The Relationship Between Fear of Childbearing Sentiment and Birth Rate in China: An Analysis Based on 2010-2022 Weibo Panel Data

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Abstract

This study constructs a fertility fear dictionary and utilizes Sina Weibo data from 2010 to 2022 to analyze the level of fertility fear across Chinese provinces and municipalities and its impact on birth rates. The results demonstrate that fertility fear sentiment significantly negatively predicts the birth rate of the subsequent year, and that increases in fertility fear significantly reduce fertility behavior. Furthermore, per capita disposable income and individualistic cultural orientation exert a positive influence on fertility fear, further affecting birth rates by exacerbating fertility fear. This study provides novel empirical evidence for understanding the influence of fertility fear on fertility behavior and offers socio-psychological theoretical support for population policy formulation.

Full Text

The Relationship Between Fertility Fear and Birth Rates in China: A Panel Data Analysis of Weibo from 2010 to 2022

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Abstract: This study constructs a "fertility fear" dictionary and analyzes fertility fear levels across Chinese provinces using Sina Weibo data from 2010 to 2022. The findings reveal that increased fertility fear significantly and negatively predicts birth rates in the following year, with heightened fertility fear leading to reduced reproductive behavior. Additionally, both per capita disposable income and individualistic cultural tendencies positively influence fertility fear, further

affecting birth rates. This research provides new empirical evidence on the impact of fertility fear on reproductive behavior and offers socio-psychological insights for shaping population policies.

Keywords: Fertility fear, Birth rate, Social media, Panel data analysis

1. Introduction

Low fertility rates represent a universal challenge facing industrialized and modernized nations worldwide. Between 1950 and 2021, the global total fertility rate declined from 4.84 to 2.23, a reduction of more than half. In 2021, only 46.1% of countries and regions maintained fertility rates above the replacement level of 2.1 required for population stability (Bhattacharjee et al., 2024; Aitken, 2024). Alongside socio-structural transformations and economic transitions, China's persistent fertility decline has emerged as a critical social issue (Lin et al., 2024).

In response to falling birth rates, China has gradually shifted from its one-child policy to a three-child policy. The "two-child policy for both parents if either is an only child" was implemented in 2011 (Jia et al., 2021), followed by the "two-child policy for families where one parent is an only child" in 2013 (Qiao, 2014), the universal two-child policy in 2015 (Ge & Shi, 2023), and finally the three-child policy in 2021 (Shi et al., 2022). However, despite these policy adjustments, the overall fertility rate has continued to decline since 2011, with China's population entering negative growth territory by 2022 (Chen, 2023). While these demographic policies have provided short-term incentives, the overall downward trend in fertility rates remains unabated, constrained by low fertility intentions (Zhang et al., 2021; Wang & Wang, 2016).

Fertility intention serves as a reliable predictor of individual reproductive behavior and plays a decisive role in determining national or regional fertility levels (Quesnel-Vallée & Morgan, 2003). Research has shown that widely disseminated mass information on social media influences individuals' fertility intentions (Barber & Axinn, 2004; Guldi & Herbst, 2017), while an increasing number of women express their fears about childbearing on these platforms (Wan & Zhou, 2023). Fertility fear is defined as the negative emotions—such as anxiety, dread, and aversion—that individuals experience in child-rearing contexts when influenced by negative cultural symbols, leading them to believe they cannot fulfill the identity commitment of a caregiver (Shott, 1979; Gao, 2020). This emotion is situational and temporary but can transform into stable affect over time (Gao, 2020), subsequently influencing whether individuals choose to reproduce and ultimately affecting fertility rates (Turner, 2009; Gao, 2020). Fertility fear is a common sentiment among unmarried and childless women, and through triggering, connection, and resonance on social media, it has become a persistent negative social emotion that hinders the formation of rational fertility cognition at both individual and collective levels. Its long-term accumulation creates a breeding ground for negative (or zero) fertility intentions, ultimately impacting birth rates (Gao, 2020).

Previous research has primarily focused on the dissemination pathways and formation mechanisms of fertility fear, with less attention paid to its actual impact on fertility rates, and no consensus has been reached on its mechanism of action. Current studies suggest that fertility fear influences reproductive behavior through complex cognitive-social mechanisms. According to Bachrach and Morgan's (2013) cognitive-social model, fertility intentions represent a complex psychological state influenced by both individual cognitive processes and social structures. Cognitive processes encompass both automatic and deliberate cognitive activities that jointly shape individuals' attitudes and decisions regarding reproduction. Fertility fear, primarily disseminated through social media and other channels, often transcends individuals' deliberate processes, directly influencing the formation of fertility intentions and reproductive decision-making. Additionally, cultural symbols and environmental cues within social structures subtly shape individuals' fertility decisions (Bachrach & Morgan, 2013). Although research has demonstrated that fertility fear may affect actual reproductive behavior by influencing fertility intentions (Mu, 2020), its impact mechanism on birth rates remains to be further explored due to the multiple socio-cultural factors at play during its dissemination (Johnson-Hanks et al., 2011). Studies have shown that childbirth-related fear among eligible unmarried and childless individuals negatively predicts their subsequent reproductive behavior (Zeng et al., 2023). However, Gao (2020) argues that the dissemination of fertility fear helps broaden reproductive knowledge among unmarried and childless women, facilitating a transition from emotional responses to rational reproductive behavior.

Sina Weibo is China's most active social networking platform, characterized by high timeliness and ecological validity. The high timeliness of Weibo data enables researchers to capture users' authentic thoughts and behavioral data in real time, rapidly reflecting social hotspots and public opinion trends (Li et al., 2020). Weibo data possesses high ecological validity, reflecting users' natural behaviors and viewpoints while avoiding interference and bias inherent in traditional surveys (Menon & Muraleedharan, 2020). The large sample size of Weibo data covers extensive user populations, enhancing representativeness and reliability while reducing sampling error (Wang & Zhao, 2022). These advantages make Weibo data a valuable resource for social science research, facilitating deeper understanding of social phenomena and behavioral patterns.

Panel data analysis is a statistical method that combines time series and cross-sectional data. By observing multiple individuals across multiple time points, it effectively controls for unobservable heterogeneity and provides more precise estimates (Hsiao, 2022). This approach simultaneously considers variations across individuals and over time, increasing data utilization efficiency and result reliability (Baltagi, 2021). Widely applied in social science research, panel data analysis can reveal complex causal relationships (Berrington et al., 2006).

The combination of Weibo's high timeliness and ecological validity with panel data analysis's capacity for precise causal estimation effectively compensates for

limitations of traditional research methods, offering richer and more dynamic perspectives for understanding social phenomena. This study employs panel data models combined with large-scale Weibo data to investigate the impact of fertility fear on reproductive behavior.

2. Constructing the Fertility Fear Dictionary

In Study 1, we constructed a fertility fear dictionary to measure fertility fear levels among Sina Weibo users. The final dictionary comprised 22,581 complete words, combined from seven word lists.

2.1 Methods

To generate a keyword dictionary with clear orientation that aligns with research objectives, an operational definition of the "fertility fear" concept is required. However, literature on fertility fear indicates that no universally accepted definition exists in academia (Gao, 2020). Based on relevant literature and research objectives, this study defines fertility fear as: individuals' negative emotions such as worry, dread, and aversion toward childbearing, along with tendencies to avoid it.

2.1.1 Dictionary Construction Developing the Initial Keyword Dictionary

Based on the operational definition of fertility fear, researchers generated an initial keyword dictionary through discussion. This list included synonyms and near-synonyms of fertility fear and terms expressing related concepts, such as "fear of childbearing" and "low fertility intention," totaling 26 words.

Following the creation of the initial dictionary, this study recruited 14 psychology professionals (graduate students familiar with word frequency analysis) to expand upon it. Researchers provided training on the definition of fertility fear and the purpose of dictionary compilation. Two researchers then integrated the expansions from these 14 professionals and independently identified words that did not clearly indicate fertility fear or were semantically inappropriate. The preliminary screening criterion was deletion only when both researchers agreed. After initial cleaning, the expanded list included 99 complete words and seven word lists for combining into complete words. The seven word lists were: synonyms for childbearing (A), words expressing reluctance (B), words indicating high degree (C), negative emotional adjectives (D), words expressing lack (E), synonyms for intention (F), and words indicating low degree (G).

Table 1 shows the combination patterns of these seven word lists into complete words.

Table 1. Combination Method and Meaning of the Initial Integrated and Refined Word List

To further screen and revise the expanded word list, researchers required the 14 psychology professionals to rate the list again. For complete words, professionals rated on a five-point Likert scale the extent to which each word accurately indicated fertility fear (1 = completely inaccurate, 5 = completely accurate). For combinable words, professionals judged whether each word was suitable for combination (1 = suitable, 0 = unsuitable). Based on the rating results, complete words with mean scores ≥ 4 and combinable words with mean scores ≥ 0.75 were retained. The final dictionary's word list types and word counts are shown in **Table 2**, and the numbers of combined complete words are shown in **Table 3**.

Table 2. Word List Types and Number of Words

Table 3. Types and Number of Complete Words

2.1.2 Validity Analysis (i) Validity Analysis Procedure

We investigated whether the fertility fear dictionary authentically reflects public fertility fear by examining the consistency between dictionary-captured texts expressing fertility fear and manual ratings.

First, based on the core childbearing word list (Table 1), we obtained sample Weibo text data from the past five years related to childbearing themes. We then compiled a manual for manual assessment of fertility fear, with a clear operational definition: using a dichotomous judgment to determine whether a text expresses fertility fear (yes = 1, no = 0). We randomly selected 100 Weibo texts from the sample data (with 50 texts from childbearing themes and 50 from fertility fear dictionary captures to increase the proportion of fear-expressing texts) for manual rating by six psychology professionals. Rating consistency was calculated using Kendall's W coefficient.

Subsequently, we randomly extracted 1,050 texts from the five-year Weibo sample data. Six psychology professionals, paired into three groups, re-evaluated the fertility fear expression in these 1,050 texts.

Finally, we used the fertility fear dictionary to judge the same 1,050 texts and calculated the consistency between manual ratings and dictionary judgments by constructing a confusion matrix.

(ii) Fertility Rates and Fertility Fear

We also validated the dictionary by examining the relationship between word frequency calculated using the fertility fear dictionary and actual fertility rates.

Measurement of Fertility Fear

This study used word frequency analysis to obtain fertility fear data from the Weibo database, which contained Weibo data from active users in 31 provincial-level administrative regions of China from 2010 to 2023. We first used the "TextMind" system developed by the Chinese Academy of Sciences' Institute of Psychology CCPL Lab to segment Weibo posts and calculate word frequencies. We then used the fertility fear dictionary to compute the frequency of fertility

fear-related words, calculated as the number of dictionary words divided by the total number of words in the text. Word frequency represented fertility fear levels across different regions and periods. Through this processing, we obtained fertility fear data for 31 provinces/municipalities/autonomous regions in China from 2010 to 2023.

Measurement of Fertility Rates
Fertility rate data were obtained from the National Bureau of Statistics website (www.stats.gov.cn) using the data query function for provincial annual data. By entering the corresponding time periods and information, we downloaded publicly available regional fertility rate data for 31 provincial-level administrative regions in mainland China from 2010 to 2022 (with 2020 provincial data not published).

The results showed high consistency among the six raters following the manual (Kendall's W = 0.616, p < 0.001), indicating reliable ratings. For the 1,050 texts, the dictionary achieved a precision of 0.795, recall of 0.397, and F1 score of 0.53, demonstrating the dictionary's validity.

Table 4. Confusion Matrix

National Fertility Fear Levels (2010-2022)
Using the mean fertility fear word frequency across 31 provincial-level administrative regions to represent the national fear level for each year, we obtained national fertility fear trends from 2010 to 2022, as shown in **Table 5**. Fertility fear levels generally increased over time, with the lowest level in 2012 and the highest in 2021.

Table 5. National Fear of Childbearing Levels in China (2010-2022)

Note: M = mean, SD = standard deviation; (unit: 1$×10^{-6}$)

Provincial Fertility Fear Levels (2010-2022)
Using the mean fertility fear word frequency across the 13-year period (2010-2022) for each administrative region to represent that region's overall fertility fear level, the results are shown in **Table 6**.

Table 6. Fear of Childbearing Levels by Administrative Region in China (2010-2022)

Note: M = mean, SD = standard deviation; (unit: 1$×10^{-6}$)

Correlations Between Regional Fertility Fear and Birth Rates (2010-2022)
Since the transition from fertility intention to behavior involves processes such as pregnancy and childbirth, requiring a one-year lag, we calculated Pearson correlations between fertility fear word frequency and both current-year and following-year birth rates. Overall, national fertility fear word frequency showed significant negative correlations with birth rates, with r = -0.36 for current-year birth rates and r = -0.43 for following-year birth rates (both significant at p < 0.01). At the regional level, correlations between fertility fear word frequency

and following-year birth rates were significantly higher than with current-year birth rates in most regions, indicating that fertility fear word frequency has better predictive power for following-year birth rates within the same region, thus validating the dictionary.

Table 7. Pearson Correlation Between Fear of Childbearing Word Frequency and Birth Rate by Region (2010-2022)

Note: Higher absolute correlation coefficients are bolded; N = 11; P < 0.05, **P < 0.01*

The results showed no significant correlation between fertility fear word frequency and following-year birth rates across different regions, indicating poor predictive power across regions. Notably, correlations between fertility fear word frequency and following-year birth rates significantly increased in 2013, 2015, and 2021—years that corresponded precisely with fertility policy announcements: the "single-child second child" policy in 2013, the universal two-child policy in 2015, and the three-child policy in 2021.

We posit that policy announcements triggered widespread public discussion, increasing the frequency of discourse on childbearing topics and providing more opportunities for people to express their fertility perspectives, thereby strengthening the correlation between fertility fear word frequency and birth rates.

Table 8. Pearson Correlation Between National Fear of Childbearing Word Frequency and Birth Rate (2010-2022)

Note: 2020 provincial birth rate data missing; 2023 provincial birth rate data not yet available; N = 31; P < 0.05, **P < 0.01*

3. Study Two

Study Two utilized the panel data on fertility fear and birth rates from Study 1, employing panel data modeling techniques to construct a main model and a secondary model. The main model explored the relationship between fertility fear and birth rates, while the secondary model examined how other socio-economic factors in the main model influenced fertility fear.

3.1.1 Dependent Variables

The main model's dependent variable was the following-year birth rate for each province/municipality from 2010 to 2022. Given the typical one-year lag between fertility intention and behavior, we used following-year regional birth rates as an indicator of reproductive behavior. Birth rate data were obtained from the National Bureau of Statistics website (www.stats.gov.cn) using the provincial annual data query function, downloading publicly available regional fertility rate data for 31 provincial-level administrative regions in mainland China from 2013 to 2022 (with 2020 provincial data missing).

The secondary model's dependent variable was fertility fear word frequency. Using the fertility fear dictionary constructed in Study 1 to analyze Weibo data, we obtained quantitative fertility fear indicators for 31 provincial-level administrative regions from 2013 to 2022.

3.1.2 Independent Variables

The main model's independent variable was fertility fear word frequency. The secondary model's independent variables included socio-economic and cultural factors such as per capita disposable income, individualism, and collectivism.

3.1.3 Control Variables

Individual demographic behaviors are typically influenced by two factors: external structural opportunities such as institutions and resources, and internal motivations and preferences (Zeng & Xie, 2008). The translation of fertility intention into behavior is moderated by individuals' capacity to realize their intentions. Fertility intentions often overestimate actual fertility behavior at both personal and aggregate levels, which is related to whether individuals possess the economic capacity to achieve reproduction (Quesnel-Vallée et al., 2003). In this study, we used regional per capita disposable income as an indicator of individual economic capacity, also obtained from the National Bureau of Statistics website.

Cultural value orientations significantly influence individuals' fertility intentions. Research shows that individualistic fertility motivations emphasizing personal emotional value pursuit negatively inhibit reproductive behavior, while collectivistic fertility motivations emphasizing family development and continuation positively stimulate reproductive behavior (Chen & Hu, 2020). In this study, we calculated collectivistic and individualistic tendencies for each provincial-level administrative region using a cultural value dictionary (Ren et al., 2017). This dictionary has high external validity, with its effectiveness demonstrated in multiple studies (Huang et al., 2020; Liu et al., 2020; Ren et al., 2020; Ji et al., 2024).

3.2.1 Main Model

The main model employed a two-way fixed effects model to analyze the relationship between fertility fear word frequency and following-year birth rates. The model formula is:

$$Y_{it} = \beta_1 X_{it} + \lambda_t + \alpha_i + \varepsilon_{it}$$

where Y_{it} represents the dependent variable (following-year birth rate for region i at time t), X_{it} represents explanatory and control variables (including fertility fear word frequency, per capita disposable income, individualism word frequency, and collectivism word frequency for region i at time t), λ_t denotes

time fixed effects, α_i denotes region fixed effects, and ε_{it} represents the error term (independently and identically distributed).

3.2.2 Secondary Model

The secondary model also used a two-way fixed effects model to analyze how other socio-economic factors in the main model influenced fertility fear word frequency. The model formula is:

$$X_{it} = \beta_2 Z_{it} + \lambda_t + \alpha_i + \varepsilon_{it}$$

where X_{it} represents the dependent variable (fertility fear word frequency for region i at time t), Z_{it} represents explanatory variables (including per capita disposable income, individualism tendency word frequency, and collectivism tendency word frequency for region i at time t), with λ_t, α_i, and ε_{it} defined as above.

To control for unexplained regional differences, we analyzed the 2013-2022 provincial annual panel data for 31 provincial-level administrative regions using Stata 16.0. To reduce heteroskedasticity, all data were log-transformed before establishing the panel data with provincial regions as individual variables and years as time variables. Balance testing confirmed a strongly balanced panel suitable for further analysis. Based on Hausman's sigma-more test results ($p < 0.001$, rejecting the null hypothesis), we selected the fixed effects model over the random effects model.

Given that the panel data's cross-sectional dimension (N = 31) far exceeds its time dimension (T = 10), we employed a short panel data model. For two independent non-stationary variables in short panel data, structural parameter estimates converge to zero in panel data but remain random variables in time series. Although non-stationary panel data may bias standard errors, point estimates remain consistent, eliminating the need for unit root or cointegration tests (Kao, 1999).

3.3.1 Descriptive Statistics

Table 9 presents Pearson correlation coefficients among variables in both models. Results show that fertility fear word frequency is significantly negatively correlated with following-year birth rates ($r = -0.44$, $p < 0.01$), per capita disposable income is significantly positively correlated with birth rates ($r = 0.53$, $p < 0.01$), individualism is significantly positively correlated with fertility fear word frequency ($r = 0.73$, $p < 0.01$), while collectivism shows no significant effect in either model.

Table 9. Pearson Correlation Matrix

Note: P < 0.05, **P < 0.01*

3.3.2 Main Model

The data covered 31 provincial-level administrative regions with 310 valid observations. Results in **Table 10** show that fertility fear word frequency has a significant negative predictive effect on following-year birth rates (β = -0.07, p $<$ 0.05), with increased fertility fear significantly reducing following-year birth rates. Additionally, per capita disposable income has a significant positive predictive effect on following-year birth rates (β = 0.76, p $<$ 0.01), with increased income significantly raising birth rates.

Table 10. Two-Way Fixed Effects Model (Main Model)

Note: N = 310; P $<$ 0.05, **P $<$ 0.01; Dependent variable: log-transformed following-year birth rate*

3.3.3 Secondary Model

The data covered 31 provincial-level administrative regions with 372 valid observations. Results in **Table 11** show that per capita disposable income has a significant positive predictive effect on fertility fear word frequency (β = 0.77, p $<$ 0.01), with increased income significantly increasing fertility fear. Individualistic tendency word frequency also has a significant positive predictive effect on fertility fear word frequency (β = 0.73, p $<$ 0.01), with increased individualism significantly increasing fertility fear. Collectivism shows no significant effect on fertility fear (β = 0.26, p = 0.61).

Table 11. Two-Way Fixed Effects Model (Secondary Model)

Note: N = 372; P $<$ 0.05, **P $<$ 0.01; Dependent variable: log-transformed fertility fear word frequency*

4. Conclusion and Discussion

By constructing a fertility fear dictionary and conducting quantitative analysis of Weibo data from 2010 to 2022, this study reveals the spatiotemporal distribution characteristics of fertility fear across China.

Study 1 demonstrated trends in fertility fear word frequency. Results indicate that fertility fear has gradually increased over the past decade, particularly during years of heightened economic pressure and fertility policy adjustments. This phenomenon is especially pronounced in economically developed regions like Beijing and Shanghai, where higher fertility fear word frequencies likely reflect increased child-rearing costs and the inhibitory effect of socio-economic pressures on fertility intentions.

Study 2 confirmed the significant negative predictive effect of fertility fear word frequency on following-year birth rates through panel data modeling, further supporting the impact of fertility fear on reproductive behavior. When regional fertility fear intensifies, the region's following-year birth rates tend to decline

significantly, indicating that fertility fear inhibits actual reproductive behavior by affecting individuals' fertility intentions. The relationship between fertility fear and following-year birth rates was particularly strong during policy adjustment years such as 2013 and 2015, suggesting that policy changes may intensify fertility fear expression by stimulating public attention to childbearing issues.

The secondary model further explored factors influencing fertility fear. Results show that per capita disposable income positively predicts both following-year birth rates and fertility fear itself. While economic development may enhance the capacity to reproduce, it simultaneously increases anxiety about the economic burden of raising children, thereby exacerbating fertility fear. Additionally, individualistic culture has a significant positive effect on fertility fear, consistent with previous research (Chen & Hu, 2020). Individualistic culture emphasizes personal freedom and self-actualization, contexts in which childbearing is often perceived as a constraint on personal freedom, thus more likely to trigger fertility fear.

This study provides new empirical evidence for understanding how fertility fear influences reproductive behavior and suggests that socio-psychological factors should receive greater attention in population policy formulation. Although economic development positively impacts birth rates, its effects may be offset by fertility fear if concerns about child-rearing costs and quality of life are not simultaneously addressed. When designing pro-natalist policies, beyond economic incentives, more comprehensive social support systems should be considered to alleviate parenting burdens and reduce fertility fear. The amplifying effect of individualistic culture on fertility fear indicates that in societies emphasizing individual freedom, people are more inclined to postpone or forgo childbearing. Therefore, social policies should account for cultural context differences and help individuals balance personal pursuits with family responsibilities through encouraging family responsibility and providing psychological support, thereby mitigating fertility fear and enhancing fertility intentions.

Despite its innovative methodology and analytical approach, this study has several limitations. Although Weibo text data offer good timeliness and ecological validity, the sample may suffer from selection bias, limiting result representativeness. Future research should expand data sources by incorporating other social media platforms to enhance generalizability. While this study effectively quantified fertility fear through dictionary construction and word frequency analysis, the diverse and complex expressions on social media may not be fully captured, leaving some omissions. With advances in natural language processing, future studies could employ more sophisticated sentiment analysis tools to improve identification precision.

This study is limited to the Chinese context, and the applicability of the fertility fear dictionary in non-Chinese contexts remains unclear. Future cross-cultural comparative research could provide more comprehensive understanding of how fertility fear manifests and influences reproductive behavior across different socio-economic backgrounds. While this study focused on quantify-

ing fertility fear and its impact on birth rates, it also revealed social media's important role in fertility fear dissemination. The widespread propagation of fertility fear may partly stem from social media's amplification of individual and collective reproductive risks and negative emotions. However, this study's data and methods have not directly examined social media's specific role in this process. Future research should further explore the formation mechanisms and dissemination pathways of fertility fear to deepen understanding of underlying socio-cultural and psychological factors, providing important references for developing more effective fertility support policies.

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