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The moderating role of happiness in the relationship between fertility desire and behavior in China

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This paper examines how happiness moderates the relationship between fertility desire and actual fertility behavior in contemporary China. Drawing on data from the Chinese General Social Survey (CGSS) for the years 2012, 2013, 2015, 2017, 2018, and 2021, we employ Poisson and logistic regression models to analyze this dynamic. The results indicate that while fertility desire significantly predicts the number of children, happiness exerts a positive moderating effect: individuals who report higher levels of happiness are more likely to act on their fertility desires. To mitigate concerns of endogeneity, we use instrumental variables related to clan culture. Heterogeneity analysis reveals that this moderating effect of happiness is stronger among older birth cohorts. Additionally, our findings suggest that rising parenting costs—particularly education expenses—dampen the positive effect of happiness, while the expansion of social security reduces the reliance on children for old-age support, thereby weakening the happiness-fertility linkage. These results highlight the need for fertility policies that go beyond economic incentives and aim to foster a broader sense of well-being to create a supportive environment for childbearing.

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Introduction

China's demographic landscape has undergone a profound transformation over recent decades, marked by a pronounced decline in fertility rates following the enforcement of stringent family planning policies (Zhang et al., 2022). Consequently, the nation's population growth rate has sharply decreased from 0.79% in 2000 to a mere 0.07% in 2021 (Macrotrends, 2023). Recent reports indicate that China has entered a phase of negative population growth, underscoring significant challenges such as an aging population and economic stagnation, which collectively intensify concerns regarding long-term economic and social stability (SCMP, 2023).

China currently confronts what scholars describe as a "Fertility Trap," a self-reinforcing cycle in which persistently low fertility rates exacerbate economic and social conditions that further suppress birth rates, thereby complicating demographic recovery (Lin et al., 2024; Du and King, 2025). Multiple factors contribute to this dynamic, including population aging, rising childrearing costs, and evolving social norms that deprioritize larger families. These shifts have precipitated a sustained decline in fertility, with long-term implications for economic growth, labor supply, and the intergenerational transmission of cultural values.

In efforts to counteract declining fertility, the Chinese government has progressively relaxed family planning policies, transitioning from the one-child policy to a "selective two-child policy" in 2013, followed by a "universal two-child policy" in 2016, and most recently, a "universal three-child policy." However, these policy relaxations have not produced the anticipated rise in birth rates, as evidenced by a notable decline in births following the introduction of the universal two-child policy (Hsu et al., 2022; Basten and Jiang, 2015). Despite the removal of legal restrictions on family size, fertility rates have continued to decline, indicating that structural factors beyond formal policy constraints significantly influence reproductive decisions.

Existing literature has identified both economic and cultural factors as primary determinants of fertility behavior. Among these, economic constraints—particularly escalating childrearing costs—are widely acknowledged as substantial inhibitors of fertility (Billari et al., 2009; Zeng & Hesketh, 2016; Liu et al., 2023). Nonetheless, an emerging body of research highlights a persistent gap between individuals' fertility desires and their actual fertility outcomes (Lu & Mao, 2014; Sobotka et al., 2014). This so-called intention-behavior gap suggests that while fertility desire constitutes a necessary precondition for childbearing, it is insufficient on its own to guarantee corresponding fertility behavior. This observation prompts a critical inquiry: what factors enable individuals to translate fertility intentions into actual childbearing? This paper posits that, alongside economic and cultural determinants, individual subjective well-being—specifically, happiness—may serve as a pivotal moderating factor bridging the gap between fertility desire and fertility behavior.

Understanding the interplay between economic and cultural factors is vital for addressing China's fertility decline. Prior studies indicate that policy reforms have had limited efficacy in reversing low fertility trends (Wu, 2022), and previous family planning policies have produced unintended demographic consequences, such as a skewed sex ratio (Garcia, 2024). Yet, the drivers underpinning the intention-behavior gap remain inadequately explained. Given these complexities, it is imperative to explore how psychological factors such as happiness interact with contemporary economic conditions to shape fertility behavior in China.

Accordingly, this study investigates the moderating role of happiness in the relationship between fertility desire and fertility decisions, employing data from the Chinese General Social Survey (CGSS). The results demonstrate that happiness significantly and

positively moderates this relationship: individuals expressing higher fertility desire are more likely to have children if they also report elevated levels of happiness. However, this positive moderating effect is constrained by prevailing economic realities. Rising parenting costs and improvements in social old-age security both attenuate the influence of happiness on fertility outcomes.

By providing empirical evidence on the evolving interplay between psychological and economic factors in fertility decisions, this paper offers novel insights into China's ongoing demographic transformation. Utilizing large-scale survey data, it presents a comprehensive analysis of regional fertility patterns and advances understanding of the complex non-economic and economic forces shaping the nation's population trajectory.

Literature review and hypotheses

Fertility decisions are inherently complex, shaped by the interplay of deeply rooted cultural values and evolving socioeconomic conditions. While cost theory foregrounds rational economic decision-making, cultural theory emphasizes the persistent influence of traditional beliefs, including Confucian values and the imperative of lineage continuation (Lieming, 2019). This paper centers on the interaction between fertility desire and psychological states in determining fertility outcomes, with particular attention to the moderating role of happiness within the context of China's shifting demographic and economic landscape.

The gap between fertility desire and behavior. Traditional Chinese culture has historically placed significant importance on family reproduction, fostering elevated fertility desires. This cultural emphasis on family size has been a foundational element of Chinese society across generations. However, recent scholarship indicates that the strength of this traditional cultural influence is increasingly challenged by economic pressures and changing social structures (Lieming, 2019). These pressures have engendered a gradual normative shift away from the historical paradigm of "high fertility and son preference" toward an ethos emphasizing "fewer and better children" alongside greater gender equality.

Despite these evolving trends, a pronounced gap between individuals' fertility desires and their realized fertility behavior has emerged as a significant phenomenon (Lu & Mao, 2014; Sobotka et al., 2014). This intention-behavior gap implies that fertility desire, while necessary, is insufficient alone to translate into actual childbearing. This discrepancy highlights the presence of substantial economic and psychological barriers impeding the fulfillment of fertility intentions. Thus, it is essential first to reaffirm the foundational positive association between fertility desire and fertility behavior.

Hypothesis 1: Fertility desire positively influences actual fertility behavior in contemporary China.

Happiness as a moderator of fertility decisions. While fertility desire constitutes a key antecedent of childbearing, this paper proposes that subjective happiness functions as a critical psychological facilitator that may bridge the desire-behavior gap. We theorize that happiness, conceptualized as a relatively stable state of positive well-being, affects fertility decisions through multiple channels. First, individuals with higher happiness levels tend to maintain a more optimistic outlook toward the future, increasing their willingness to undertake the long-term commitments associated with childrearing. Second, elevated subjective well-being is linked with enhanced psychological resilience, enabling individuals to better manage the stresses and challenges inherent to parenthood. Third, happiness often correlates with higher-quality

marital relationships and more stable family environments—both essential foundations for successful childrearing.

From a cultural preference perspective, the association between happiness and fertility transcends the psychological domain and is deeply embedded within social values. In Chinese culture, which has long underscored the importance of family, children are frequently perceived as direct sources of enduring happiness and life satisfaction. Traditional preferences encompass not only lineage continuation (Zhang and Li, 2017) and patriarchal structures (Murphy, 2003) but also the emotional and psychological fulfillment children provide. Empirical evidence supports this view, indicating that elderly individuals with more children report better mental health and overall happiness (Liu et al., 2020).

Accordingly, if childbearing is culturally framed as a pathway to enhanced well-being, an individual's current happiness may serve as a crucial resource or 'green light,' bolstering confidence to pursue this culturally valued goal with the expectation that it will sustain or augment their happiness over time. Based on this reasoning, we hypothesize that happiness does not simply exert a direct effect on fertility behavior; rather, it moderates the relationship between fertility desire and childbearing by acting as a catalyst that empowers individuals to actualize their intentions.

Hypothesis 2: Happiness positively moderates the relationship between fertility desire and actual fertility behavior. The positive effect of fertility desire on fertility will be stronger for individuals reporting higher levels of happiness.

Constraints on the moderation effect: costs and social security. Although happiness may positively moderate the link between fertility desire and fertility behavior, this moderating effect is likely bounded by the prevailing economic and social context. This section examines how transformations in the costs and benefits associated with childbearing may weaken the positive moderating influence of happiness. Specifically, we consider the rising financial burden of raising children and the declining security benefits traditionally associated with larger families.

The rising cost burden of raising children: a potential weakening factor. Recent studies have increasingly documented the growing financial burden of child-rearing in contemporary China, particularly in urban areas where educational demands and social mobility pressures are intense. Gao, Song, and Timmins (2022) demonstrate that increased pollution levels adversely affect fertility, as parents allocate more resources per child to mitigate pollution-related health risks, thereby reducing overall fertility in line with Becker's quantity-quality (Q-Q) trade-off model. This underscores a parental shift prioritizing child 'quality' (e.g., education, healthcare, well-being) over 'quantity,' contributing to fertility declines.

Similarly, Chen and Guo (2022) find that higher female education correlates with permanently lower fertility, especially in rural populations, suggesting that opportunity costs play a key role in fertility decisions. Pan and Yang (2022) further document the negative impact of rising housing prices on fertility, highlighting that substantial economic pressures may override cultural preferences for larger families. Moreover, Liu et al. (2023) reveal that increases in home value growth decrease the likelihood of childbearing among home-owning women, particularly in regions with underdeveloped credit markets, indicating financial constraints as critical mediators of fertility behavior. Based on this discussion, we have a hypothesis as follows:

Hypothesis 3: The positive moderating effect of happiness on the relationship between fertility desire and fertility behavior is weakened by the increased financial burden of raising children.

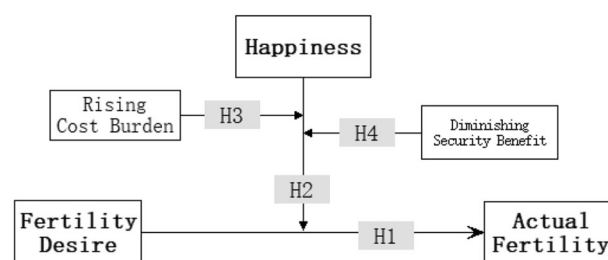


Fig. 1 Theoretical Framework.

The diminishing security benefit of larger families: another potential weakening factor. The traditional perception of children as a dependable source of old-age security is undergoing substantial transformation in modern China. While direct empirical evidence on this 'security benefit' is limited, broader societal changes suggest a decreasing reliance on children for support in later life. Skirbekk (2022) underscores that low fertility contributes to population aging, indirectly reflecting a reduced dependence on offspring for elderly support. Concurrently, the expansion of formal social security programs, improved healthcare access, and accelerated urbanization contribute to diminishing the necessity of large families as a means of old-age provision. As modern social safety nets become more comprehensive and accessible, the traditional function of children as old-age security providers correspondingly declines.

Accordingly, we hypothesize:

Hypothesis 4: The positive moderating effect of happiness on the relationship between fertility desire and fertility behavior is weakened by increased access to and enrollment in modern insurance and social security systems.

While enduring cultural norms continue to influence fertility desires, the escalating financial costs of child-rearing and the reduced reliance on children for old-age support likely constrain the extent to which psychological factors such as happiness shape fertility decisions. Figure 1 presents a schematic representation of the theoretical framework guiding this study, illustrating how rising cost burdens and diminishing security benefits are expected to weaken the moderating role of happiness in linking fertility desire to actual fertility behavior.

The reviewed literature highlights the multifaceted nature of fertility decision-making in China, shaped by economic, cultural, and psychological factors. This study empirically examines the moderating role of happiness within this complex context, leveraging data from the Chinese General Social Survey (CGSS) to address key questions: To what extent does happiness facilitate the translation of fertility desire into actual childbearing? And how have economic factors constrained this influence?

Data description and identification strategies

This study utilizes data from the Chinese General Social Survey (CGSS), China's earliest and most comprehensive nationwide academic survey, administered by the National Survey Research Center at Renmin University of China since 2003. The CGSS systematically collects data at multiple levels—including individual, family, community, and society—and is designed to capture the evolving dynamics of Chinese social structure, attitudes, and behavior. Although the content of the CGSS questionnaire has undergone periodic revisions, the core design and survey methodology have remained broadly consistent over time, ensuring comparability across survey waves.

For this analysis, we construct a pooled cross-sectional dataset spanning the six most recent CGSS waves for which relevant variables are available: 2012, 2013, 2015, 2017, 2018, and 2021. The corresponding sample sizes for these years are 11,765, 11,438,

10,968, 12,582, 12,787, and 8148, respectively. These datasets collectively offer rich information on individuals’ fertility preferences, behaviors, subjective well-being, and demographic characteristics, making them well-suited for examining the proposed relationships.

The CGSS employs a multistage stratified probability sampling method. Households are randomly selected from all provinces, autonomous regions, and municipalities directly under the Central Government. Within each selected household, one individual is randomly chosen as the respondent according to established randomization protocols. This design ensures the national representativeness of the survey sample.

To empirically assess the moderating role of happiness in the relationship between fertility desire and actual fertility behavior, we specify an individual-level econometric model based on the regression framework. The model is designed to capture the interactive effects of fertility desire and happiness on the likelihood of child-bearing, while controlling for relevant demographic and socio-economic covariates. Specifically, we assume that an individual’s fertility behavior is determined by the following regression equation:

$$fertility_{it} = \alpha_0 + \beta_0 * children_{it} + \lambda_0 * X_{it} + province + year + province * year + \varepsilon_{it} \tag{1}$$

$$fertility_{it} = \alpha_1 + \beta_1 * children_{it} + \rho * happiness_{it} + \sigma * children_{it} * happiness_{it} + \lambda_1 * X_{it} + province + year + province * year + \varepsilon_{it} \tag{2}$$

The dependent variable in this study is *fertility*, which measures actual fertility. Two variables are used to measure actual fertility: the actual number of children (*fertility_num*), and whether the respondent has a second child (*fertility_2*). *Fertility_num* is a continuous variable created based on the answer to the question “How many children do you have?” in the CGSS.¹ *Fertility_2* takes the value 1 if the number of children is equal to or greater than two; 0 otherwise. *X* is a vector of control variables. *province* and *year*, respectively, are time and region dummies, and ε is the usual error term. This framework allows us to test the moderating hypothesis by including interaction terms between fertility desire and happiness, as well as to explore heterogeneity across different economic and institutional conditions. Robustness checks and alternative model specifications are employed to verify the consistency of the results.

We divided the CGSS data from six survey periods by province to generate Fig. 2. Both the total fertility rate and the second-child birth rate exhibit consistent trends across periods. In most provinces, the fertility rate per capita ranges between one and two children per woman, with nearly half of the provinces reporting a relatively high proportion of second-child births.

The primary independent variable in this study is “children desired,” a continuous variable derived from responses to the question posed in the China General Social Survey (CGSS): “How many children would you like to have if there were no policy restrictions?” The principal moderating variable is “Happiness,” measured based on the CGSS question “Are you happy?” Respondents who answered “happy,” “fairly happy,” “quite happy,” “rather happy,” or “very happy” were assigned a value of 1 for the Happiness variable; all other responses were coded as 0.

From a theoretical standpoint, fertility desire is expected to exert a direct influence on actual fertility outcomes. However, a substantial body of international research has demonstrated that fertility intentions do not always translate into realized fertility, as the latter is shaped by a range of economic, cultural, biographical, religious, and policy-related factors. Consequently, the number of children individuals desire may exceed, match, or fall short of the

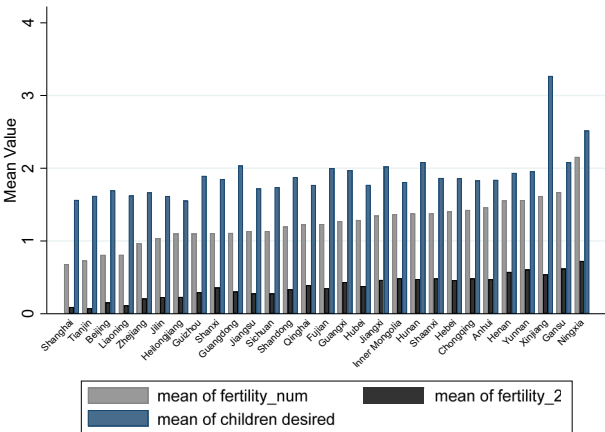


Fig. 2 Mean of fertility-related indicators. This figure excludes regions with missing data, and the sample ranges from 18 to 50 years old.

number they actually have. This phenomenon is not unique to China; fertility gaps have also been observed in many Western countries, where the desired number of children often surpasses the realized number (Sobotka et al., 2014; Beaujouan & Berghammer, 2019). Consistent with this literature, Fig. 2 shows that in most regions of China, the average number of children desired exceeds the actual number of children born, particularly in areas where actual fertility rates are relatively low.

To empirically assess the moderating role of happiness, we adopt a standard econometric approach by incorporating an interaction term between fertility desire and happiness—children desired \times happiness—into the right-hand side of the regression model (see Eq. 2). The coefficient associated with this interaction term, denoted as σ , captures the extent to which happiness moderates the relationship between fertility desire and actual fertility. A statistically significant σ would indicate that the strength or direction of the association between fertility desire and fertility outcomes varies with the individual’s reported level of happiness.

Nonetheless, this estimation strategy may be subject to endogeneity concerns. Specifically, the number of children an individual already has may influence their reported happiness, potentially resulting in reverse causality and biased coefficient estimates. To mitigate this issue, we conduct a series of robustness checks and implement an instrumental variable (IV) strategy. In particular, we use clan culture as an instrument for happiness. This choice is grounded in the idea that traditional clan-based social structures shape individuals’ subjective well-being through mechanisms such as communal identity and intergenerational expectations, while remaining plausibly exogenous to short-term individual fertility outcomes. The IV approach thus strengthens the validity of our causal inference regarding the moderating effect of happiness.

X is the vector of other characteristics that affect individual fertility. Based on the variable selection process in existing literature (Zhang et al., 2022), we include the following individual characteristics in the vector *X* that may affect fertility: gender (1 for males and 0 for females), age (the age of the respondent at the time of the survey), ethnicity (1 for Han nationality and 0 for minorities), education (1 for university and higher education and 0 otherwise), religion (1 for having religious beliefs and 0 otherwise), marital status (1 for married and 0 otherwise), household registration (1 for non-agricultural household registration and 0 otherwise), occupation (1 for non-agricultural employment and 0 otherwise), social security (1 for receiving basic medical and old-age insurance for urban and rural residents

Table 1 Variable definitions and descriptive statistics.

Variable	Definition	Obs	Mean	Std.dev	Min	Max
fertility_num	The total number of children born	32,957	1.19	0.9	0	12
fertility_2	Coded as 1 if the number of children is equal to or greater than two and 0 otherwise	33,014	0.35	0.48	0	1
Children desired	The number of children one is willing to have if there were no policy restrictions	32,296	1.84	0.71	0	6
Desired number of daughters	The number of daughters one is willing to have if there were no policy restrictions	27,166	0.96	0.48	0	5
Desired number of sons	The number of sons one is willing to have if there were no policy restrictions	27,166	0.93	0.49	0	6
Happiness	Coded as 1 if the respondents answered “happy” or higher levels, and 0 otherwise	30,031	0.75	0.44	0	1
Gender	Coded as 1 for male and 0 for female	33,014	0.47	0.5	0	1
Age	The age of the respondent at the time of the survey	33,014	36.76	9.11	18	50
Ethnicity	Coded as 1 for Han nationality and 0 otherwise	33,014	0.92	0.28	0	1
Education	Coded as 1 for university and higher education and 0 otherwise	32,983	0.29	0.46	0	1
Religion	Coded as 1 for having religious beliefs and 0 otherwise	32,478	0.67	0.48	0	1
Marital status	Coded as 1 for married and 0 otherwise	33,002	0.79	0.42	0	1
Household registration	Coded as 1 for non-agricultural household registration and 0 otherwise	32,933	0.38	0.49	0	1
Occupation	Coded as 1 for non-agricultural employment and 0 otherwise	33,014	0.61	0.49	0	1
Social security	Coded as 1 for receiving basic medical and old-age insurance and 0 otherwise	32,297	0.92	0.29	0	1
Commercial insurance	Coded as 1 for having commercial medical and old-age insurance and 0 otherwise	32,045	0.17	0.38	0	1
Individual income	The annual income of the respondent in the previous year (in 10,000 RMB)	30,620	4	4.99	0	22
Family income	The annual income of the respondent's family in the previous year (in 10,000 RMB)	26,428	7.61	7.94	0.2	40

and 0 otherwise), commercial insurance (1 for having commercial medical and old-age insurance and 0 otherwise), individual income (the annual income of the respondent in the previous year) and family income (the annual income of the respondent's family in the previous year). Province represents the regional variable, and year represents the time variable. To control for regional differences over time as much as possible, we further control for the interaction term “province*year.”

This study utilizes CGSS data from six survey waves: 2012, 2013, 2015, 2017, 2018, and 2021. First, abnormal values were excluded, and Winsorization was applied to the top and bottom 1% of the distribution to mitigate the influence of extreme values. Second, given the age-related feasibility of fertility behavior, the sample was restricted to individuals aged between 18 and 50. We focus on individuals aged 18–50, a range that captures the reproductive years for the vast majority of the population. Biologically, this age group encompasses the period during which fertility decisions are most actively made, and fertility-related behaviors are most likely to be observed. Sociologically, individuals within this age group are at various stages of family formation, making them key to understanding trends in fertility intentions and practices.

Table 1 presents the definitions of all variables along with descriptive statistics of the original dataset. On average, respondents reported 1.19 actual children, with approximately 50% having two or more children. In terms of fertility intentions, the average number of desired children was 1.84, highlighting a notable gap between actual and desired fertility levels. Additionally, a preliminary analysis of the two happiness measures reveals that approximately 75% of respondents reported feeling happy.

The moderating effect of happiness on fertility

Baseline results. The continuous variables were logarithmically transformed to achieve a normal distribution. Table 2 presents the baseline regression results, where Poisson regression is employed in columns 1 and 3 due to the dependent variable being

fertility_num being a count variable. For the remaining columns, logistic regression models are used as the dependent variables are dummy variables, i.e., fertility_2. Furthermore, the regression analysis includes provincial spatial effects, time effects, and provincial trends over time, in addition to the vector of individual characteristics

The regression results presented in Columns 1 and 2 of Table 2 evaluate the baseline model corresponding to Hypothesis 1. These results indicate that the number of children desired exerts a statistically significant and positive effect on actual fertility outcomes, particularly with regard to the likelihood of having a second child. This finding affirms the foundational assumption that fertility desire is positively associated with realized fertility behavior.

Building on this, Columns 3 and 4 incorporate both the variable for subjective happiness and the interaction term children desired × happiness to test the moderating role of happiness, as posited in Hypothesis 2. The coefficient of the interaction term is positive, and the estimate reported in Column 4 is statistically significant at the 5% level. This suggests a robust positive moderation effect, indicating that the influence of fertility desire on actual fertility is significantly stronger among individuals who report higher levels of happiness.

In substantive terms, these results imply that happiness acts as a facilitating psychological condition that enhances the likelihood of individuals realizing their fertility intentions, especially in the case of second-child births. This finding offers preliminary empirical support for the central hypothesis of the study—that happiness moderates the relationship between fertility desire and behavior by strengthening the translation of intention into action.

The results for the vector of individual characteristics reveal that females, older individuals, ethnic minorities, those with a low education level, married individuals, individuals with rural household registration, and those employed in agricultural occupations tend to have more children. Additionally, the effect of social security, commercial insurance, and income on actual fertility is uncertain and will be further explored in the section on mechanism regulation.

Table 2 Baseline results.

	(1) fertility_num	(2) fertility_2	(3) fertility_num	(4) fertility_2
Children desired	0.207*** (0.0133)	1.705*** (0.0613)	0.184*** (0.0243)	1.389*** (0.125)
Children desired *Happiness			0.0309 (0.0288)	0.352** (0.145)
Happiness			−0.0362* (0.0194)	−0.211** (0.101)
Gender	−0.0549*** (0.00788)	−0.0362 (0.0403)	−0.0581*** (0.00845)	−0.0505 (0.0425)
Age	0.929*** (0.0225)	2.292*** (0.0966)	0.916*** (0.0241)	2.190*** (0.102)
Ethnicity	−0.0154 (0.0156)	−0.176** (0.0809)	−0.0182 (0.0169)	−0.195** (0.0859)
Education	−0.212*** (0.0111)	−0.872*** (0.0600)	−0.215*** (0.0118)	−0.883*** (0.0632)
Religion	−0.0167 (0.0133)	−0.0924 (0.0706)	−0.0197 (0.0144)	−0.117 (0.0763)
Marital status	1.062*** (0.0321)	1.741*** (0.0831)	1.084*** (0.0342)	1.772*** (0.0869)
Household registration	−0.188*** (0.00914)	−1.101*** (0.0477)	−0.184*** (0.00975)	−1.074*** (0.0507)
Occupation	−0.0524*** (0.00916)	−0.369*** (0.0464)	−0.0521*** (0.00983)	−0.370*** (0.0492)
Social security	−0.00997 (0.0164)	−0.0742 (0.0733)	−0.00530 (0.0178)	−0.0528 (0.0783)
Commercial insurance	−0.0131 (0.0107)	−0.154*** (0.0562)	−0.0124 (0.0113)	−0.140** (0.0592)
Individual income	0.0301*** (0.00634)	0.0354 (0.0306)	0.0331*** (0.00676)	0.0473 (0.0321)
Family income	−0.0474*** (0.00708)	−0.0993*** (0.0335)	−0.0485*** (0.00756)	−0.112*** (0.0352)
Province	Y	Y	Y	Y
Year	Y	Y	Y	Y
Province*Year	Y	Y	Y	Y
N	20500	20529	18259	18285

Figures in parentheses are standard errors. *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Robustness tests. There are numerous factors that influence happiness, and our findings regarding its moderating effect may be sensitive to the way happiness is measured. Specifically, the interaction term children desired \times happiness could reflect characteristics of individuals who simultaneously exhibit strong fertility intentions and elevated happiness levels, thereby introducing potential sample selection bias.

To assess the robustness of our findings and evaluate the extent to which they may be influenced by measurement sensitivity, we introduce an alternative operationalization of happiness. We replace the original happiness variable with a new proxy, Happiness_child, derived from the 2012 CGSS survey question: “Watching children grow up is the greatest joy in life.” This new variable captures a child-specific dimension of subjective well-being. We then construct a new interaction term by multiplying Happiness_child with the number of children desired.

The regression results, presented in Columns 1 and 2 of Table 3, demonstrate that the coefficient of the new interaction term remains statistically significant and consistent in sign with the baseline findings. This outcome suggests that the moderating effect of happiness is robust across alternative measures of subjective well-being and is not solely an artifact of the original variable specification.

Furthermore, in constructing the happiness variable, a binary classification method was employed to clearly differentiate between “happy” and “unhappy” states, thereby enhancing the intuitive clarity of the research conclusions. However, this dichotomization may obscure important variation in subjective well-being. To evaluate whether this binary approach introduces bias into the regression results, we conduct an additional robustness check using the full five-point Likert scale of happiness, treating it as an ordinal variable ranging from 1 (very unhappy) to 5 (very happy).

Using this ordinal measure, we reconstruct the interaction term between the number of children desired and the happiness score. The results of this robustness test are presented in Columns 3 and 4 of Table 3. Although the magnitude of the coefficient for the interaction term decreases, its statistical significance increases relative to the baseline specification. This pattern suggests that the positive moderating effect of happiness on the relationship between fertility desire and actual fertility remains robust, even when a more nuanced measurement of subjective well-being is employed.

Overall, the robustness checks using both an alternative conceptualization of happiness (Happiness_child) and an ordinal scale of happiness provide convergent validity for our main findings. These results strengthen the inference that happiness acts as a meaningful moderator in the translation of fertility desire into behavior.

Table 3 Robustness Tests.

	(1) fertility_num	(2) fertility_2	(3) fertility_num	(4) fertility_2
Children desired	0.202** (0.103)	0.395 (0.599)	0.178*** (0.0167)	1.239*** (0.0880)
Children desired *Happiness_child	0.0104 (0.0394)	0.557** (0.247)		
Happiness_child	0.00715 (0.0264)	−0.347** (0.170)		
Children desired *Happiness_5			0.00580*** (0.00121)	0.0427*** (0.00698)
Happiness_5			−0.0208*** (0.00751)	−0.0226 (0.0368)
Control variables	Y	Y	Y	Y
Province	Y	Y	Y	Y
Year	Y	Y	Y	Y
Province*Year	Y	Y	Y	Y
N	4390	4394	15411	15436

Figures in parentheses are standard errors. *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 4 Comparison of the effect of clan culture.

	sample>25% quantile		sample>50% quantile		sample>75% quantile	
	fertility_num (1)	fertility_2 (2)	fertility_num (3)	fertility_2 (4)	fertility_num (5)	fertility_2 (6)
Children desired *Happiness	0.0628* (0.0368)	0.651*** (0.162)	0.0891 (0.0569)	0.636*** (0.210)	0.125* (0.0756)	0.983*** (0.320)
Children desired	0.181*** (0.0300)	1.193*** (0.136)	0.242*** (0.0497)	1.607*** (0.176)	0.219*** (0.0664)	1.497*** (0.269)
Happiness	−0.0545** (0.0250)	−0.421*** (0.114)	−0.0809** (0.0381)	−0.442*** (0.148)	−0.0945* (0.0518)	−0.729*** (0.227)
Control variables	Y	Y	Y	Y	Y	Y
Province	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y
Province*Year	Y	Y	Y	Y	Y	Y
N	13652	13675	8291	8307	3668	3673

Note: This table presents the regression results for the data in Fig. 2. Figures in parentheses are standard errors. *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Endogeneity analysis. The interaction term *Children Desired* × *Happiness* is employed to examine the moderating role of happiness in the relationship between fertility desire and actual fertility behavior. However, this estimation may be subject to endogeneity concerns. Although it is typically assumed that desire precedes behavior, the variable *children desired* may be endogenous in cross-sectional data, as individuals' current number of children could influence their reported fertility preferences.

Similarly, the *happiness* variable—derived from the self-reported response to “Are you happy?”—may exhibit reverse causality with actual fertility. Fertility outcomes can influence happiness through multiple channels. For instance, having too many children may lead to excessive parenting burdens, while having too few may raise anxieties over future old-age support, both potentially diminishing happiness. Conversely, a higher number of children may alleviate such concerns, whereas fewer children might reduce caregiving stress, potentially improving subjective well-being. Attribution analysis further suggests that the relationship between fertility and happiness is largely shaped by broader economic and institutional pressures.

To mitigate potential endogeneity—particularly concerning the *happiness* variable and its interaction with fertility desire—we adopt an instrumental variable (IV) strategy based on inter-generationally transmitted cultural values. As argued by

Fernández (2011), deep-seated cultural norms often shape contemporary preferences and behaviors and can serve as a source of exogenous variation.

We use *clan culture* as an instrument for the potentially endogenous interaction term. For this instrument to be valid, it must be correlated with the interaction term but uncorrelated with actual fertility except through its impact on desire and happiness. In regions with strong clan traditions, individuals tend to favor larger families—particularly sons—to preserve lineage. Moreover, in such contexts, having children tends to be more strongly associated with personal fulfillment and happiness. Thus, clan culture plausibly affects both fertility desire and happiness, satisfying the relevance condition for a valid instrument.

To empirically capture clan culture, we use the number of ancestral halls and genealogies across regions as proxies. We then conduct regressions on three subsamples—those above the 25th percentile, median, and 75th percentile in ancestral hall and genealogy counts—to assess whether the moderating effect of happiness is more pronounced in regions with stronger clan traditions. Table 4 presents the estimated coefficients of the interaction term, while Fig. 3 displays the corresponding confidence intervals, providing support for the instrument's relevance.

We further construct instruments by interacting the number of ancestral halls and genealogies with respondents' education levels and include them in model (1) for two-stage least squares (2SLS) estimation. As shown in Table 5, the IV estimation reveals a significantly larger moderating effect of happiness on both overall fertility and second-child fertility. The first-stage regressions confirm a strong relationship between the instrument and the endogenous interaction term, with F-statistics exceeding the conventional threshold of 10, supporting the strength and validity of the instrument.

In conclusion, the IV analysis confirms that, after accounting for endogeneity, the moderating effect of happiness on the link between fertility desire and actual fertility remains significant and is even amplified. This reinforces the robustness of our core finding.

Heterogeneity analysis. Differences in cultural concepts may exist among people of different age groups, particularly with regard to fertility. In China, the implementation of the family planning policy in the 1980s led to gradual changes in fertility culture, with a tendency towards intergenerational weakening. Previous research suggests that the post-70s generation still inherits the fertility culture of the older generation. On the other hand, the post-80s generation represents the first one-child generation in China and has fully accepted the family planning concept of “one child is enough.” The post-90s generation, being

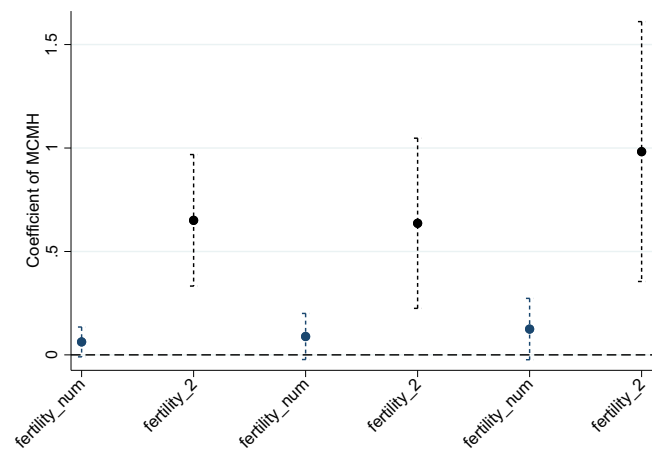


Fig. 3 Comparison of the effect of clan culture. The first two columns display coefficients and confidence intervals for samples with ancestral halls and genealogies above the 25th percentile, the third and fourth for those above the 50th percentile, and the fifth and sixth for those above the 75th percentile.

the beneficiaries of the reform and opening up, tends to choose to marry later and have fewer and better children, based on rational and voluntary decisions. Therefore, we hypothesize that the moderating effect of happiness on fertility decisions may have a stronger impact on actual fertility among older people Table 6.

To test this hypothesis, we examine the heterogeneity by dividing the sample by year of birth: before 1970, 1970 to 1980, and after 1980. Estimation results presented in Table 6 show that the interaction term “children desired*happiness” has a positive effect on actual fertility in people born before 1980, with a significant effect on having a second child. However, these effects are not significant in the post-80s group. These results suggest that the role of happiness as a facilitator for fertility choices is more pronounced among older generations, who may hold stronger traditional views on the link between family size and well-being.

Numerous studies have demonstrated that individuals' ideal number of children is influenced by the gender composition of their offspring, particularly in regions like Southeast Asia, where a strong cultural preference for sons persists (Ebenstein & Leung, 2010). In China, the sex ratio at birth remains above the biological natural level, reflecting the continued influence of gender-based cultural norms. Against this backdrop, we hypothesize that the moderating effect of happiness on fertility decisions may be heterogeneous depending on the desired gender of the children. To test this hypothesis, we introduce interaction terms between the desired number of sons and the desired number of daughters with happiness into model (2). The regression results, presented in Table 7, show that only in Column 4 does the coefficient for the interaction term involving desired sons display a significant positive effect on the probability of having a second child. This suggests that happiness primarily moderates the desire for sons when couples are considering a second child, reflecting the continued influence of son preference. However, the overall heterogeneous effect by child gender is not pronounced.

Building on the heterogeneity analysis based on birth cohorts, we further explore the heterogeneity of gender preferences across different birth cohorts. Interestingly, for individuals born before 1970, both the interaction term for sons and the interaction term for daughters show a positive association with fertility quantity and the likelihood of having a second child, with the effect of the son-related interaction term on second births significant at the 5% level (see Table 8). The combined gender-age heterogeneity analysis further reveals that in older cohorts, the moderating effect of happiness on the desire for sons exerts a significant positive influence on fertility decisions. This finding is consistent with prior studies on son preference in China and highlights how happiness interacts with persistent traditional cultural beliefs to shape fertility behavior among older generations.

Table 5 Instrumental variables (IV) estimation results.				
	(1)	(2)	(3)	(4)
Variable	Children desired *Happiness	fertility_num	Children desired *Happiness	fertility_2
	Stage I	Stage II	Stage I	Stage II
Children desired *Happiness		2.482***		2.664***
		(0.704)		(0.080)
IV-clan culture	4.57e-06***		4.57e-06***	
	(0.030)		(0.004)	
F statistic	22.93		22.93	
Control variables	Y	Y	Y	Y
Province	Y	Y	Y	Y
Year	Y	Y	Y	Y
Observations	18100	18075	18100	18100
R-squared	0.034		0.034	

Figures in parentheses are standard errors. *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 6 Age differences.

	Pre-70s		70-80		Post-80s	
	fertility_num (1)	fertility_2 (2)	fertility_num (3)	fertility_2 (4)	fertility_num (5)	fertility_2 (6)
Children desired *Happiness	0.0458 (0.0436)	0.700*** (0.221)	0.0309 (0.0288)	0.352** (0.145)	−0.0352 (0.0628)	−0.384 (0.324)
Children desired	0.157*** (0.0319)	0.858*** (0.178)	0.184*** (0.0243)	1.389*** (0.125)	0.242*** (0.0555)	2.184*** (0.292)
Happiness	−0.0345 (0.0303)	−0.427*** (0.158)	−0.0362* (0.0194)	−0.211** (0.101)	0.0384 (0.0418)	0.332 (0.230)
Control variables	Y	Y	Y	Y	Y	Y
Province	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y
Province*Year	Y	Y	Y	Y	Y	Y
N	4982	4949	18259	18285	7021	6841

Figures in parentheses are standard errors. *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 7 Gender differences.

Full sample	fertility_num (1)	fertility_2 (2)	fertility_num (4)	fertility_2 (5)
Children desired of daughter*Happiness	−0.00494 (0.00781)	−0.0352 (0.0393)		
Children desired of daughter	0.0425*** (0.00703)	0.217*** (0.0348)		
Children desired of daughter*son			−0.00594 (0.00668)	0.0209 (0.0339)
Children desired of son			0.0542*** (0.00591)	0.275*** (0.0288)
Happiness	−0.0113 (0.0109)	0.0178 (0.0523)	−0.0178 (0.0111)	0.0102 (0.0538)
Control variables	Y	Y	Y	Y
Province	Y	Y	Y	Y
Year	Y	Y	Y	Y
Province*Year	Y	Y	Y	Y
N	15416	15441	15413	15438

Figures in parentheses are standard errors. *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 8 Gender-age differences.

Pre-70s sample	fertility_num (1)	fertility_2 (2)	fertility_num (4)	fertility_2 (5)
Children desired of daughter*Happiness	0.00531 (0.0121)	0.0601 (0.0642)		
Children desired of daughter	0.0332*** (0.0107)	0.117** (0.0542)		
Children desired of daughter*son			0.00766 (0.0102)	0.113** (0.0546)
Children desired of son			0.0436*** (0.00875)	0.205*** (0.0446)
Happiness	0.00173 (0.0163)	0.0228 (0.0918)	−0.00176 (0.0165)	0.0333 (0.0956)
Control variables	Y	Y	Y	Y
Province	Y	Y	Y	Y
Year	Y	Y	Y	Y
Province*Year	Y	Y	Y	Y
N	4139	4142	4140	4143

Figures in parentheses are standard errors. *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 9 Effects of education and total expenditures.

	fertility_num (1)	fertility_2 (2)	fertility_num (4)	fertility_2 (5)
Children desired *Happiness*education expenditure	−0.0664* (0.0390)	−0.817*** (0.153)		
Children desired*education expenditure	−0.0134 (0.0258)	−0.0194 (0.0810)		
Happiness*education expenditure	0.0532* (0.0299)	0.583*** (0.138)		
Education expenditure	0.0126 (0.0212)	0.165* (0.0981)		
Children desired *Happiness*total household expenditure			−0.0257 (0.0653)	−0.0962 (0.240)
Children desired*total household expenditure			−0.0172 (0.0519)	−0.139 (0.168)
Happiness*total household expenditure			0.0627 (0.0467)	0.192 (0.186)
Total household expenditure			0.0294 (0.0381)	0.212 (0.146)
Children desired	0.190 (0.245)	0.490 (0.721)	0.304 (0.554)	1.876 (1.798)
Happiness	−0.594** (0.278)	−6.525*** (1.281)	−0.737 (0.502)	−2.818 (1.979)
Children desired *Happiness	0.714* (0.371)	9.214*** (1.486)	0.364 (0.708)	2.201 (2.572)
Control variables	Y	Y	Y	Y
Province	Y	Y	Y	Y
Year	Y	Y	Y	Y
Province*Year	Y	Y	Y	Y
N	2345	2334	3473	3477

Figures in parentheses are standard errors. *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Mechanisms: what weakens the positive moderating effect of happiness?

The analysis presented so far indicates that happiness positively moderates the relationship between fertility desire and behavior, particularly for second-child births. However, this effect is not uniform across all contexts and is likely constrained by powerful socioeconomic forces. This section aims to empirically investigate two key mechanisms proposed in our hypotheses that may weaken this positive moderating effect: the rising cost of parenting (Hypothesis 3) and the expansion of social security systems (Hypothesis 4). By examining these channels, we can better understand why even happy individuals may not translate their fertility desires into reality.

The constraining role of parenting costs. “More children” entails increased parenting costs, which include living expenses for the children and education costs. Moreover, with the growth of the economy, education costs have become a larger proportion of the total cost of parenting. According to Brand & Davis (2011), higher educational attainment is associated with lower fertility rates because well-educated individuals delay childbearing and have fewer children due to increased opportunity costs. Therefore, policies that increase public expenditure on education would likely further suppress fertility rates. However, it has also been reported that the impact of education expenditure on fertility is uncertain (Hong, 2017). Nevertheless, there is a consensus that cost constraints, including education costs, are a crucial reason for the continued decline in fertility in modern society. The key aspect is that the decline in the fertility rate is not due to a decrease in the desire to have children, but rather because the desire cannot be fully realized under cost constraints.

Accordingly, two variables were created to measure education expenditures and total annual household expenditures based on two questions in the 2015, 2017, and 2018 CGSSs: “What were your children’s education expenditure and other education and training expenditures in the last year?” and “What were your total household expenditures in the last year?” The two variables were expressed in natural logarithms and included in the baseline model in the form of triple interaction terms.

The estimation results presented in Table 9 indicate that the regression coefficients of the triple interaction term “children desired*happiness*education expenditures” are significantly negative for both total fertility and the likelihood of having a second child, with a particularly stronger negative effect on the latter. This suggests that higher education expenditures significantly weaken the positive moderating effect of happiness on fertility decisions, especially regarding the decision to have a second child. These findings support Hypothesis 3, implying that the rising cost of education poses a significant constraint on the ability of happy individuals to realize their fertility preferences.

In contrast, the coefficients for the interaction involving Total Household Expenditure are statistically insignificant, indicating that it is specifically education costs, not general household expenses, that critically constrain the fertility decision process within our framework. This highlights the unique role of education costs as a critical factor in shaping fertility outcomes.

A noteworthy observation is that, following the implementation of the three-child policy, individuals often express the sentiment, “we want to have children, but we cannot afford it.” This reflects the dynamic we have identified: while a desire for children and a sense of happiness (‘we want to have children’) are present, the increasing costs, particularly related to education (‘we can’t afford it’), ultimately override the positive psychological disposition, thus discouraging higher fertility.

Table 10 Subsample tests by insurance.

Sample	With public insurance		With Commercial insurance	
	fertility_num (1)	fertility_2 (2)	fertility_num (4)	fertility_2 (5)
Children desired *Happiness	0.0271 (0.0305)	0.360** (0.153)	0.0758 (0.0664)	0.184 (0.472)
Children desired	0.187*** (0.0260)	1.407*** (0.132)	0.133** (0.0581)	1.767*** (0.431)
Happiness	−0.0346* (0.0205)	−0.230** (0.106)	−0.0332 (0.0449)	−0.000642 (0.344)
Control variables	Y	Y	Y	Y
Province	Y	Y	Y	Y
Year	Y	Y	Y	Y
Province*Year	Y	Y	Y	Y
N	16864	16889	3024	2943

Figures in parentheses are standard errors. *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively.

The effect of social security. Another mechanism that may weaken the moderating effect of happiness is the expansion of social security systems. Traditionally, a key benefit of having “more children” was old-age support, a major contributor to long-term well-being or “happiness.” However, as studies have shown, formal old-age insurance replaces the mechanism of “raising children for old age,” thereby reducing the incentive for fertility (Hohm, 1975). Therefore, we test Hypothesis 4 by examining whether the moderating effect of happiness differs between those with and without comprehensive insurance, which alters the perceived need for children as a source of old-age security.

To empirically evaluate these views, a subsample was used to test whether the respondents had public or commercial medical and old-age insurance. Estimation results are presented in Table 10. According to the descriptive statistics, over 90% of the respondents had public medical and old-age insurance.

The subsample estimation results are presented in columns 1–2 of Table 10. The coefficients for the interaction term “children desired*happiness” indicate that the positive moderating effect of happiness on fertility still holds, especially for the choice of having a second child, among people with basic public medical and old-age insurance. In contrast, there were relatively few people with commercial medical and old-age insurance, accounting for only approximately 12% of the total sample. The analysis results of this subsample are presented in columns 3–4. It can be seen that for this group, the moderating effect of happiness has a negligible effect on the total number of children and the choice of having a second child. This suggests that for individuals with better economic conditions and stronger formal security nets (proxied by commercial insurance), the need to rely on children for old-age support and the associated “happiness” benefit is greatly reduced. This, in turn, weakens the role of happiness as a facilitator for fertility, providing support for Hypothesis 4.

Conclusion and implications

Conclusion. This paper investigates the moderating role of happiness in the relationship between fertility desire and actual fertility behavior in contemporary China. The study uses pooled cross-sectional data from the Chinese General Social Survey (CGSS) spanning 2012, 2013, 2015, 2017, 2018, and 2021. Using Poisson and logistic regression models, our analysis provides robust evidence that happiness acts as a significant positive moderator. The findings reveal that individuals who express a stronger desire for more children are more likely to translate that desire into having a larger family if they also report higher levels of happiness. This moderating effect is particularly pronounced

for the decision to have a second child, underscoring the importance of subjective well-being in fertility decisions amid China’s rapidly evolving socioeconomic landscape.

Further analysis reveals that this positive moderating effect of happiness is subject to significant heterogeneity. The effect is stronger among older cohorts, particularly those born before 1980, reflecting a generational shift in how psychological states and traditional values interact. In contrast, the influence of happiness as a moderator is weaker among younger cohorts. Furthermore, the analysis shows that son preference continues to play a role, as happiness primarily moderates the desire for sons in second-child decisions among older generations, although this effect appears to be diminishing.

The paper also identifies two key mechanisms that weaken the positive moderating effect of happiness. First, rising education costs significantly undermine the ability of happiness to promote fertility. This suggests that increasing parenting costs act as a powerful constraint that can override the positive psychological disposition towards childbearing. Second, the expansion of social security systems also reduces the moderating effect of happiness, likely by substituting the traditional old-age support function of children, thereby weakening one of the perceived long-term benefits of having more children.

A key contribution of this study is its construction of a testable behavioral model, in which a psychological state (happiness) moderates the link between intention (fertility desire) and action (actual fertility). Building on this fundamental model, we then incorporate economic and social factors into the research framework. The findings indicate that while economic factors—particularly rising child-rearing costs and the declining reliance on children for old-age security—are powerful inhibitors, their impact is best understood in interaction with individuals’ subjective well-being. This research advances fertility studies by integrating psychological and economic perspectives, offering a more nuanced understanding of the forces shaping fertility decisions in China’s demographic transition.

Implications. The findings of this study offer valuable policy implications for addressing China’s ongoing fertility decline. Given the significant moderating role of happiness and the powerful constraints of economic burdens, policies aimed at raising fertility rates should adopt a comprehensive approach that integrates psychological well-being, economic incentives, and cultural considerations.

First, alleviating the economic burdens of childrearing—particularly education costs—should be a central policy priority. Expanding public education subsidies, improving access to

affordable childcare services, and strengthening parental leave policies could help families realize their fertility aspirations by easing financial constraints that currently override the positive effect of happiness. Second, demographic strategies should incorporate efforts to reshape fertility norms. Public campaigns promoting gender equality, challenging son preference, and highlighting the benefits of smaller families could accelerate the erosion of traditional high-fertility desires, particularly in rural areas and among older generations. Third, the expansion of social security systems should be accompanied by measures that promote voluntary intergenerational support networks without reinforcing traditional family obligations. Policies such as tax incentives for family caregiving could help strike a balance between institutionalized old-age support and family-based social bonds. Finally, targeted interventions are needed to support vulnerable groups—such as rural households, low-income families, and women with lower educational attainment—whose fertility decisions are most constrained by structural inequalities. Tailored financial assistance, housing support, and family-friendly work arrangements could help mitigate the structural inequalities that constrain fertility choices in these populations.

In overall terms, this paper highlights the need for fertility policies that address both psychological well-being and economic realities. As China seeks to reverse its fertility decline and promote sustainable population development, a more integrated policy approach will be essential for fostering a supportive environment for childbearing. However, the study has several limitations that may impact the interpretation of the results. First, the use of the interaction term “fertility intention*happiness” to test for moderation, while standard, relies on self-reported happiness which is influenced by various factors and may not perfectly capture the stable psychological state relevant to long-term fertility intentions. Additionally, the survey data did not directly assess respondents’ views on this belief, which could further distort the findings. Second, the differences observed between younger and older age groups could reflect endogeneity concerns, particularly the lack of fertility plans among younger generations and their relatively young age at the time of the survey. Finally, while robustness checks have been conducted to address these issues, the temporal relationship between fertility intentions and behavior remains challenging, and the data does not capture pre-fertility beliefs. Future research should explore the causal relationship between fertility intentions and happiness, possibly using longitudinal datasets or pre-fertility perception surveys, to gain more accurate insights into this dynamic.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Note

1 This question was divided into “How many children (including step, adopted, deceased ones) do you have” and “How many (biological) children do you have (including deceased ones)” in 2017 and 2018, and not in the previous years. For consistency, the general data from “how many children do you have” are used as the observation data in this study.

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Author contributions

Na Tan: Conceptualization, Original draft Sajid Anwar: Editing, validation, and final draft.

Competing interests

The authors declare no competing interests.

Ethics approval

We use secondary data from multiple waves of the Chinese General Social Survey (CGSS), a nationally representative survey conducted and administered by Chinese government agencies under legal and institutional authority. The data were collected by these agencies and made publicly available in anonymized form, with all personally identifiable information removed. As our research involves no direct interaction with human participants and uses data collected, processed, and released by government bodies under statutory frameworks, ethics clearance is not required. This is consistent with established research ethics standards for the use of publicly available secondary data.

Informed consent

Informed consent was not sought because the research does not involve direct interaction with individuals or the collection of personal data. The data used are anonymized and publicly available, with all identifying information removed prior to release. As the data were collected by official agencies and released for research purposes under legal and institutional frameworks, the requirement for obtaining informed consent from individuals does not apply.

Additional information

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