cohort indicators (Zeman et al. 2018). The age profile is often neglected when studying the parity progression ratio as a fertility indicator. In China, recent evidence shows that reduced progression to first births among women aged 20 to 34 contributes more to fertility decline than reductions in higher-order births (Ren et al. 2024). It is important to include age in the analysis of fertility trajectories and to examine the impact of early fertility decline on the childlessness proportion and the number of CEB.

Structural changes in education and residence have contributed to shifts in cohort fertility levels. The expansion of higher education has increased the number of individuals with higher education, from 16.87 million in 2000 to 105.36 million in 2020. In some countries, the educational gradient in cohort fertility has nearly disappeared among younger cohorts (Yoo 2014; Jalovaara et al. 2019). In others, a widening gap in completed fertility has been observed (Berrington, Stone, and Beaujouan 2015; Gray and Evans 2019). As China continues to urbanize rapidly and women's educational attainment rises, it is essential to further investigate how structural shifts in education are driving changes in cohort fertility.

In this paper, using 2017 China Fertility Survey data, we briefly describe trends in childlessness proportion and the average number of CEB, analyze patterns of fertility postponement and recuperation and their impact on childlessness and CEB, examine the effect of changes in age-parity-specific progression ratios on childlessness proportion and the number of CEB, and evaluate the contributions of changes in urban–rural composition and educational structure to overall differences in cohort fertility. Through this systematic and detailed analysis of cohort fertility among Chinese women born between 1957 and 1987, we aim to offer new insights into the evolving demographic landscape.

2. Data and methods

2.1 Data

This study utilizes data from the 2017 China Fertility Survey, which covered a nationally representative sample of 249,946 women aged 15 to 60. The survey collected detailed information on women's fertility histories, including the end date and outcome of each pregnancy (live birth, stillbirth, abortion, or miscarriage), providing a comprehensive basis for analyzing cohort fertility patterns among Chinese women. Post-enumeration quality checks and data verification confirmed the high quality of the dataset (Zhuang et al. 2019). We excluded women who gave birth before age 10 or after 50, those whose first marriage occurred before age 10, and cases with missing information on age at marriage or childbearing. All analyses applied post-stratification weights to ensure national representativeness.

2.2 Methods

2.2.1 Childlessness proportion and average number of CEB

The number of CEB for each parity at age x for women in cohort a is denoted as $CEB_{par}^{a}(x)$, and the average number of CEB at age x is $CEB^{a}(x)$, where

$$CEB^{a}(x) = \sum_{par} CEB_{par}^{a}(x) = \sum_{par} \sum_{j=\sigma}^{x} \frac{B_{par}^{a}(j)}{TP^{a}} \quad (1)$$

TP^{a} denotes the total number of women in cohort a, $B_{par}^{a}(j)$ denotes the number of parity-order births to women in the cohort at age j, and σ denotes the minimum childbearing age. The childlessness proportion for cohort a at age x is calculated as:

$$P^{a}(x) = 1 - \sum_{j=\sigma}^{x} \frac{B_{1}^{a}(j)}{TP^{a}} = 1 - CEB_{1}^{a}(x) \quad (2)$$

2.2.2 Fertility postponement and recuperation

Fertility postponement and recuperation can be measured by comparing the age-specific average number of CEB between the observed and benchmark cohorts.

Let *m* denote the age at the maximum absolute difference in age-specific average number of CEB between the observed cohort *a* and the benchmark cohort *b*. The degree of postponement by parity can then be expressed as:

$$D_{par}^{a}(m) = CEB_{par}^{a}(m) - CEB_{par}^{b}(m) \quad (3)$$

The fertility recuperation by parity after postponement at age n is calculated as:

$$R_{par}^{a}(n) = CEB_{par}^{a}(n) - CEB_{par}^{b}(n) - D_{par}^{a}(m) \quad (4)$$

For first births, the degree of postponement is the difference between the two childlessness proportions:

$$\begin{aligned} D_{1}^{a}(m) &= CEB_{1}^{a}(m) - CEB_{1}^{b}(m) \\ &= \left[1 - P^{a}(m)\right] - \left[1 - P^{b}(m)\right] \\ &= P^{b}(m) - P^{a}(m) \end{aligned} \quad (5)$$

2.2.3 Effect of changes in age-parity-specific progression ratio

Let $q_{par}^{a}(x)$ denote the age-parity-specific progression ratio (APSPR) for women by exact age x with $par-1$ children in cohort a who gave birth to the par order births during the age interval $[x, x+1)$. Starting from the minimum childbearing age σ, the childlessness proportion and average number of CEB for first-order births (CEB1) at age ω for cohort a are:

$$P^{a}(\omega) = \prod_{j=\sigma}^{\omega}[1 - q_1^{a}(j)] = 1 - CEB_1^{a}(\omega)$$

$$CEB_1^{a}(\omega) = \sum_{x=\sigma}^{\omega}\left\{q_1^{a}(x)\prod_{j=\sigma}^{x-1}[1 - q_1^{a}(j)]\right\} \qquad (6)$$

Using the stepwise replacement method, the contribution of changes in the APSPR to first birth (APSPR1) at age x to the overall difference in childlessness proportion at age ω between two cohorts is calculated as:

$$\Delta_1^{a-b}(x) = \prod_{n=\sigma}^{x-1}[1 - q_1^{a}(n)] \times [q_1^{b}(x) - q_1^{a}(x)] \times \prod_{x+1}^{\omega}[1 - q_1^{b}(n)] \qquad (7)$$

The contribution of changes in APSPR1 at age x to the overall difference in the average number of CEB1 at age ω between two cohorts is:

$$\delta_1^{a-b}(x) = \prod_{n=\sigma}^{x-1}[1 - q_1^{a}(n)] \times [q_1^{a}(x) - q_1^{b}(x)] \times$$

$$\left\{1 - \sum_{j=x+1}^{\omega}\left(q_1^{b}(j)\prod_{k=x+1}^{j-1}[1 - q_1^{b}(k)]\right)\right\} \qquad (8)$$

To eliminate the effect of the two replacement directions, the final age-specific components are calculated as the average:

$$\Delta_1(x) = \frac{1}{2} \times [\Delta_1^{a-b}(x) - \Delta_1^{b-a}(x)]$$

$$\delta_1(x) = \frac{1}{2} \times [\delta_1^{a-b}(x) - \delta_1^{b-a}(x)] \qquad (9)$$

The average number of CEB for second-order births (CEB2) for the cohort a at age ω is:

$$CEB_2^a(\omega) = \sum_{x=\sigma}^{\omega}\left\{q_2^a(x)\sum_{n=\sigma}^{x-1}\left(q_1^a(n)\prod_{j=\sigma}^{n-1}[1-q_1^a(j)]\prod_{k=n+1}^{x-1}[1-q_2^a(k)]\right)\right\} \qquad (10)$$

With the stepwise replacement method, we computed the final contributions of changes in APSPR1 and APSPR2 to the total difference in the average number of CEB2 between two cohorts at age ω as $\delta_1^{'}(x)$ and $\delta_2^{'}(x)$, respectively, and $\delta_1^{'}(x)$ and $\delta_2^{'}(x)$ sum to the total difference in the average number of CEB2 between two cohorts: $\delta_2(x)$.

2.2.4 Effect of changes in urban–rural and educational structures

Let i denote the residence of women (urban or rural) and e denote women's education level. The difference in the average number of CEB between two cohorts by a specific age can be decomposed as:

$$\begin{aligned} CEB^a - CEB^b = & \sum_{par}\sum_{i}\sum_{e}\left(U_i^a - U_i^b\right)\times\frac{E_{i,e}^a \times F_{par,i,e}^a + E_{i,e}^b \times F_{par,i,e}^b}{2} \\ & +\sum_{par}\sum_{i}\sum_{e}\left(E_{i,e}^a - E_{i,e}^b\right)\times\frac{U_i^a \times F_{par,i,e}^b + U_i^b \times F_{par,i,e}^a}{2} \\ & +\sum_{par}\sum_{i}\sum_{e}\left(F_{par,i,e}^a - F_{par,i,e}^b\right)\times\frac{U_i^a \times E_{i,e}^a + U_i^b \times E_{i,e}^b}{2} \end{aligned} \qquad (11)$$

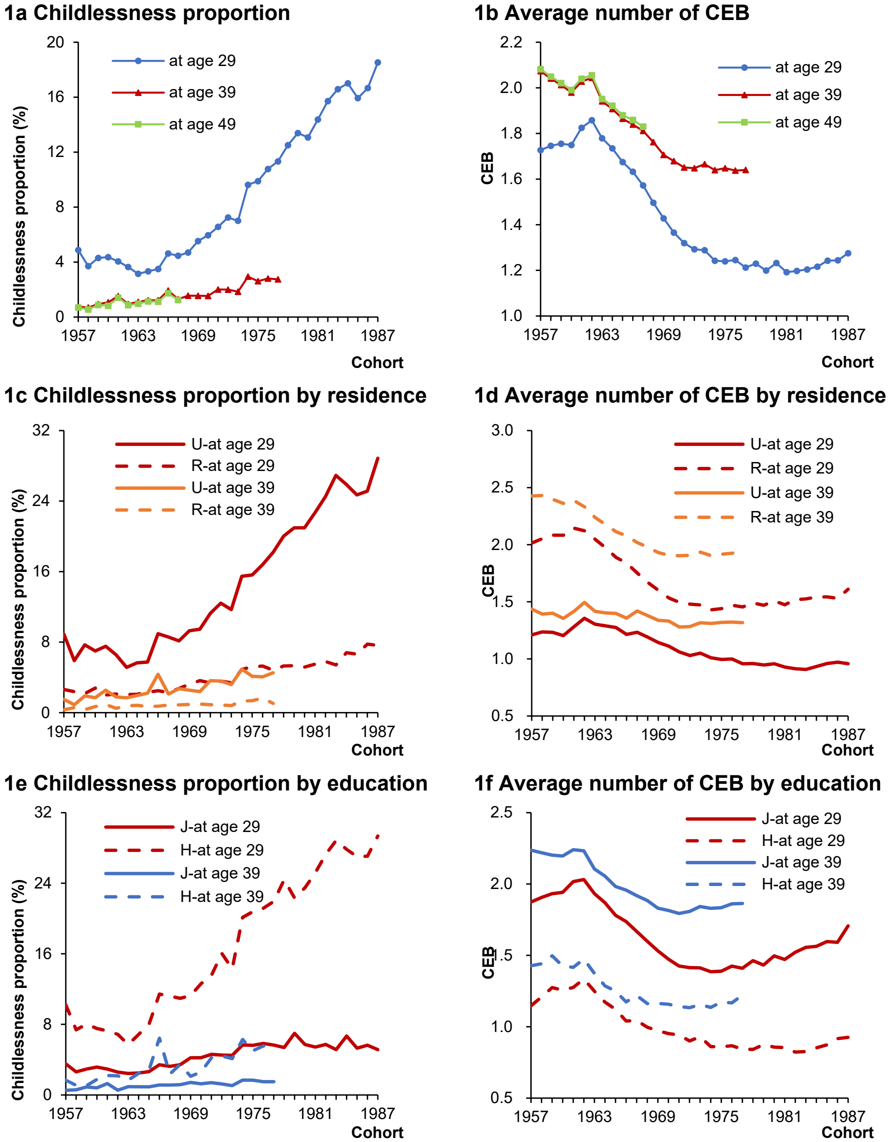
The three terms on the right of Equation (11) denote the contributions of changes in women's urban–rural population structure (U), residence-specific educational structure (E), and residence/education-specific average number of CEB (F), respectively.

3. Results

3.1 Overall trend of cohort fertility level

Over time, the childlessness proportion at specific ages has increased while the average number of CEB has declined at ages 29, 39, and 49, as shown in Panels 1a and 1b of Figure 1.

Figure 1: Childlessness proportion and average number of CEB



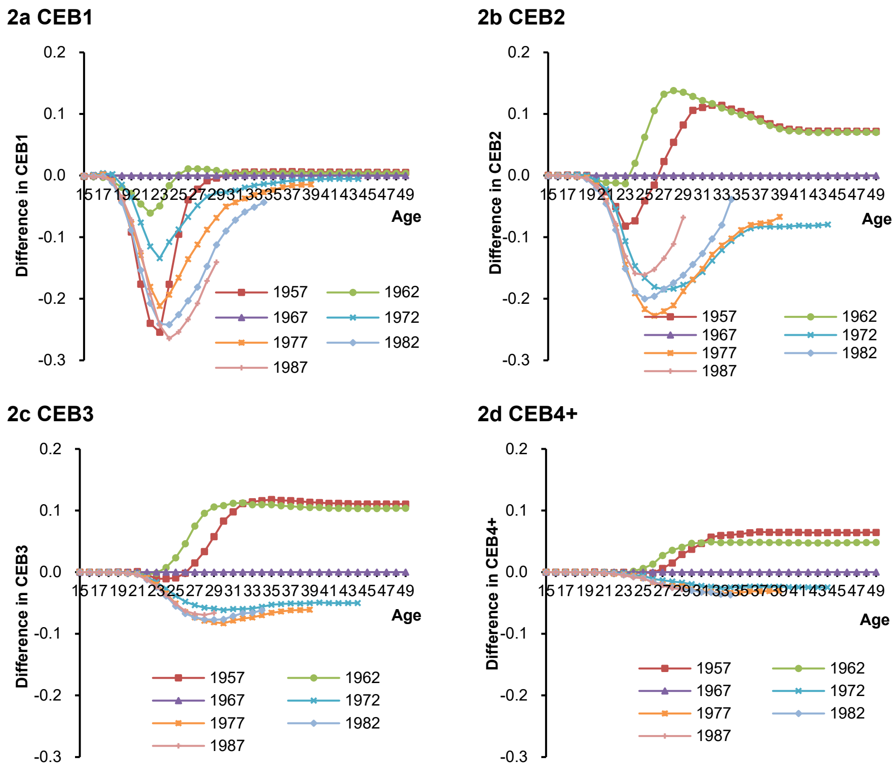
Note: U and R represent urban and rural areas, respectively. J and H represent junior middle school education or below and high school education or above, respectively.

Urban women exhibited higher childlessness proportions at all observed ages, while rural women consistently had a higher number of CEB, as depicted in Panels 1c and 1d. Panels 1e and 1f illustrate that more educated women consistently showed higher rates of childlessness and lower fertility. Across cohorts, the increase in childlessness was most pronounced among more educated women.

3.2 Fertility postponement and recuperation

First-birth postponement has increased across cohorts, as shown in Panel 2a of Figure 2. Compared to the 1967 cohort, the curves of differences in the age-specific CEB1 show a rightward shift for later birth cohorts. Furthermore, the absolute peak value of this curve increases across successive cohorts, and the recuperation occurs later and to a lesser extent, suggesting a deepening postponement and weakened recuperation among later birth cohorts. Similar postponement patterns are observed for second and higher-order births, as shown in Panels 2b–2d of Figure 2. Compared to the 1967 cohort, the overall recuperation of higher-order births has weakened across cohorts, and much of the postponement remains uncompensated.

Figure 2: Fertility postponement and recuperation by birth order

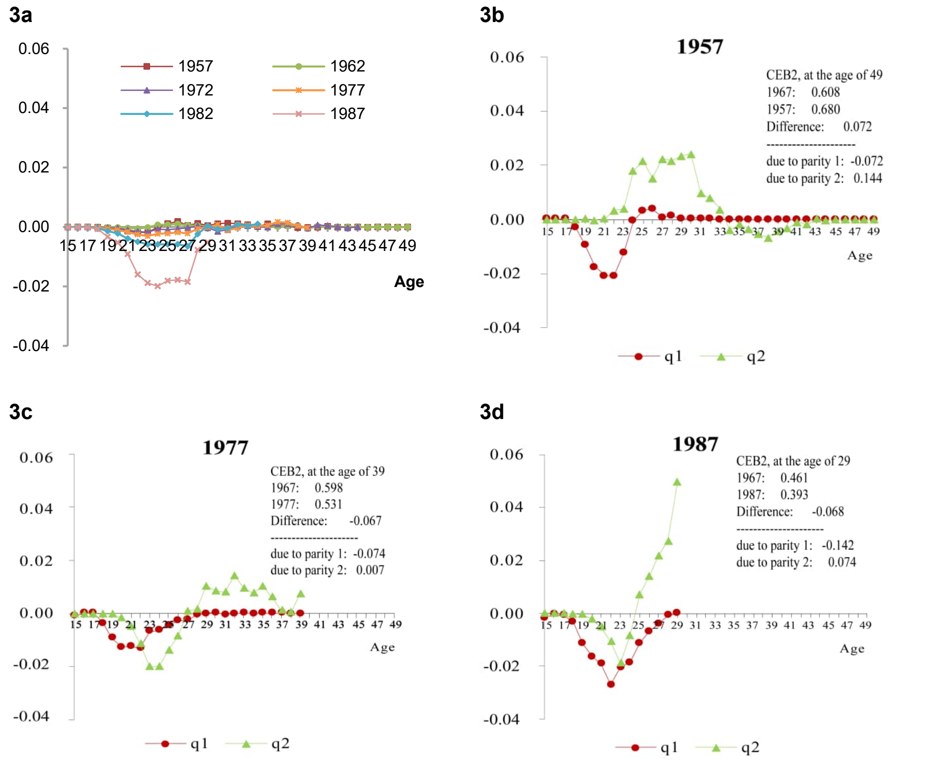


3.3 Effect of changes in age-parity-specific progression ratio

3.3.1 Effect on changes in childlessness proportion and average number of CEB1

A consistent decline in APSPR1 at younger reproductive ages has contributed to a rising childlessness proportion across cohorts, with the primary contribution coming from reductions in APSPR1 between ages 18 and 29, as shown in Panel 3a of Figure 3.

Figure 3: Effects of changes in APSPR on changes in cohort childlessness proportions and average numbers of CEB1 and CEB2



Notes: Panel 3a shows the effect of changes in APSPR1 on the cohort childlessness proportion and the average number of CEB1; Panels 3b–3d show the effects of changes in APSPR1 and APSPR2 on the cohort average number of CEB2; q1 and q2 represent the effects of changes in APSPR1 and APSPR2, respectively.

3.3.2 Effect on changes in average number of CEB2

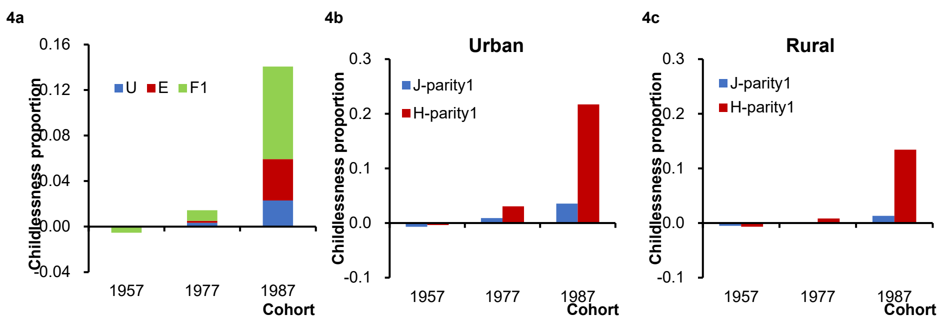
The decline in the average number of CEB2 across cohorts is primarily driven by the reduction in APSPR1 at younger ages. Among earlier cohorts, such as the 1957 cohort, lower APSPR1 at younger ages was offset by a rapid increase after age 23 and consistently higher APSPR2 up to age 34, resulting in higher CEB2 by age 49 compared to the 1967 cohort. However, later cohorts experienced larger reductions in APSPR1, and they were greater than the changes in APSPR2, indicating that higher-order recuperation was insufficient to counteract earlier delays in first births.

3.4 Effect of changes in urban–rural and educational structures

3.4.1 Effect on changes in childlessness proportion

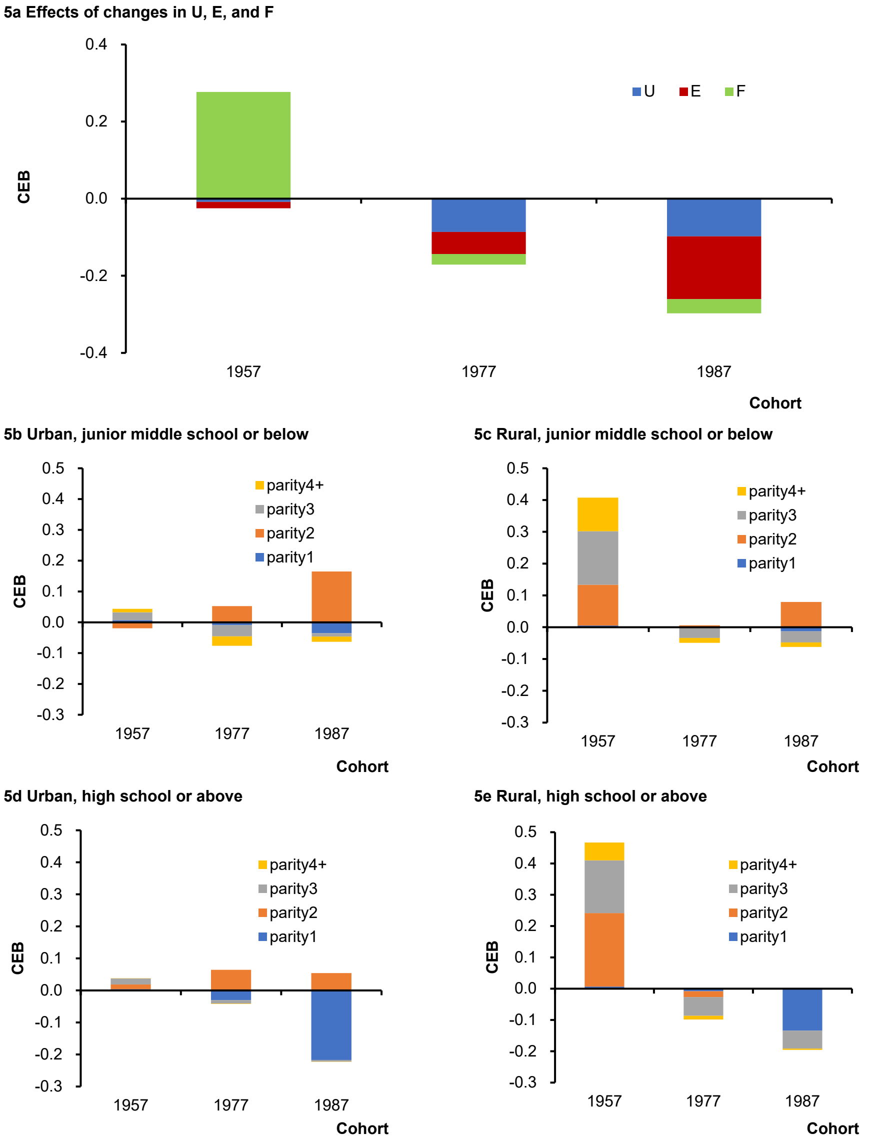
Changes in educational composition, urban–rural population structure, and residence/education-specific fertility levels of first births have all contributed to the rising childlessness across cohorts. However, declines in first-birth fertility within each residence/education group were the dominant driver, as shown in Panel 4a of Figure 4. Figures 4b and 4c further show that, at all education levels, the decline in subgroup-specific first births has increasingly contributed to the rising childlessness across cohorts, especially among urban and more educated women.

Figure 4: Decomposition of the changes in the cohort childlessness proportion



Notes: Panel 4a shows the effect of changes in U, E, and F1 on the cohort childlessness proportion. Panels 4b and 4c depict the contributions of changes in the fertility level of first births by residence and education level. U, E, and F1 represent the effects of changes in women's urban–rural population structure, residence-specific educational structure, and residence/education-specific average number of CEB1, respectively.

Figure 5: Decomposition of the changes in cohort average number of CEB



Note: Panel 5a shows the effect of changes in U, E, and F on the cohort average number of CEB. Panels 5b to 5e show the parity-specific contributions to changes in the average number of CEB by residence and education level. U, E, and F represent the effects of changes in women's urban–rural population structure, residence-specific educational structure, and residence/education-specific average number of CEB, respectively.

3.4.2 Effect on changes in number of CEB

The impact of changes in educational structure on the reduction in the number of CEB has become more pronounced in later birth cohorts. In the 1957 cohort, the higher number of CEB compared to the 1967 cohort was primarily driven by differences in fertility levels across all residence/education-specific groups. In contrast, the decline in CEB among later cohorts was more strongly influenced by changes in urban–rural population structure and educational composition. The effect of increasing education on reducing CEB strengthened in successive cohorts.

Panels 5b to 5e show that the decline in the progression to first births contributed more to the reduced CEB among urban women in later cohorts and that the contribution of reduced progression to first births strengthened over time among women with a high school education or higher.

4. Conclusion

We examined fertility postponement and recuperation patterns and assessed the contributions of changes in age-parity-specific progression ratios, residence structure, and educational composition to overall shifts in childlessness and CEB across cohorts. The analysis yields the following key conclusions:

Later birth cohorts exhibit a higher childlessness proportion and lower CEB at specific ages. Rising childlessness is more pronounced among urban, more educated women, while the decline in CEB is sharper among rural, less educated women. Permanent childlessness among Chinese women has notably increased, reflecting several mixed factors, including both rising infertility (Jiang et al. 2023) and behavioral changes, such as voluntary childlessness, delayed marriage, and reduced desired family size, particularly in younger cohorts.

Fertility postponement has intensified across birth cohorts, while the capacity for recuperation at older reproductive ages has weakened. Later cohorts experienced greater delays in initiating childbearing and limited recovery at older ages. While first-birth recuperation remains relatively robust in China, it has weakened in recent cohorts, raising the likelihood of permanent childlessness. Recuperation for second and third births has improved slightly, likely due to recent fertility policy adjustments.

Cohort fertility trends were strongly shaped by age-parity-specific progression ratios, particularly the transition to first birth. The increase in childlessness and the decline in the number of CEB1 among later birth cohorts were primarily driven by reductions in APSPR1 between ages 18 and 29. Although APSPR2 has risen in younger cohorts following policy relaxation, the persistent decline in the progression ratio to first births remains the main driver of declining cohort fertility. Given the foundational role of first births in shaping cohort fertility (Wang 2021), the total number of CEB is likely to continue falling as younger cohorts approach the end of their reproductive years.

Structural changes in education and urban–rural residence have also influenced cohort fertility patterns. The overall decline in the number of CEB is more closely associated with changes in the population composition of women, and the effect of increasing education on reducing CEB has strengthened across cohorts. The impact of declining progression to first births is particularly pronounced among urban, higher-educated women in later cohorts. Due to rapid educational expansion, notions of education have shifted across cohorts. For example, women with a high school education represented a small, elite group in the earlier cohorts, while a high school education represented a much larger and more general population in more recent cohorts. This significant shift in the educational composition of the female population is expected to exert continued downward pressure on cohort fertility (Lazzari, Mogi, and Canudas-Romo 2021).

This study has several limitations, such as the recall bias in retrospective self-reported data, the entanglement between voluntary and involuntary childlessness, and the incomplete reproduction process for later birth cohorts. We also acknowledge that the conventional static classifications for education level and residence commonly used in demographic research (Zeman et al. 2018; Lazzari, Mogi, and Canudas-Romo 2021; Hwang 2023; Kuang et al. 2024) may not fully capture the dynamic changes driven by socioeconomic and cultural development over time. Future research especially at the micro level may consider alternative approaches that use cohort-specific percentile ranks (Dong and Xie 2023). Despite these limitations, this analysis of China's cohort fertility sheds light on both academic research and policymaking.

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