

A Study on the Influencing Factors of Fertility Rate in China

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Abstract. Over the past 40 years of reform and opening up, the family planning policy, as a basic state policy of China, has had a very profound impact on the development of the Chinese economy. Due to the dropping fertility rate in recent years, the birth rate has once again been under intense public scrutiny. To comprehend the reasons for the reduction in fertility, we must comprehend the variables that affect the fertility rate. It was discovered that the fundamental demographic position of the nation is influenced by the economy, education, and the state's fertility policy. By developing regression equations and examining the generated mathematical models, this research comes to the conclusion that the rates of female illiteracy, the elderly dependency ratio, the juvenile dependency ratio, and elderly dependency have a major impact on fertility rates. This study will assist the government in determining what can be done to raise the rate of fertility.

Keywords: Fertility rate; ridge regression; influencing factors.

1. Introduction

The fertility rate is the ratio of the total number of births to the total number of women of childbearing age in the corresponding population. It is typically expressed in thousands. The fertility rate is the ratio of the number of births in a given period (typically a year) to the average number of women of childbearing age in the same period. The reproduction rate is one typical criterion among the numerous that each nation uses to gauge its annual variations, as is well known. There are other countries with population issues besides China. Nearly all nations in the world must address this crucial issue for their own national development, and China is no exception. The population issue is directly tied to China's economic growth. For example, if the fertility rate rises, a larger labor force will be available in the future. National policy has a significant impact on the birth rate among many other factors, as seen, for instance, in the small Japanese town of Nara. Every family receives a birth bonus and childcare stipend in addition to paying half as much for daycare as the national average [1]. Similar to how fertility is vital, family planning, a fundamental state policy in China, has had a significant impact on the nation's economic development.

However, the birth rate has not increased dramatically as anticipated since China's policy to fully liberalize the two-child limit went into effect on January 1, 2016. As we can see from the data on China's fertility rate, the country's fertility rate is significantly lower than it was in earlier decades. The annual birth rate decreased from 2016 to 2021, with birth rates of 12.95% in 2016, 12.43% in 2017, 10.94% in 2018, 10.48% in 2019, and 8.52% in 2020, according to data from the China Statistical Yearbook (2017–2021) [2]. Why should China be concerned if its population is declining? First off, there are steadily fewer young people and steadily more elderly people, which will result in a population that is aging at an alarmingly rapid rate. This is because there are fewer and fewer young individuals when aging is severe, which causes a dearth of young talent when huge organizations hire. The effectiveness of a company will be significantly decreased if the senior management hires a group of employees who are between the ages of 50 and 60. And China is most concerned about that. Second, China's economy will suffer a bit as a result of the low fertility rate. For instance, it will result in a significant fall in the labor force and zero productivity in China, which will cause the economy to weaken.

To address this issue, China issued a number of fertility regulations. Wei Chen declared in 2005 that not only coercive but also important voluntary factors contributed to China's abnormal decline in fertility during the 1970s and 1980s [3]. However, in the present, with the implementation of the

policy of "separate two-child" to "comprehensive two-child," the pertinent survey reveals that the current one-child families have a low willingness to have a second child. Even if the policy supports more births, the birth rate in our country has recently shown a falling tendency, as evidenced by the fact that more than half of the families are unwilling to have a second child. There are numerous arguments that support the fact that fewer and fewer people wish to start families.

The first reason is that the impact of socioeconomic development on fertility intentions and birth rates is becoming increasingly prominent. Jianwei Li studied the relationship between economic factors, the degree of social security, the cost of raising children, and the birth rate [4]. All three factors showed a negative relationship with the birth rate. Liping Liu used lasso regressions to examine the effects of GDP, per capita pay, etc. on the birth rate and concluded that national GDP, per capita pay, and the child support ratio all have a positive effect on the birth rate [5]. With the rapid economic development, the cost of raising children is too high, and the life and economic burden of people of childbearing age are increased, which is the main reason why many families are afraid to have children and unwilling to have children". This shows a lot of families do not have enough money to provide for a child's life, such as tuition fees, fees for hobby classes, fees for various sports, and so on. These are only a few of the expenses for their children. Most people do not think they can offer a better life to their children, so they make the decision not to have children. According to this phenomenon, income is obviously the main factor that causes the fertility rate to decrease.

The second reason is that women are unwilling to have children, but why do women not want to have a baby during their lives? In their article, Zi Chen and Changrong Deng examined the methods used to investigate the variables impacting the fertility intentions of married, divorced, and widowed women under the age of 52 in China using discrete choice models such the Logit series and Probit [6]. Based on this information, the results revealed a negative correlation between age and education level and fertility intention. Martin's analysis, which was based on DHS data for 26 nations and regions, also shown that while education levels do consistently and negatively affect fertility levels, their specific effects vary from low to high levels of education [7]. A model of overlapping generations (OLG) with endogenous fertility and educational inputs was also built by Xi Yang [8]. It demonstrates how a rise in women's general literacy (measured as the proportion who have finished all nine years of compulsory schooling) is a factor in society's declining fertility rate. All of these things have an impact on women's willingness to have children. The dependency ratios for young people and the elderly make up the third factor. Tian Qing investigated the factors influencing the birth rate based on the OMP algorithm using ten years of relevant data from 2007 to 2017 that contained twenty variables, coming to the conclusion that the juvenile dependency ratio, per capita salary, and consumer price index were the most important variables influencing the birth rate of the population [9].

2. Method

2.1. Data Sources

All the data collected is from the "China Statistical Yearbook." The "China Statistical Yearbook" clearly shows the data from each of the years, and all the data were collected by the government, so it shows reality and authority, which can make the conclusion more persuasive. There are 7 variables chosen from the "China Statistical Yearbook" to analyze the relationship between them and the fertility rate.

2.2. Data Describing

According to Figure 1, it shows a gentle rise from 1999 to 2009, and during 2009 to 2017, the fertility rate was very volatile, and then there is a big drop-off jump from 2017 to 2020. Through the full implementation of the two-child policy, more significant positive effects should have been seen and the population should have shown a good trend, but due to factors that cannot be improved in a short time, such as the decline in the size of women of childbearing age and the delay in the age of

marriage and childbirth, as well as economic and social factors, there is a clear impact on people's willingness to have children and their fertility behavior.

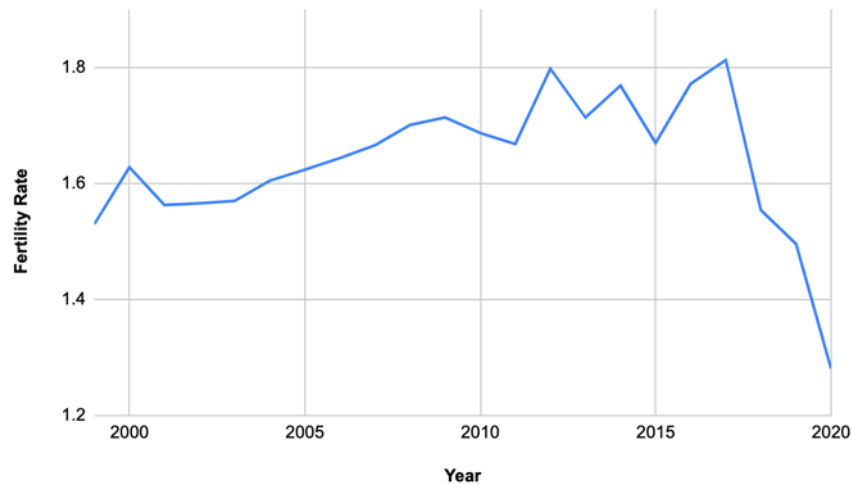


Fig. 1 The Fertility Rate during 1999-2020

2.3. Selection of Variables

There are seven aspects that need to be researched and analyzed: income per capita, female illiterate population as a percentage of the population over 15 years of age, infant mortality rate, resident consumption level, and average sales price of commercial properties. By analyzing the factors that influence fertility, it is also effective to know what factors are responsible when fertility changes. When the fertility rate goes up, it is possible to know what is being done well in a certain area, but when the fertility rate goes down, it is also possible to know what is not being done well enough and needs to be improved. We can use some analysis of the data to find the cause of low fertility or the root of the problem.

Songchen Li and Shiyang Zhang used stepwise regression to conclude that population composition and income level are the main causes of fertility and confirmed this using a linear regression model [10]. We can use a linear regression model to analyze how these factors affect fertility rates. The linear regression model analyzes the relationship between two variables by turning them into a linear relationship. For the factors influencing fertility, we can analyze them by linear regression. This image tells us intuitively whether the relationship between the factor and fertility is positive or negative, so the result can analyze whether the factor is a direct or indirect influence. In addition, when these problems arise, the government can focus on solving them so that the fertility rate can increase.

There are seven variables, which are represented with different data in order to better present the data for each variable, shown in Table 1.

Table 1. Variables Rename

Variable	Name
Fertility Rate (%)	Y
Income per capita (thousand ¥)	X ₁
Female illiterate population as a percentage of the population over 15 years of age (%)	X ₂
Infant mortality rate (%)	X ₃
Resident consumption level (thousand ¥)	X ₄
Average sales price of commercial properties (thousand RMB/m ²)	X ₅
The juvenile dependency ratio (%)	X ₆
The elderly dependency ratio (%)	X ₇

3. Results and Discussion

3.1. Data Processing

The fundamental facts about the data, including the minimum, maximum, mean, and variance, are shown in Table 2. The greatest fertility rate in this table is 1.81, the minimum fertility rate is 1.21, and the variance is 0.01, indicating that there are not many significant variations. It is therefore obvious that the birth rate in China is gradually falling.

Table 2. Data Information

Variable	Minimum	Maximum	Mean	Variance
Y	1.28	1.81	1.64	0.01
X ₁	0.87	10.41	4.87	11.61
X ₂	4.96	22.61	11.58	28.3
X ₃	5.4	54.3	16.99	152.26
X ₄	3.14	27.44	12.47	68.47
X ₅	2.05	9.9	5.08	6.22
X ₆	8.52	14.02	12.43	1.71
X ₇	7.1	19.7	12.54	9.46

3.2. Ridge Regression

Ridge regression, which is simply a modified least squares estimation approach, is a biased estimating regression technique used to analyze covariance data. The regression coefficients are more realistic and reliable by sacrificing the least squares approach's unbiased nature, but at the expense of some information and accuracy. The fit to the pathological data is also stronger than using the least squares method. In general, the (matrix) form of the regression analysis is as follows:

$$Y = \sum_{i=1}^p \beta_i x_i + \beta_0 \quad (1)$$

In general, the objective of solving the above regression problem using the least squares method is to minimize the following equation:

$$\hat{\beta} = \operatorname{argmin}_{\beta} \sum_{j=1}^N (y_j - \beta_0 - \sum_{i=1}^p \beta_i x_j)^2 \quad (2)$$

Ridge regression is to add a penalty term to the above minimization objective.

$$\hat{\beta}^{\text{bridge}} = \operatorname{argmin}_{\beta} \left\{ \sum_{j=1}^N (y_j - \beta_0 - \sum_{i=1}^p \beta_i x_j)^2 + \lambda \sum_{i=1}^p \beta_i^2 \right\} \quad (3)$$

3.3. Model Test

First of all, the data are tested by linear regression (the least squares method), and it shows us the VIF value in Table 3. The VIF value measures how multicollinear the model is and is used to determine whether cointegration—a high degree of correlation between the explanatory variables—is present in the model (VIF should be less than 10 or 5, strictly 5).

Table 3. VIF value

Variable	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇
VIF	234.934	33.708	13.436	477.656	206.546	3.963	54.215

Ridge regression is used to analyze the data because the VIF values are greater than 10. Table 4 displays the model's parameter results and test results, such as the standardized coefficient, t value, F test results, R^2 , modified R^2 , etc., which are used to evaluate the model's performance and examine its mathematical structure. The results of the Ridge regression demonstrated that there was a regression link between the independent variable and the dependent variable based on the F test, where the significance P value was 0.001***, which was significant at the level and the null

hypothesis was rejected. At the same time, the model's performance is respectable, with a goodness-of-fit R^2 of 0.798.

Table 4. Results of ridge regression analysis

K=0.139	standardized coefficient	<i>t</i>	<i>P</i>	R^2	Adjust R^2	<i>F</i>
	<i>Beta</i>					
X_1	0.026	0.335	0.743			
X_2	-0.247	-1.93	0.074*			
X_3	-0.488	-3.78	0.002***			
X_4	-0.034	-0.5	0.625	0.798	0.696	7.883(0.001***)
X_5	-0.032	-0.499	0.66			
X_6	0.662	5.755	0.000***			
X_7	-0.309	-2.793	0.014**			

Note: ***, **, * represent the significance levels of 1%, 5%, and 10% respectively

The formula for the model is as follows:

$$Y = 1.194 - 0.005X_2 - 0.005X_3 + 0.06X_6 - 0.012X_7 \quad (4)$$

According to Table 4, the regression coefficients B values of X_1 , X_4 and X_5 are 0, which indicates that they have no effect on the fertility rate. Therefore, this indicates that fertility is not affected by per capita income, level of residential consumption, or average sales price of commercial properties. Except for the variables with a regression coefficient of 0, the remaining variables have a significant effect on fertility. The regression coefficients of -0.247 for X_2 , -0.488 for X_3 and -0.309 for X_7 are all negative, which indicates that these three variables are negatively correlated with fertility. Therefore, it can be said that when the female illiterate population as a percentage of the population over 15 years of age, the infant mortality rate, and the elderly dependency ratio decrease, China's fertility rate tends to increase. In addition, the regression coefficient for X_6 is 0.662, a positive number, which also indicates a positive relationship between this variable and fertility. This data shows that when the juvenile dependency ratio increases, the fertility rate in China also increases.

4. Conclusion

The newborn mortality rate, the juvenile dependency ratio, the elderly dependency ratio, and the female illiteracy population as a percentage of the population over 15 years of age are all clearly major influencing aspects of the study findings that have a negative impact on fertility. In order to increase fertility rates, a nation must lower the rate of female illiteracy, which necessitates encouraging women to pursue higher education. Education is something that can influence women to think differently about the matter of having children. In particular, the role of education can be summed up as twofold: on the one hand, education provides women with knowledge (including knowledge of fertility); on the other hand, education affects people's socioeconomic status (e.g., altering husbands' levels of education, affecting people's places of residence (urban or rural), etc.), so that when education is widely available, fertility rates will also significantly rise. The infant mortality rate is the second element. A higher fertility rate results from a decline in infant mortality. The ratio of elderly reliance makes up the third element. Obviously, the state cannot increase fertility by decreasing the old dependency ratio, but it can improve the security of the elderly population's means of subsistence through social welfare, pension insurance, etc. The fertility rate will naturally rise if young people can lessen the stress of caring for the elderly and some of the financial burden.

The juvenile dependency ratio is the fourth determining element. A child's family has a significant impact on them. If they are raised in a happy family, they will desire to have children so that they can raise them in a happy family. On the other hand, if children grow up in a home where there are only daily arguments or no parental interaction, they will not grow up desiring a family and they are unlikely to want to have children. Therefore, the fertility rate grows along with the juvenile

dependency ratio. The nation still needs to make significant progress and keep expanding numerous policy benefits for families if it wants to raise its fertility rate. It is a historical necessity in our country to fully liberalize the policy of limiting fertility, and how to avoid falling into this historical trend of permanently declining fertility levels should be the main direction of thinking about fertility policy. Most importantly, though, is to change the mindset of today's youth through policy rationalization. Declining fertility rates are a fact that almost all modern countries have experienced or are experiencing.

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