The 6th International Conference on Economic Management and Green Development (ICEMGD 2022)
DOI: 10.54254/2754-1169/4/20221035

Analysis of factors affecting fertility rate in China

Han Chen[1], Jinfeng Jiang[2],Yaoyu Wang[3,a,*], and Zihan Zhang[4]

[1]*Shanghai Shangde Experimental School, 200072, Shanghai, China*
[2]*Guangzhou 7 middle school, Guangzhou510080, China*
[3]*Department of Mathematics, Tiangong University, Tianjin, 300387, China*
[4]*Sino Canada High School, Suzhou, 215200, China*
a. 1810810222@tiangong.edu.cn
**corresponding author*

Abstract: Fertility is an important factor that determines the trend of population development in China. In recent decades, China's fertility rate is declining. Nevertheless, the formation mechanism and influence behind it are still lack of unified explanation. Hence, this article researches and analyzes the reasons of the decrease of China's fertility rate through factor analysis and cluster analysis based on the data collected in the past two decades since 2002. On the basis of this article, the per capita disposable income of residents, the crude divorce rate, the number of divorce registrations, the urban population ratio, and the high school enrollment rate have a prominent relevance with the fertility rate. In addition, the fertility rate alters in the past 20 years in this paper can be divided into three categories: the fertility rate was relatively stable from 2002 to 2011, the fertility rate increased significantly and fluctuated slightly from 2012 to 2015, and the fertility rate decreased rapidly from 2016 to 2021. If the government hopes to maintain a high birth rate, it can achieve this by easing the birth policy and improving the divorce calm down period system.

1. Introduction

In the past few decades, China, with its family planning policy, has focused on the quality of its population, which caused the current low birth rate. On January 17, 2022, the National Bureau of Statistics released China's economic data for 2021. The annual birth rate was 7.52% [1]. Since the two-child policy was fully implemented, half of the newborns in the country were second-children. This helped the birth rate recover in the short term, but only two years later, it has halved by 2015. The national birth rate did increase in 2016 and 2017, reaching 12.95 and 12.43 per 1,000, respectively [2]. In the first two years, the birth rate was higher than that during the 12th Five-Year Plan period (0.84 ‰ and 0.32‰ higher respectively), while in the last two years, it was much lower than that during the 12th Five-Year Plan era (1.17‰ and 1.63‰ lower respectively). On a four-year average, the birth rate was 11.70 per 1,000, still lower than the 12.11 per 1,000 recorded during the 12th Five-Year Plan Period (down 0.41 per 1,000). Therefore, even from the perspective of the annual birth rate, it cannot be said that it has increased from the level before the universal two-child policy, on the contrary, it has decreased [3]. In 2021, China lifted the three-child policy, yet the fertility rate fell to the lowest in the world, reflecting the deficient desire to have children.

For more than ten years, there are two main ways of thinking in the academic circle to evaluate the fertility rate at the national level. One view is that such "low" fertility rates are largely due to under-reporting and that the "real" fertility rate needs to be addressed. The other holds that the existing concepts, indicators and analysis methods can no longer truly reflect the fertility level

DOI: 10.54254/2754-1169/4/20221035

under the condition of delayed fertility age in the process of transition to a low fertility rate, and it is necessary to innovate theories and methods, especially to strengthen the theoretical research on low fertility rate, to correctly reflect and understand the fertility level of China. Traditional scholars believe that the birth rate is negatively correlated with the level of regional economic. For instance, developing countries had higher fertility rates than developed countries, and areas with more educated citizens tend to have lower fertility rates. In 1978, the overall number of higher education people in China was 2.28 million, with a total enrollment rate of 2.7 %. In 2017, it reached 37.79 million, with a total admission rate of 45.7 percent. The rapid development of Education in China sharply contrasts with the low fertility level [4]. The more developed the economy, the stronger the social attributes of people, and the biological instinct to procreate weakened. Studies have shown that income was positively related to fertility rates for a certain range, since the "two children" policy implementation, wealthier families and economically more developed areas in raising a second child will be strong, and great changes have taken place in population birth family and environment, from the original alive, the poorer the birth to the rich, bearing force transfer from rural to urban [5].Besides, due to the imbalance between urban and rural economic development levels, the proportion of urban residents will cause differences in fertility intentions of provinces, cities and autonomous regions, indirectly affecting the birth rate [6]. In addition, the impact of childbirth on work (especially for women) also affects people's enthusiasm to bear children. Every birth to a child will reduce the wage rate of Chinese women by about 7% [7]. In today's housing expense is totally out of proportion to residents' salaries and there is a huge gap between the rich and the poor, income level is a more significant and relatively basic factor influencing individual fertility decisions. The realistic basis of this intuitive feeling lies in the traditional concept of being born and caring for the aged, which reduces the uncertainty caused by insufficient income in the future of giving birth. In real society, "being born and supporting cannot afford" means that low income can hardly support the cost of raising children, thus reducing people's willingness to bear children [8]. When the total fertility rate rises above 1.5, the negative correlation between the Gini coefficient and the total fertility rate is more significant [9]. Of course, the marriage rate also objectively affects the birth rate. From 1985 to 2018, the number of annual marriages increased by 21.97%, while the number of divorces soared by 8.74 times, and the divorce ratio increased by 38.48 percentage points [10]. The fertility rate is an important factor determining the trend of China's population development. This article is aimed at finding out the factors influencing its change.

Analyzing the database of the National General Social Survey from 2002 to 2021, this paper aims to anwser two questions: First, what specific factors affect China's fertility rate? Secondly, in response to China's current low birth rate, if the current birth policy should be modified.

2. Methodology

Through the analysis of China's birth rate, this paper employs SPSS software to conduct factor analysis and cluster analysis on the factors influencing China's birth rate.

2.1. Introduction to methodology

Factor analysis: factor analysis refers to the statistical extraction of common factors from variable groups as a technology. Factor analysis can uncover hidden representative factors in a wide range of variables. Classifying variables with the same essence into a factor can reduce the number of variables and test the hypothesis of variable relationship. Cluster analysis: cluster analysis refers to the analysis process of grouping a set of physical or abstract objects into multiple classes composed of similar objects.

DOI: 10.54254/2754-1169/4/20221035

Cluster analysis is the process of categorizing a set of physical or abstract objects into multiple classes made up of similar objects.

2.2. Variable selection

In the data analysis of the influencing factors of China's birth rate, the sample interval is 2002-2021, and the data originates primarily from the China Statistical Yearbook 2002-2021.

Table 1: Relevant indicators.

Category	Indicator name	Index interpretation	Indicator naming
Fertility level	Birth rate	Ratio of annual birth population to annual average total population	Y
Economic level	Per capita disposal	Ratio of all cash used for families to incomes	X_1
Human level	divorce rate	Ratio of annual birth population to annual average total population	X_2
	Number of marriage registrants	—	X_3
	Number of divorce registrants	—	X_4
Social level	Total dependency ratio	The ratio of the total population aged 0-14 and over 65 to the population of working age	X_5
	Employee index	Reflect employment	X_6
	Urban population ratio	Ratio of urban population to national population	X_7
	High school enrollment rate	Percentage of the number of students entering a higher school and the number of graduates in this grade	X_8

The population birth rate is influenced by lots of factors. By researching and referring relevant literature, combined with the principles of data availability and representativeness, it is carried out at four levels: economic level, population level, policy level and social level. Consequently, this paper originally chose the per capita disposable income of residents to measure the level of economic development. Four variables, total dependency ratio, employee index, urban population ratio, and high school enrollment rate, were used to measure the level of social development: crude divorce rate, number of marriage registrations, and number of divorce registrations. These three variables were used to measure the level of population structure: total dependency ratio, employee index, urban population ratio The four variables of high school enrolment ratios are used to measure the level of social development. These nine variables are selected as the impact indicators of the birth rate. The details are shown in the chart above.

From now on, factor analysis and cluster analysis are conducted with different factors as independent variables and population birth rate as the dependent variable.

DOI: 10.54254/2754-1169/4/20221035

2.3. Descriptive statistical analysis

The data from 2002 to 2021 are selected. The data are mainly from the China Statistical Yearbook 2002-2021. Using the per capita disposable income of residents, the crude divorce rate, the number of marriage records, the number of divorce records, the total dependency ratio, the industrial population index, the urban population index, and the urban population ratio as indicators, the data are as follows:

Table 2: 2002-2021 China's birth rate and various indicators.

Year	Birth rate (‰)	Disposable income (yuan)	divorce rate (‰)	…	Employment index (%)	Rate of urban population (%)	High school enrollment rate (%)
2002	12.86	4532	0.90	…	47	39.09	83.5
2003	12.41	5007	1.05	…	47.6	40.53	83.4
2004	12.29	5661	1.28	…	48．0	41.76	82.5
2005	12.40	6385	1.37	…	48.5	42.99	76.3
2006	12.09	7229	1.46	…	48.8	44.34	75.1
2007	12.10	8584	1.59	…	50.1	45.89	70.3
2008	12.14	9957	1.71	…	49.7	46.99	72.7
2009	11.95	10977	1.85	…	43	48.34	77.6
2010	11.90	12520	2．0	…	50.6	49.95	83.3
2011	13.27	14551	2.13	…	49	51.83	86.5
2012	14.57	16510	2.29	…	47.1	53.1	87
2013	13.03	18311	2.57	…	47.8	54.49	87.6
2014	13.83	20167	2.67	…	48.2	55.75	90.2
2015	11.99	21966	2.79	…	47.9	57.33	92.5
2016	13.57	23821	3.02	…	47.8	58.84	94.5
2017	12.64	25974	3.15	…	49.2	60.24	95
2018	10.86	28228	3.2	…	48.3	61.5	95.5
2019	10.41	30733	3.36	…	47.8	62.71	96
2020	8.52	32189	3.09	…	47.5	63.89	96.5
2021	7.52	35128	3.58	…	47.7	64.72	97

DOI: 10.54254/2754-1169/4/20221035

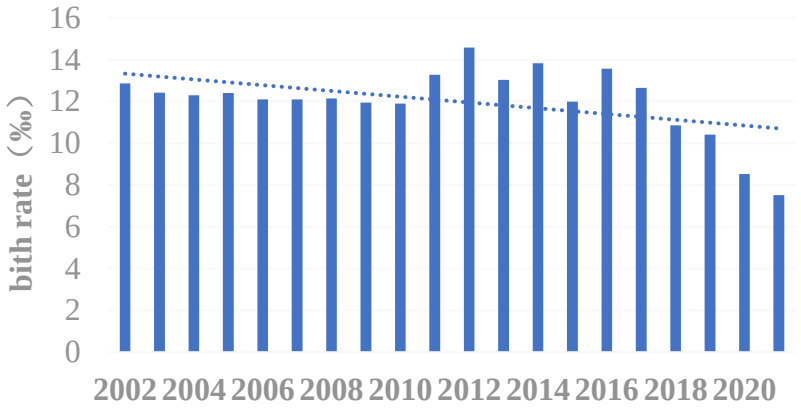

Figure 1: 2002-2021 birth rate.

Between 2002 and 2010, the birth rate in China had a slow downward trend from 12.86% to 11.90%. Since 2011, China has fully opened the two-child policy, and the birth rate has rebounded. After reaching a peak of 13.83% in 2012, there has been a small fluctuation, but it has basically remained above 12%. After 2017, the birth rate fell sharply, from 12.64% to 7.52% in five years. Although the two-child policy in 2011 has a certain effect on the improvement and stability of the birth rate, it is still showing a downward trend.

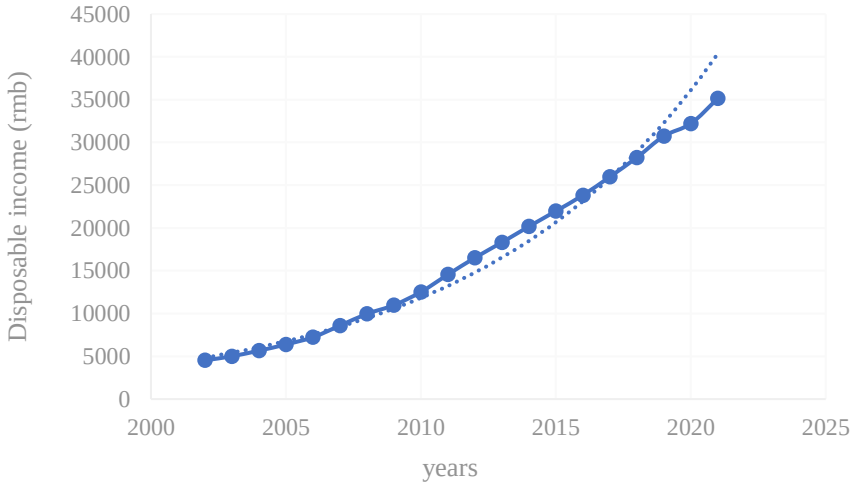

Figure 2: 2002-2021 per capita disposable income.

The disposable income of citizens has increased year by year, from 4532 yuan in 2002 to 35128 yuan in 2021. And the growth rate is faster and faster, rising exponentially.

DOI: 10.54254/2754-1169/4/20221035

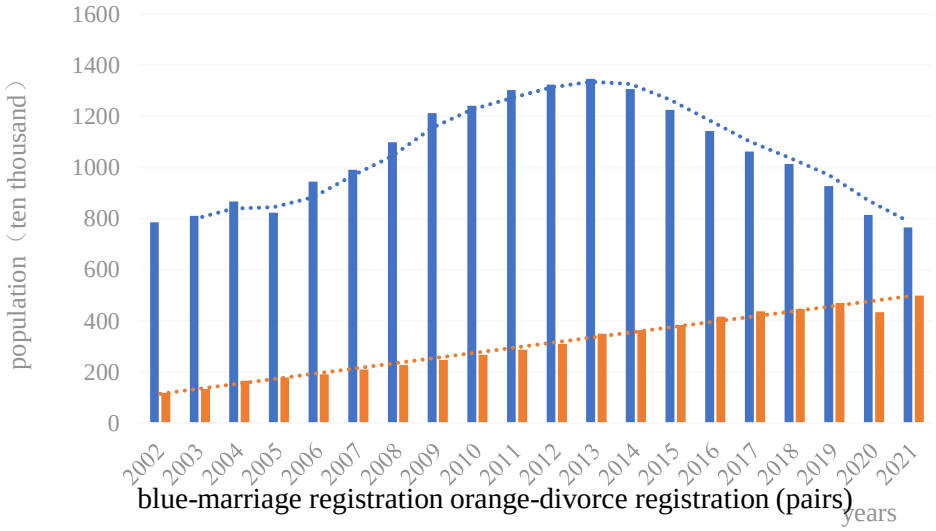

Figure 3: Number of marriage registration and divorce registration from 2002 to 2021.

The bar graph displays the number of marriage registrations and the number of divorce registrations between 2002 and 2021. From 2002 to 2013, the number of marriage registrations increased year by year, and the rising speed was more and more gentle, reaching a peak of 13.4693 million pairs in 2013, which was close to the peak period of the birth rate. The number of marriage registrations decreased rapidly after 2013. At the same time, the number of divorce registrants has continued to rise at a growth rate of about 10% since 2002, although it has decreased slightly in 2020, and the overall trend is upward.

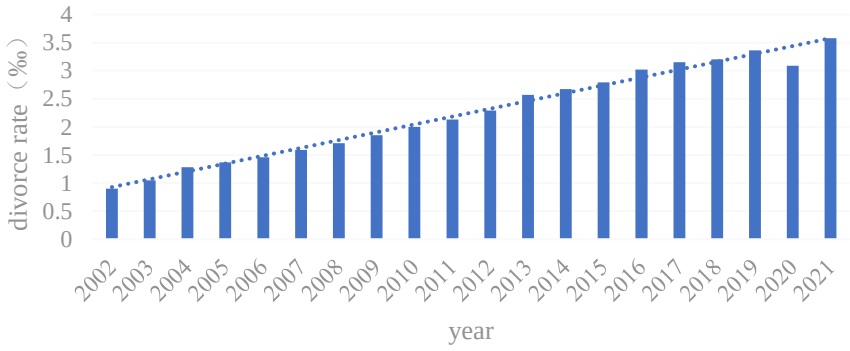

Figure 4: 2002-2021 crude divorce rate.

From 2002 to 2019, the crude divorce rate increased linearly, although it decreased slightly in 2020. The general upward trend is more in line with the trend towards changing divorce registrations.

DOI: 10.54254/2754-1169/4/20221035

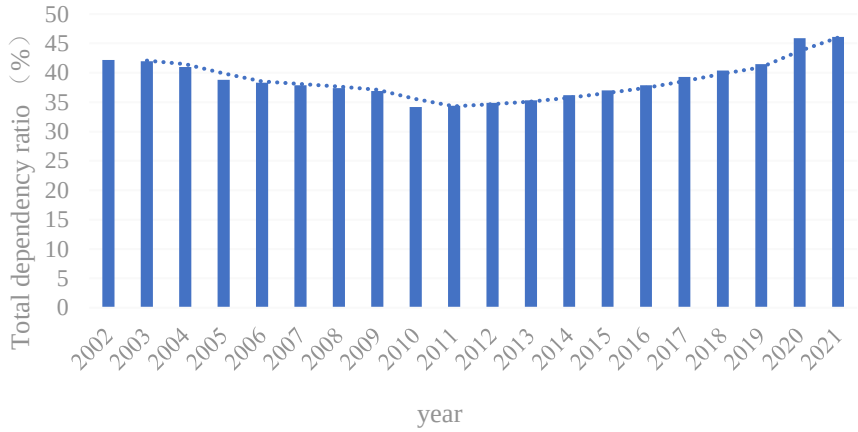

Figure 5: 2002-2021 total dependency ratio.

Since 2002, the total dependency ratio has decreased year by year, reaching a trough of 34.2% in 2010, then progressively increased, but the global change is small.

3. Results and discussion

According to factor analysis and cluster analysis, this paper studies factors having impact on fertility rate, and the specific process is as follows: Kaiser-Meyer-Olkin (KMO) test and Bartley sphere test are carried out. Factor analysis can be implemented only when KMO test coefficient is higher than 0.5 and a P value is less than 0.05.

Table 3: KMO test and Bartlett test.

KMO value		0.685
Bartlett test	Approximate chi square	374.924
	df	28.000
	p	0.000***
Note: ***, ** and * show the significance level of 1%, 5%, and 10% respectively.		

The results of KMO test showed that the value of KMO was 0.685, which was higher than 0.5. Meanwhile, the outcomes of the Bartlett sphericity test supported that the significance P value was 0.000***, presenting significance at the level, rejecting the null hypothesis. There was correlation between variables, and the factor analysis was effective. That is, the total dependency ratio, divorce rate, marriage registration number, divorce registration number, resident income level, employment rate, urban population ratio and high school enrollment rate are the probable factors concerning the birth rate. Then factor analysis was carried out on eight themes.

DOI: 10.54254/2754-1169/4/20221035

Table 4: Total variance interpretation table.

Component	Characteristic root			Interpretation rate of variance after rotation		
	Characteristic root	Variance percentage	Accumulation	Characteristic root	Variance percentage	Accumulation
1	4.834	60.42%	60.42%	4.811	60.14%	60.14%
2	1.915	23.94%	84.36%	1.913	23.91%	84.05%
3	1.002	12.53%	96.88%	1.027	12.83%	96.88%
4	0.209	2.62%	99.50%			
5	0.032	0.40%	99.90%			
6	0.007	0.09%	99.99%			
7	0.001	0.01%	100.00%			
8	0	0.00%	100.00%			

In the variance explanation table, when the principal component is 4, the characteristic root of the total variance explained is lower than 1, so three principal components are extracted, and the contribution rate of variable explanation reaches 99.498%. In other words, these three principal components are considered to concentrate 99.498% information on the eight preliminary variables, and the above eight variables are separated into three sorts for analysis.

Table 5: Factor load coefficients.

Definition	Factor 1	Factor 2	Factor 3	Commonality (common factor variance)
Per capita disposable income of residents (yuan)	0.988	0.121	-0.013	0.991
Crude divorce rate (‰)	0.992	-0.052	0.013	0.987
Number of marriage registrations (10000 pairs)	0.153	-0.979	-0.048	0.984
Number of divorce registrants (10000 pairs)	0.994	-0.035	0.011	0.989
Total dependency ratio (%)	0.242	0.955	-0.125	0.986
Employee index (%)	-0.02	-0.048	0.997	0.997
Urban population ratio (%)	0.992	-0.028	0.007	0.986
High school enrollment rate (%)	0.892	0.146	-0.117	0.83

According to the proportion in Table 5, factor 1 has a large load on the five variables of per capita disposable income of residents, crude divorce rate, number of divorce registrants, urban population

DOI: 10.54254/2754-1169/4/20221035

rate and high school admission ratio, so these five variables are representative variables of factor1.Marriage registration number and total dependency ratio were representative variables of factor 2. The practitioner index is a representative variable of factors.

Table 6: Component score coefficient matrix.

	Component		
	1	2	3
Per capita disposable income of residents (yuan)	0.204	0.042	0.021
Crude divorce rate (‰)	0.210	-0.048	0.036
Number of marriage registrations (10000 pairs)	0.053	-0.526	-0.111
Number of divorce registrants (10000 pairs)	0.209	-0.040	0.034
Total dependency ratio (%)	0.026	0.492	-0.051
Employee index (%)	0.023	0.044	0.981
Urban population ratio (%)	0.209	-0.036	0.031
High school enrollment rate (%)	0.181	0.050	-0.082

The common factor score is calculated as follows:

$$F_1=0.204\times X_1+0.210\times X_2+0.052\times X_3+0.209\times X_4+0.026\times X_5+0.023\times X_6+0.209\times X_7+0.181\times X_8 \quad (1)$$

$$F_2=0.042\times X_1-0.048\times X_2-0.056\times X_3-0.040\times X_4+0.492\times X_5+0.044\times X_6-0.036\times X_7+0.050\times X_8 \quad (2)$$

$$F_3=0.021\times X_1+0.036\times X_2-0.111\times X_3+0.034\times X_4-0.051\times X_5+0.981\times X_6+0.031\times X_7-0.082\times X_8 \quad (3)$$

$$\text{Total } F=\frac{60.137\times F_1+23.911\times F_2+12.834\times F_3}{96.883}=0.621\times F_1+0.247\times F_2+0.132\times F_3 \quad (4)$$

As shown in the table, residents' per capita disposable income, crude divorce rate, divorce registration, urban population ratio and high school enrollment rate have more information about their contributions to factor1. Marriage registration, total dependency ratio, contributing factor 2; The employment index contributes much to factor 3, and the common factor 3 can be named as employee index. 4Finally, cluttering analysis was conducted to classify the samples from 2002 to 2021.

Table 7: Initial clustering centers.

Clustering	1	2	3
Per capita disposable income of residents (yuan)	4532	35128	32189
Crude divorce rate (‰)	0.9	3.58	3.09
Number of marriage registrations (10000 pairs)	786	765.49	814.33
Number of divorce registrants (10000 pairs)	117.7	499.01	433.9
Total dependency ratio (%)	42.2	46.1	45.9
Employee index (%)	47	47.7	47.5
Urban population ratio (%)	39.09	64.72	63.89
High school enrollment rate (%)	83.5	97	96.5

DOI: 10.54254/2754-1169/4/20221035

Table 8: Iteration history.

Iteration	Changes in cluster centers		
	1	2	3
1	5494.657	0	6040.449
2	754.38	2445.877	3078.308
3	725.154	1114.738	1953.814
4	0	0	0

Convergence is reached. That is because no change or only small change is there in the cluster center. The maximum absolute coordinate alteration of any center is 0.000. The present iteration is 4. The minimum distance between the original centers is 2940.127. As can be seen from Table8, when the number of iterations is the fourth, the changes of cluster center are all 0,and the iteration is terminated .Categories initially randomly generated by the system, after four iterations, can serve as category centers.

Table 9: Final clustering centers.

	clustering		
	1	2	3
Per capita disposable income of residents (yuan)	8540	31570	21125
Crude divorce rate (‰)	1.53	3.31	2.75
Number of marriage registrations (10000 pairs)	1007.82	880.27	1234.65
Number of divorce registrants (10000 pairs)	202.57	462.26	376.91
Total dependency ratio (%)	38.3	43.5	36.8
Employee index (%)	48.2	47.8	48
Urban population ratio (%)	45.17	63.21	56.63
High school enrollment rate (%)	79.1	96.3	91.1

As can be seen from the above table, category 1 is the one with the smallest index. Category 2 is the largest category of all indicators. Category 3 is the middle of all index values. In this way, we divided the 20 samples into 3 categories according to high, middle and low levels. As a result, years can be separated into the following three periods: the first period is 2002 to 2011, the second period is 2012 to 2015, and the third period is 2016 to 2021. It can be found that from 2002 to 2011, residents' income, divorce rate and high school enrollment rate were relatively low, while from 2016 to 2021, these three indicators increased significantly.

Table 10: Case categories in each cluster.

clustering	1	10
—	2	4
—	3	6
validity	—	20
deficiency	—	0

DOI: 10.54254/2754-1169/4/20221035

It can be seen from Table 10 that the 20 samples are divided into three categories, which is inclusive of 10 samples in the first category, 4 samples in the second one, and 6 samples in the third one. They are consistent with the final clustering results. The fertility rate was relatively stable from 2002 to 2011, while it increased significantly and fluctuated slightly from 2012 to 2015.The fertility rate fell rapidly from 2016 to 2021. Accordingly, in Table 9, the three indicators of resident income, divorce rate and high school enrollment rate from 2016 to 2021 were significantly higher than those from 2002 to 2011. It can be seen that the fertility rate is negatively correlated with the above three indicators.

4. Conclusion

Through the analysis of China's birth rate, this paper uses SPSS software to conduct factor analysis and cluster analysis on the reasons of China's fertility rate. The key points of conclusions are as follows:

The fertility rate in China generally shows an upward and then downward trend. Since 1990, China is already in a stage of low fertility. Since 2011, China has fully opened the two-child policy, and the birth rate has rebounded. In 2021, the birth rate hit a new low and fell precipitously.

Through the factor analysis and cluster analysis of data in the past two decades, the variable screening is carried out, and the conclusion is drawn: the reasons of the low fertility rate are complicated, and the per capita disposable income of residents, the number of marriage registration, and the index of employees are the most important indicators affecting the birth rate in China.

This paper mentions that income reflects the level of social and economic development, which will virtually reduce people's income really used for daily consumption in addition to housing loans, so that families can't afford heavy parenting costs. Moreover, the increase of residents' per capita disposable income will provoke people's aspiration of high-quality life, and raising children is bound to mean more constraints, both economically and temporally. In addition, the current higher income means that even in their later years, there are at least more pensions, which reduces the concept of "raising children to prevent old age", and naturally they will not have a sense of urgency to have children, and they are more willing to have good children. With regarding to the number of marriage registrations, it is obvious that in China, where the social atmosphere is relatively conservative, few people choose to get pregnant before marriage, and they basically consider having children after marriage. The corresponding divorce rate is the same. The number of employed people reflects the employment rate, but today's enterprises have not established a good maternity security system, and it is common for women to be marginalized in the workplace because of maternity leave. With the development of society and the increase of living costs, the income of men alone is not enough to maintain the normal operation of families. The employment rate of women is rising, and women are paying more attention to self-development.

Meanwhile, this paper believes that the government should focus on enhancing people's willingness to bear children while loosening the fertility policy. For example: crack down on the education and training industry to reduce parenting costs; Control housing prices in low-income areas to improve the buffer zone for people's survival and leave enough resources to raise the next generation; Local governments should implement the divorce calm down period system, minimize irrational divorce, and publicize the happy side of married life to promote the rise of marriage rate. Enterprises should abide by the labor law, give the same respect to women after childbirth, and improve the sense of reproductive security.

References

[1] *Chen W China's low fertility rate and three child policy -- an analysis based on the data of the seventh national census Population and economy, 2021 (05): 25-35*

DOI: 10.54254/2754-1169/4/20221035

[2] *Sun X X, Gao Y, Yuan X and Wang Z X Analysis and prediction of China's birth rate Journal of Shandong Normal University (NATURAL SCIENCE EDITION), 2020,35 (03): 256-264.*
[3] *Feng X T the implementation effect of the "comprehensive two child" policy: existing evaluation analysis and thinking Journal of Southeast University (PHILOSOPHY AND SOCIAL SCIENCES EDITION), 2020,22 (05): 103-111+156.*
[4] *Zhang C and Wan XY has educational progress reduced the birth rate?Statistics and information forum, 2019,34 (07): 108-114.*
[5] *Xu K, Hu D W and Liu Y Fertility policy, cost socialization and birth rate Journal of Guizhou University of Finance and economics, 2022 (02): 69-78.*
[6] *Cai D D and Yuan J Y The impact of urban-rural income distribution gap on the birth rate Journal of Shenyang University of Technology (SOCIAL SCIENCE EDITION), 2019,12 (04): 313-317.*
[7] *Yu J and Xie Y effect of childbirth on female wage rate in China Population research, 20143801:18-29.*
[8] *Li Z L Income and fertility: an explanation for the change of fertility rate in China Economic trends, 2016 (05): 37-48.*
[9] *Wang C L and Luo Chun Income distribution adjustment, social security improvement and fertility recovery -- EU experience and Enlightenment in the stage of low fertility Western forum, 2022, 3202:78-93.*
[10] *Zhang C, Chen Y X and Zheng Q Trends, influencing factors and Countermeasures of divorce rate in China Journal of Xihua University (PHILOSOPHY AND SOCIAL SCIENCES), 2020,39 (02): 41-49.*