Influencing Factors of Declining Birth Rate in China

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Abstract: China is facing a dramatic demographic transformation in the recent decade. The family planning policies achieved their designated goal of keeping a sustainable population. However, the declining birth rate and minimal population growth brought the country new challenges: the demographic dividend that leads to low labor costs is disappearing and the cost of supporting the elderly population is increasing. Therefore, a study on the influencing factors of the declining birth rate is imperative to guide policymaking to reverse the trend. This study used the panel data of birth rate and four indicators in 31 provinces of China, spanning the years 2005 to 2021, obtained from the China Statistical Yearbooks. A fixed-effect panel regression model that accounts for both temporal and provincial variations, is employed to find essential factors that are significantly correlated with the birth rate. The implications of the significance and directions of the factors' relationships with the birth rate were analyzed and discussed. This study found that the level of education, which is reflected in the number of students in university and college, and the extent of aging among the population, which is reflected in the elderly dependency ratio, have significant negative effects on birth rate, and per capita disposable income has a strong positive relationship with the birth rate.

Keywords: birth rate, demographic transition, fixed-effect panel regression, regression analysis, China

1. Introduction

China's demographic landscape has undergone transformative shifts over the past decades, most notably characterized by a significant decline in birth rates. The watershed moment in China's demographic history was marked by the implementation of the one-child policy in 1979, a policy rooted in the intention to curb population growth and manage resources. According to Cao and Wang(2009), this policy greatly succeeded in maintaining a sustainable

population for the country. However, the pursuit of this policy over a long period caused problems like a shift in the country's population distribution towards the elderly and increasing difficulty supporting that elderly population[1]. The Chinese government relaxed the one-child policy in 2011, 2014, and 2016, making it the two-child policy, which means that a couple can legally give birth to two children. This number was made three in May 2021 due to the historically low birth rate in 2020 as suggested by the seventh national population census of the People's Republic of China. Although the problems brought about by the declining birth rate in China started to concern some sociologists and statisticians over a decade ago, and the government made many political efforts to address them, the difficulty of solving the problems persists till today. With a low birth rate and potential population decline, the demographic dividend leading to low labor costs and a large market that has prompted China's modernization is disappearing[2]. The ramifications of a declining birth rate are manifold, making research on this topic imperative.

This study is focused on finding social, economic, and demographic factors that have significant effects on the birth rate of a province, using provincial birth rate data of China. Based on past research in this field, this study uses fixed-effect panel regression to investigate whether the selected factors have a significant influence on the birth rate. The determined influencing factors are used to gain some perspective on the solutions to the problems.

Compared to past research in this field that uses data from the last century, this study spans the years 2005 to 2021, encapsulating the transformative period of modern China. Meanwhile, since past research did not reach a monolith of opinions on the influencing factors of birth rate, this study selected different indicators recognized by previous research, and employed a fixed-effect panel regression that accounts for both temporal and provincial variations, to find essential factors that affect birth rate. Also, this study explored practical policy implications of the factors, providing an initial step towards understanding modern China's demographic trends and solving problems brought by the declining birth rate and aging population.

The remaining portions of the paper are broken down into five sections: a literature review, data and methodologies, results, discussion, and conclusions.

2. Literature Review

2.1 Family Planning Policies and Demographic Trend

China's demographic trajectory has been significantly shaped by a series of family planning policies. These policies have not only impacted birth rates but have also wielded profound influence on social dynamics and economic development.

In the late 1970s China initiated its most well-known family planning policy: the One Child Policy. Launched in 1979, this policy sought to rein in population growth through strict

limitations on family size, allowing most urban couples to have only one child[3]. However, under the cumulative impact of the rapid decline in fertility levels, structural issues such as population aging intensified, and the persistent low fertility level began to emerge[7].

The turn of the century witnessed a shift in family planning policies, reflecting the evolving needs of a changing society. In 2013, China announced the relaxation of the One-child Policy, replacing it with the Two-child Policy, which permitted couples to have two children if one of the parents was an only child[8]. In 2016, a further relaxation to the Two-Child Policy made it legal for all couples to have two children. Under the incentive effect of proactive fertility policies, the number of births temporarily rebounded in 2016, reaching 17.86 million[6]. According to Liang, these relaxations of the policies have a positive influence on the fertility behavior of Chinese families on an individual level[7]. However, the increase in fertility levels did not last, and the birth rate has been decreasing since the year 2017[6].

2.2 Economical Factors

Choosing appropriate indicators is fundamental to this study. Past research suggested many plausible factors for further investigation. Yang et. al.(2022) based on national data from 31 provinces of China, found that marketization and the proportions of secondary and tertiary industries are important factors in the birth rate[2]. Another study that also studied the available provincial data, concluded that CPI is a main influencing factor of the birth rate[9].
Given the vast territory of China and the great discrepancies in the developments of different regions, regional studies based on data from a province, or a metropolis, are also often conducted. According to a Shanghai-based study, the government's spending has a major negative impact on the birth rate[11]. Some studies also investigated the significance of individual factors. It was found that an excessive housing-price-to-income ratio had a negative impact on the birth rate[12]. A study during the COVID-19 period found that per capita disposable income was responsible for changes in the birth rate[5]. This conclusion was consistent with Xue’s study of birth rate trends in seven different continental regions, which suggested that per capita income was a strong positive factor in the birth rate in all regions except Africa [13]. Zhang and Song(2013) explained in more detail the relationship between per capita disposable income and the trade-off between the costs and benefits of childbearing. They argued that as income rises, people tend to invest in quality over quantity when it comes to children, leading to a preference for fewer children with better life prospects[4].

2.3 Socio-cultural Factors

Studies from sociological perspectives provided additional insights regarding the effects of education, the aging population, and social institutions like marriage. Yang(2018) argued that the number of students in university and colleges and pension level are both negatively related to

the birth rate[9]. With higher education levels and a more developed pension system, people are more likely to abandon traditional views on fertility, embedded in traditional Chinese culture, that encourage them to have more offspring, especially male offspring to carry their heritage. Lucero-Prisno et. al. claimed that marriage rates are a contributing factor to China's declining birth rate. By 2020, the number of marriages registered had decreased for seven years in a row. For physiological and psychological reasons, a low marriage rate and delayed marriages resulted in a decreased birth rate[14].

2.4 Methodologies

To investigate the effects of diverse factors, accounting for the huge special and temporal variation in the provincial birth rate of China, a wide range of regression models were employed in past research, including feasible generalized least-square regression[2], spatial regression model(Yang, 2018)[9], and multiple linear, stepwise, and ridge regression[11].

This study intends to approach the problem using a Fixed-effect(FE) regression model. Many studies suggested that it is a promising tool when the results are interpreted properly. It is a useful method of making causal inferences in social science studies where confoundedness and unmeasured heterogeneity are often present, according to Gangl's study of statistical estimation of treatment effects in sociological research practice [16]. FE regression model is usually used for panel data analysis and enables causal inferences under the mere assumption of no unit-specific unobserved heterogeneity, by wiping out all group-specific unobserved heterogeneity[17]. Thus, it is appropriate to apply multiway FE regression for the annual provincial birth rate data with both temporal and spatial variance that this study is based on.

3. Data and Methodology

3.1 Data Source

The original data was sourced from the National Bureau of Statistics of China's publication of the China Statistical Yearbooks from 2005 to 2021 for all 31 provinces[6]. As a result of the availability of statistics in the Yearbooks, the year 2020 was excluded from the study. It is likely for the better excluded because the Covid-19 pandemic caused many special circumstances in the country that year and the data collected may be biased. Missing values in the data set were filled in using the linear interpolation method in SPSS software. All the independent variables were transformed through a natural logarithm to normalize the time series data used in this case and stabilize the variance for more accurate regression results. Taking the natural logarithm of variables also linearizes relationships that are intrinsically exponential or multiplicative, making them easier to characterize using a linear regression model.

3.2 Fixed-effect Panel Regression Model

The panel data were set up in longitudinal format in this case, which means that the birth rates of each province were ordered chronologically, and the time series of the 31 provinces were stacked together longitudinally. The years were labeled $t = 1, 2,..., 16$ and the provinces were labeled $i = 1, 2,..., 31$. Based on this data structure, a fixed-effect regression model, which builds on the error components model[17] was constructed,

$$y_{it} = \beta_0 + \sum_{k}^{K} x_{kit}\beta_k + \alpha_i + \epsilon_{it}$$

Here, y_{it} is the birth rate of a province i in a year t, β_0 is the constant(y-intercept), K is the set of all independent variables, x_{kit} is the k independent variable for province i in year t, α_i denotes the province-specific fixed effect, capturing unobserved heterogeneity across provinces, $\beta_0, \beta_1, \beta_2,..., \beta_k$ are the regression coefficients to be estimated for the intercept and each of the independent variables, ϵ_{it} represents an idiosyncratic error that varies across the provinces and over the years.

T-tests were used to assess whether each estimated β in the above model is statistically different from zero. The t statistic for β_k, for example, is calculated as,

$$t_k = \frac{\widehat{\beta_k}}{SE(\widehat{\beta_k})}$$

Here, $\widehat{\beta_k}$ is the estimated value of the coefficient for independent variable k, and $SE(\widehat{\beta_k})$ is the standard error of the estimated coefficient. The significance of the coefficient β_k is assessed by comparing the absolute value of t_k to the critical value of the t-distribution at a chosen significance level(.1, .05, and .01 in this study). If the absolute value of t_k is greater than the critical value, the coefficient β_k is considered statistically significant, indicating that the corresponding independent variable has a significant effect on the dependent variable.

To take into account the heteroskedasticity and correlation of error terms in the regression, robust SE was also calculated for each coefficient and used for corresponding t-tests. It is calculated as,

$$SE^{robust}(\widehat{\beta_k}) = \sqrt{\widehat{\sigma}^2 \times [(X'X)^{-1}X'\widehat{u}\widehat{u}'X(X'X)^{-1}]_{kk}}$$

Here, $\widehat{\sigma}^2$ is the estimated variance of the error term (residuals), X is the design matrix containing the independent variables, $\widehat{u}$ is the vector of residuals, and $[\dots]_{kk}$ denotes the k^{th} diagonal element of the matrix inside the brackets. The robust standard error provides a more accurate estimate of the true standard error of the coefficient when the assumptions of homoscedasticity and no serial correlation are violated.

3.3 Indicator Selection

The annual provincial birth rate was used as the dependent variable in this study. It was calculated as the number of births in a particular province in a particular year divided by the total population of the province that year, in units of birth per thousand people.

For independent variables, several indicators from economic, demographical, and social-cultural perspectives were considered, with reference to the past research results discussed in the literature review. Since a multiple linear regression was to be performed, multicollinearity diagnostics were obtained before determining the indicators to be put into the final regression model. After obtaining the multicollinearity diagnostics, indicators with high colinearity were reexamined and several were removed to ensure that each independent variable was not significantly correlated to any other independent variables in the regression model. Four essential indicators survived this process and were therefore used in the fixed-effect panel regression. The first indicator is per capita disposable income. It is computed by dividing the entire annual income of a province by the population of that province. This includes all kinds of revenue, including wages, government transfers, and rental income. It also includes taxes, savings, and total payments. Its significance lies in its ability to capture the economic conditions of households and individuals, which can play a pivotal role in shaping fertility decisions.

The second indicator is the number of students in colleges and universities. It is a statistic that reflects the amount of educational resources available in a particular province because the educational resources are not distributed in a spatially even manner, and some provinces have a more extensive network of higher education systems. This indicator was chosen because educational development can improve career opportunities and cause changes in people's fertility decisions to pursue their careers and economic stability[15].

The third indicator is the consumer price index(CPI). It is a widely used inflation indicator that captures the yearly average rise in consumer prices for a market basket of goods and services. Greater CPI values reflect a higher inflation rate and reduced buying capacity of an average consumer, which may also impact people's decisions regarding childbearing because childbearing is regarded as a huge financial burden in recent Chinese society.

The last indicator is the elderly dependency ratio. It is calculated by dividing the number of people aged 65 and older by the number of people aged 15 to 64 (working-age population), then multiplying by 100. This ratio offers a quick insight into the population structure of the province, where a higher ratio means more aging population and a heavier burden on the working population to support that population.

4. Results

Using birth rate(birrate) as the dependent variable, natural logarithm of the four indicators described in 3.1, ln per disposable income(lperdi), ln number of students in university and college(lsuc), ln consumer price index(lcpi), and ln elderly dependency ratio(ledr), as independent variables, a Fixed-effect Panel Regression was performed using Stata software. The results of the regression are

shown in Table 1 below. Colum (4) shows the result for all independent variables using normal standard errors and Column (5) shows the result using robust standard errors.

	(1)	(2)	(3)	(4)	(5)
	birrate	birrate	birrate	birrate	birrate
lperdi	-0.726***	0.550**	0.585**	1.210***	1.210**
	(0.110)	(0.240)	(0.241)	(0.249)	(0.517)
lscu		-3.211***	-3.197***	-3.235***	-3.235***
		(0.541)	(0.541)	(0.528)	(1.133)
lcpi			4.901	-1.033	-1.033
			(3.316)	(3.297)	(1.453)
ledr				-3.593***	-3.593***
				(0.464)	(0.712)
_cons	18.170***	18.951***	-4.192	27.041*	27.041***
	(1.063)	(1.035)	(15.692)	(15.685)	(6.121)
Observations	496	496	496	465	465
R-squared	0.086	0.150	0.154	0.259	0.259

Standard errors are in parentheses

**** p<.01, ** p<.05, * p<.1*

	(1)	(2)	(3)	(4)	(5)
	birrate	birrate	birrate	birrate	birrate

Table 1. Regression Results of the Fixed-effect Panel Regression

As seen in Table 1, per disposable income(lperdi), number of students in university and college(lsuc), and elderly dependency ratio(ledr) have significant effects on birth rate, while consumer price index(lcpi) does not. The regression model can be expressed as,

$$birth\,rate = 27.041 + 1.210 \cdot ln(per\ disposable\ income) - 3.235 \cdot ln(number\ of\ students\ in) - 1.033 \cdot ln(cpi) - 3.593 \cdot ln(elderly\ dependency\ rate)$$

The model R^2 is equal to 0.259, which means that overall the model explains 25.9% of the variation in birth rate.

5. Discussion

By analyzing the regression results, it is clear that per capita disposable income has a positive influence on the birth rate. This result is reasonable from an economic point of view because per capita disposable income measures the amount of money an average person can potentially spend on all kinds of activities, including childbearing. As family plan policies were imposed to limit the number of children a family could have, there was a dramatic shift in people's childbearing behavior. In recent years, it is very common for an urban Chinese family to support their children fully through college, which includes paying their tuition and living expenses. This makes childbearing a great financial burden on the parents, so it is reasonable for the birth rate to be positively correlated with higher income and better economic conditions on a macro level.

The number of students in university and college(lsuc) and elderly dependency ratio(ledr) have significant negative effects on the birth rate. The number of students in university and college measures the development of the higher education system. Higher education would render individuals more career opportunities in more demanding jobs, which could result in less time and energy available for childbearing. Also, individuals with higher education levels are more willing to challenge the conventional views on the necessity of having children and their economic stabilities enable them to decide for themselves when and how many children they want to have. The elderly dependency ratio, on the other hand, measures the population structure of the region. Some provinces in China bear severe outflow of the young adult population, which may cause the elderly dependency ratio to be particularly high. It is reasonable to infer that a smaller young adult population leads to a lower birth rate. Also, when there are more elderly individuals requiring care and support, families may decide to have fewer children or delay childbearing.

On the contrary, per capita CPI does not have a significant effect on the birth rate transition. The reason behind this can be that CPI is a major indicator of inflation and the inflation in China is relatively stable over the years studied in this empirical research due to governmental regulations and other factors. However, the birth rate has a general declining trend due to other social and cultural transitions that happened during the same period.

The overall R^2 of regression model in this study is 25.9%, which means that the model explains about 25.9% of the variation in birth rate. This value indicates that only a small portion of the variation in the dependent variable is explained by the four independent variables used in the model. One of the possible reasons for this is that only four indicators are chosen in this study because of the limited availability of provincial data in China. Many statistics were not collected by the province until 2005 or even later. Also, due to the types of data used in the study, it is impossible to eliminate confounding effects among the independent variables.

6. Conclusion

6.1 Influencing factors and policymaking suggestions

Through the fixed-effect regression using panel data of provincial birth rate, per disposable income, number of students in university and college, consumer price index, and elderly dependency ratio, it was found that level of education, which is reflected in the number of students in university and college, and extent of aging among the population, which is reflected in the elderly dependency ratio, have significant negative effects on birth rate, and per capita disposable income has strong positive relationship with birth rate. Thereby, a few suggestions for policymaking would be:

1. **Tax reduction and financial rewards**: Reducing tax on economic activities involved in childbearing and giving financial rewards to parents who have or plan to have young children brought to their household would largely lighten their financial burden of childbearing, as well as making childbearing psychologically less intimidating for young adults.
2. **Family-friendly work environment**: A work environment that prioritizes the work-life balance of employees is beneficial for promoting fertility behavior because childbearing is not only financially costly but also demanding in the amount of time and energy the parents put in. With a better work-life balance, the task of time management between companying one's children and working a full-time job would be less overwhelming. Also, it is important to build a work environment that prohibits discrimination based on pregnancy or family status. According to Liefbroer's study in 2005, women expect a strong decline in their career opportunities and their autonomy, as a result of fertility[10]. Thus, policies that ensure paid paternal and maternal leaves and benefits, and fair treatment and support for pregnant employees are vital.
3. **Pension system and medical system improvements**: The aging population is a direct result of the low birth rate and fertility rate below the replacement line. From a social perspective, the government needs to increase pension expenditure, especially for the elderly in rural areas who have a minimal amount of pension now. This could improve life quality for the elderly and reduce the amount of financial support they need from the working population. From an individual

perspective, as a result of the one-child policy, many people are or will be solely responsible for taking care of both of their parents. It is important to make nursing homes and healthcare more affordable and more convenient for the elderly. When the elderly population is taken care of, young adults will have more time and energy for the next generation.

6.2 Limitations of the study

This study is based on the provincial annual data published by the National Bureau of Statistics of China. The period of data could not be expanded due to the availability of the statistics used, which caused the sample size to be relatively small for a single province. The availability of data also limited the number of indicators used in this study. These limitations are reflected in the fact that the regression model developed in this study only explains about 25.9% of the variation in the birth rate of a province.

Also, this study does not establish cause-effect relationships. To make causal inferences from the regression model, counterfactual interpretations of the regression coefficients ought to be used. However, they require some strong assumptions that cannot be met in empirical settings.[18] The factors found by this study should only be seen as indicators that have significant positive or negative correlations with birth rate, instead of the causes of the changes in birth rate.

7. References

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