Analysis of the Factors Affecting Education Expenditure in Sichuan, China: Based on Grey Correlation Method of Mathematical Model

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Keywords: Education Expenditure, Grey Correlation Analysis, Correlation Coefficient Mathematical Model.

Abstract: The level of educational investment is one of the important standards to measure a country's civilization and national quality. The Chinese government's educational expenditure has increased year by year. After 2012, the proportion of education expenditure in GDP has continued to be more than 4%. Sichuan Province is one of the big provinces in Western China, and the regional education level and education expenditure are improving year by year. This paper uses the grey correlation analysis method of evaluation model in mathematical modeling to build a model, applies the model to calculate the correlation coefficient and correlation degree of the factors that affect the education expenditure in Sichuan Province, and judges the importance of each factor. It concludes that the economic development level, industrial structure, population scale, population structure, urbanization degree, fiscal centralization and decentralization degree, the number of college graduates have a significant impact on public financial education expenditure.

1 INTRODUCTION

One of the important standards to measure a country's civilization and national quality is the level of a country's education input. Adolf Wagner, a famous German economist, summed up the growth of public sector expenditure in Europe, the United States and Japan in the 19th century and concluded that with the increase of real income, the growth of expenditure on education and culture in fiscal expenditure would be faster than the growth of GDP. The main reasons why the government provides financial expenditure to develop education are as follows. Education is an effective means to improve the efficiency of a country's human capital, it is also an effective way to achieve fair income distribution. From the financial practice experience of countries around the world, the government, especially developing countries, plays an important role in education. In recent years, the education expenditure of China accounts for about 16% of the fiscal expenditure and about 4% of GDP. The practice in China also conforms to this trend. What are the factors affecting public education expenditure and how judge the importance of each influencing factor? Rong Wang and Jianfang Yang (2008) constructed an econometric model to analyze the education fiscal expenditure behavior of local governments in China, taking the economic development level, industrial structure, population size and structure, urbanization degree, fiscal decentralization, etc. as independent variables and the relative number of public education expenditure as dependent variables. Wenjun Che (2010) analyzed the influencing factors of public finance education expenditure in Guangxi by using grey correlation analysis. Huitian Bai and Li'an Zhou (2020) draw a conclusion through mathematical model analysis that economic decentralization has improved the budget situation of local governments by promoting the rise of local industries and the increase of financial resources. Drawing on the analysis methods of scholars, this paper analyzes Sichuan public education expenditure and its influencing factors and judges the importance of each factor by using the grey correlation analysis method in the evaluation model of mathematical modeling.

2 METHOD

Grey relation analysis (GRA) is a multi-factor statistical analysis method. It was proposed by Chinese scholar Julong Deng in 1982 and received the attention and support of scholars and experts.

Li, X. and Liu, X.
Analysis of the Factors Affecting Education Expenditure in Sichuan, China: Based on Grey Correlation Method of Mathematical Model.
DOI: 10.5220/0011935100003613
In *Proceedings of the 2nd International Conference on New Media Development and Modernized Education (NMDME 2022)*, pages 609-613
ISBN: 978-989-758-630-9

Grey correlation analysis is a method to judge the degree of correlation between factors according to the similarity of the geometric shapes of the change curves of various factors. Through the quantitative analysis of the development trend of the dynamic process, this method completes the comparison of the geometric relationship of the relevant statistical data of the time series in the system, and obtains the grey correlation degree between the reference series and the comparison series. The specific calculation steps are as follows:

2.1 Definite Sequence

Set reference sequence Y_{0t}, compare sequence X_{it}.

t=1,2,3,…,n； i=1,2,3…,m

t indicates different periods and i indicates different sequences.

2.2 Dimensionless Processing

Since the data in the reference sequence and the comparison sequence may be affected by different units to draw correct conclusions, the data are dimensionless processed. In this paper, the mean processing method is selected, which divides the series of data by the mean.

$$x_{it} = \frac{X_{it}}{\overline{X_t}} \quad (1)$$

t=1,2,3,…,n. i=1,2,3…,m.

$\overline{X_t}$ represents the mean of series i.

2.3 Calculate Correlation Coefficient

$$\delta_{it} = \frac{\min_t \min_i |Y_{0t} - X_{it}| + \rho \cdot \max_t \max_i |Y_{0t} - X_{it}|}{|Y_{0t} - X_{it}| + \rho \cdot \max_t \max_i |Y_{0t} - X_{it}|} \quad (2)$$

t=1,2,3,…,n.i=1,2,3…,m.ρϵ(0,1).

2.4 Calculate Relevance

The correlation degree is the average value of the correlation coefficient.

$$\tau_i = \frac{1}{n} \cdot \sum_{i=1}^{n} \delta_{it} \quad (3)$$

2.5 Relevance Ranking

Degree of association to be calculated τ_i results are arranged in ascending order. The larger the correlation value, the closer the relationship between the influencing factors.

3 EMPIRICAL ANALYSIS PROCESS

3.1 Data Indicator Selection

This paper selects Sichuan provincial government's education expenditure and the influencing factors as the research object. The data are from Sichuan statistical yearbook and China Statistical Yearbook from 2010 to 2020. The paper selects the proportion of Sichuan provincial government's education expenditure in the province's fiscal expenditure as the reference sequence, and selects the regional economic development level, industrial structure, population size, population structure, urbanization degree, fiscal centralization, and the number of ordinary college graduates as the comparative series.

Table 1. Interpretation of variables

Sequence classification	variables	Symbols
Reference sequence	Relative amount of education expenditure	Y_0
Comparison sequence	Economic development level	X_1
	Industrial structure	X_2
	Population size	X_3
	Population structure	X_4
	Urbanization degree	X_5
	Financial centralization and decentralization	X_6
	Total number of university graduates	X_7

The relative expenditure of public education expenditure is the proportion of total education expenditure in Sichuan Province to total fiscal expenditure, expressed by Y_0. Economic development level is expressed by per capita GDP as X_1. The industrial structure is measured by the proportion of the output value of the tertiary industry in Sichuan Province to the total output value of the region, expressed by X_2. The population scale is measured by the permanent resident population of Sichuan Province at the end of the year, which is expressed by X_3. The population structure is expressed by the ratio of the population aged 0-14 years to the population aged 15-64 years in China, expressed by X_4. The degree of urbanization is expressed by the ratio of the urban resident population to the total regional resident population, which is expressed by X_5. Fiscal centralization and decentralization is measured by the ratio of Sichuan's per capita fiscal expenditure to the state's per capita fiscal expenditure, which is expressed by X_6. The

number of college graduates is expressed by X_7 based on the number of graduates of ordinary colleges and universities published in the regional statistical yearbook.

Table 2. Reference series and comparative series of influencing factors of public education expenditure

Year	Y_0	X1	X_2	X_3	X_4	X_5	X_6	X_7
	%	Yuan/person	%	10000 persons	%	%	%	person
2010	12.697	21230	38.065	9001.3	22.282	40.18	70.577	1086215
2011	14.645	26136	38.867	9058.4	22.177	41.85	63.734	1139316
2012	18.221	29627	39.916	9097.4	22.267	43.35	64.661	1223680
2013	16.660	32750	40.884	9132.6	22.192	44.96	66.424	1270818
2014	15.550	35563	42.518	9159.1	22.480	46.51	67.293	1328329
2015	16.703	37150	44.455	9102	22.603	48.27	64.785	1387889
2016	16.255	40297	47.642	9137	23.035	50	65.000	1446559
2017	15.977	45835	50.319	9113.4	23.398	51.78	65.775	1499715
2018	15.058	51658	52.253	9121.8	23.736	53.5	67.706	1564710
2019	15.258	55619	52.559	9099.5	23.796	55.36	67.135	1661737
2020	15.057	58126	52.411	9081.6	26.093	56.73	70.877	1800903

Data source: according to Sichuan statistical yearbook and China Statistical Yearbook

3.2 Grey Correlation Analysis of Public Education Expenditure in Sichuan Province

The author collated the collected data, imported the data into Scientific Platform Serving for Statistics Professional (SPSSpro), and applied the grey correlation analysis function in the comprehensive evaluation analysis in the data analysis toolbar of the data processing platform to work with data. In the system, the relative expenditure of public education is put into the parent series, and the economic development level, industrial structure, population structure, urbanization degree, financial centralization and decentralization, the number of college graduates are put into the characteristic series. Since the data do not show obvious increasing or decreasing characteristics, the paper selects the non dimensional processing method as the mean value and the resolution coefficient ρ select its commonly used value of 0.5. The system uses formula (2) to calculate the correlation coefficient δ. The results are shown in table 2. The correlation coefficient represents the degree of correlation between the factors affecting public education expenditure and the relative expenditure on public education in the corresponding dimensions. The larger the number, the stronger the correlation. Calculate the grey correlation degree τ by formula (3) , the results of τ are shown in table 3.

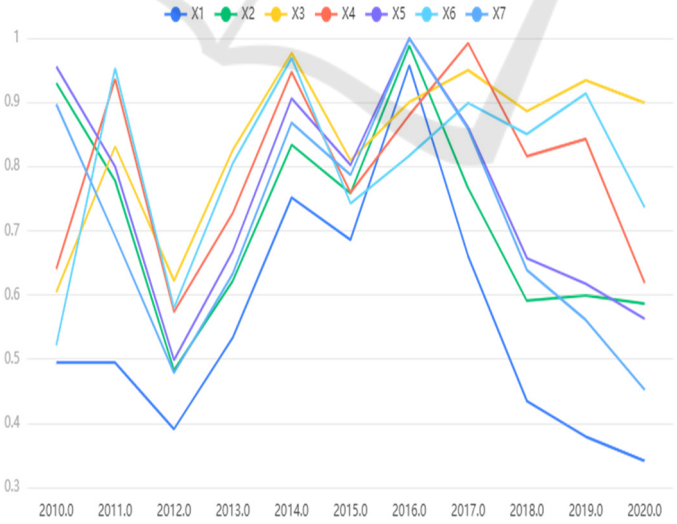

Fig. 1. Correlation coefficient diagram

Table 3. Correlation coefficient

Year	δ_{X1}	δ_{X2}	δ_{X3}	δ_{X4}	δ_{X5}	δ_{X6}	δ_{X7}
2010	0.494523	0.929694	0.604319	0.640389	0.955503	0.521617	0.896802
2011	0.494369	0.777822	0.831435	0.936117	0.799839	0.953227	0.691483
2012	0.390897	0.482828	0.622167	0.573633	0.498630	0.579954	0.478549
2013	0.533545	0.621769	0.825664	0.727610	0.668003	0.805226	0.633047
2014	0.751577	0.833505	0.976717	0.947384	0.906256	0.969200	0.868380
2015	0.685656	0.758464	0.810012	0.759366	0.802474	0.742746	0.786947
2016	0.957854	0.988302	0.900638	0.880370	1.000000	0.816671	0.998898
2017	0.660871	0.766350	0.950207	0.992207	0.861244	0.899065	0.858742
2018	0.434400	0.590931	0.886157	0.816135	0.657210	0.850552	0.638366
2019	0.379203	0.599075	0.934251	0.842815	0.617379	0.913844	0.560993
2020	0.341407	0.586230	0.899377	0.618861	0.562756	0.736556	0.452212

Table 4. Ranking of correlation degree of influencing factors of Sichuan Education Expenditure

Evaluation items	Symbols	Relevance	Rank
Population size	τ_3	0.84	1
Financial centralization and decentralization	τ_6	0.799	2
Population structure	τ_4	0.794	3
Urbanization degree	τ_5	0.757	4
industrial structure	τ_2	0.721	5
Total number of university graduates	τ_7	0.715	6
Economic development level	τ_1	0.557	7

4 CONCLUSIONS

According to the calculation of the previous mathematical model, the table 4 shows that $\tau_3>\tau_6>\tau_4>\tau_5>\tau_2>\tau_7>\tau_1>0.5$. This shows that the level of economic development, industrial structure, population size, population structure, urbanization, financial centralization and decentralization, and the number of college graduates have a significant impact on public financial education expenditure. Among them, the grey correlation degree of population size is 0.84, greater than 0.8, ranking first. It can be seen that the size of the regional resident population is a key factor affecting the public education expenditure of Sichuan Province. In the seventh census of China in 2020, the total population of Sichuan was 83674866, and it is a populous province. Education has the function of achieving social income distribution fairness. Education fairness is an important force to promote social equity, which is conducive to narrowing the income gap. With the increase of per capita income, the demand for high-quality education continues to increase, and the public financial expenditure on education is also useful for the efficiency of human resources. Education is the foundation of scientific and technological progress, and scientific and technological progress takes education as the source.

The correlation degrees of fiscal centralization and decentralization, population structure and urbanization degree are 0.799, 0.794 and 0.757 respectively, all above 0.75, indicating that fiscal centralization and decentralization, population structure and urbanization degree have an obvious impact on public financial education expenditure. Fiscal centralization and decentralization are measured by the ratio of per capita fiscal expenditure in Sichuan to the national per capita fiscal expenditure. The larger the value, the higher the degree of fiscal decentralization. The smaller the value, the higher the degree of fiscal centralization. The education expenditure in Sichuan is mainly local fiscal expenditure. The main reason for the impact of the demographic structure of regional public education expenditure on education expenditure is that the population aged 0-14 years is in the stage of

nursery education, early childhood education and compulsory education. The government is increasing the investment in nursery education and early childhood education. The Chinese government has implemented free compulsory education, and the scale of government education expenditure has increased. The degree of urbanization is the main factor affecting education expenditure. With the influx of surplus rural labor into cities and towns, people's demand for urban education increases, and public education expenditure increases.

The relevance of the impact of industrial structure on public education expenditure is 0.721, which indicates that with the continuous increase of the proportion of tertiary industry output value and the continuous optimization of industrial structure, the impact of regional industrial structure on public education expenditure is more obvious. The total size of college graduates shows the development of higher education. The number of ordinary colleges and universities in Sichuan Province has increased year by year. As of 2021, there were 134 ordinary colleges and universities in Sichuan Province, ranking fifth in the country, including 53 undergraduate colleges and 81 junior colleges. The correlation degree of the impact of the size of college graduates on public finance and education expenditure is 0.715, which indicates that the development of regional colleges and universities has a significant impact on regional education fiscal expenditure. The increase in the number of college graduates is conducive to improving the quality of regional human capital, which is one of the internal factors and driving forces of a country's and a region's long-term economic growth.

The correlation between economic development level and public education expenditure in Sichuan Province is 0.557, which indicates that economic development level has the smallest impact on public education expenditure in Sichuan Province compared with the other six influencing factors.

The education expenditure of China`s government at all levels has been continuously improved in terms of expenditure scale and structure. Combined with the above analysis of factors affecting government education expenditure, the following suggestions are made. Firstly, optimize the structure of fiscal expenditure and increase the total scale of fiscal expenditure on education. Secondly, optimize the structure of education expenditure to meet the needs of urbanization and the people for education. Thirdly, improve the supervision system of fiscal education expenditure and the output efficiency of education expenditure.

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