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An Empirical Analysis on the Influencing Factors of Economic Growth in Shanxi Province

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Abstract

Since the reform and opening up, the national economy has entered a new stage of development. As a major energy province, Shanxi's stable economic development has also attracted attention. This paper analyzes the four aspects that affect Shanxi's economic growth, namely, labor force, material capital investment, technological progress and energy consumption. Through the establishment of double logarithm model, parameter estimation, model test and analysis are carried out to explore the influencing factors of its economic development. Based on this, the potential of Shanxi's economic development is found, and reasonable suggestions are put forward for promoting Shanxi's economic development.

Keywords

Economic Growth; Technical Progress; Double Logarithmic Model.

1. Introduction

In recent years, with the supervision and implementation of economic policies by the Party and the state and the gradual promotion of reform and opening up, China's GDP has increased year by year, and the national economy has entered a normal growth. The gross national product of Shanxi Province is also growing rapidly, and its growth rate is stable from 1987 to 2021. Under the background of stable growth, what factors promote its rapid economic development? What is the contribution rate of each factor to economic growth? Solving these two problems will help Shanxi Province carry out economic system reform and economic policy adjustment, and promote the economic development to a faster, better and healthier direction.

In the current economic situation, only with the improvement of people's living standards and the increase of people's happiness index can a harmonious and stable society be created. Therefore, the study of the influencing factors of economic growth in Shanxi Province can find the problems for the development of Shanxi Province in the next few years, provide ideas to solve the development problems, and break through the bottleneck.

Regarding the selection of influencing factors of economic growth, Wang Huizi (2020) studied the influencing factors of economic growth in Inner Mongolia from four aspects: labor force, technological progress, material capital and energy consumption. Xie Yanfeng and Yu Kaifeng (2019) analyzed the influencing factors of Guizhou's economic growth through the generalized Cobb Douglas production function model, established a double logarithmic model, conducted unit root test and cointegration test, and concluded that the following suggestions were put forward: creating employment opportunities, improving the employment environment, increasing scientific and technological investment, etc. Gao Xiaoxiao (2020) also adopted ADF test, cointegration test and Granger causality test to draw the following conclusions: China's urban and rural financial development is unbalanced. At the same time, due to the profit seeking

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nature of capital, most of the capital flows to cities, leading to further widening the urban-rural gap, making rural areas more backward than cities. Wang Jianpeng (2022). Wang Shufei and Gao Peng (2022) put forward their own suggestions on the development path of coal and its industrial transformation and upgrading. They believed that we should develop green mining of coal, green development of coal mining areas, and actively explore new energy in combination with China's "dual carbon" goal to achieve healthy and sustainable development of the country.

2. Variable Selection and Data Collection

2.1. Selection of Explained Variable

The economic development level of Shanxi Province is expressed by the gross domestic product of Shanxi Province, namely GDP, which refers to the final results of production activities of all permanent residents of a country or region in a certain period. In the economic field, GDP is often used to measure the economic development of a region.

2.2. Selection of Explanatory Variables

In the preliminary analysis of the model, the selected influencing factors include: labor force, material capital, technical level, energy consumption. The labor force is represented by the number of employees in the province, the material capital investment is represented by the fixed asset investment, the research and experimental development expenditure is represented by R&D expenditure, and the energy consumption is represented by the coal consumption.

(1) Number of employees. Labor force refers to the population with labor capacity. One of China's macroeconomic development goals is full employment, and the corresponding indicator unemployment rate refers to the proportion of labor force in the unemployed population. Therefore, the change of labor force is an important indicator that affects the healthy development of economy and society.

(2) Total investment in fixed assets. Physical capital refers to the material forms used for production for a long time, such as plants, machinery, equipment, buildings, transportation facilities and other physical objects. In the traditional industrial economy, it has been in a very important position. This paper uses the total amount of fixed assets investment to express material capital.

(3) R&D expenditure. With the continuous improvement of the level of scientific and technological development, technological development has been able to affect economic development as a huge development indicator, which plays a very important role in promoting economic growth and improving the quality of economic development. This paper uses research and experimental development funds to represent the investment in technological progress.

Table 1. Selection of Explanatory Variables and Explained Variables

y	GDP (100 million yuan)
x_1	Number of employees (10000 yuan)
x_2	Investment in fixed assets (100 million yuan)
x_3	R&D expenditure (100 million yuan)
x_4	Coal consumption (10000 tons)

(4) Coal consumption. Energy consumption refers to the energy consumed in production and life. With the continuous development of the current society, energy has become an indispensable part of people's life. It is one of the most important materials to ensure people's basic life. However, due to the different distribution of resources, there are differences in

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energy between different regions. Shanxi Province is a large energy province, rich in coal resources, and some regions rely on coal to develop their economy, so coal consumption is selected as one of its influencing factors.

The variables used in this paper are shown in Table 1.

2.3. Data Collection

Since the research and experimental development funds only search for the data after 2000, this paper selects the time series data of Shanxi's GDP and various influencing factors from 2000 to 2020. See Table 2 for specific data.

Table 2. Relevant Data of Influencing Factors of Economic Growth in Shanxi Province

Year	y	x_1	x_2	x_3	x_4
2000	1845.72	1392.4	625.16	9.9	12704
2001	2029.53	1399.5	708.35	10.8	13271
2002	2324.80	1403.3	838.27	14.4	16587
2003	2854.25	1469.5	1116.35	15.8	18829
2004	3495.99	1474.6	1477.70	23.4	19112
2005	4079.38	1500.2	1859.40	26.3	22631
2006	4713.60	1561.2	2321.47	36.34	25514
2007	5935.58	1595.6	2927.17	49.25	27772
2008	7222.98	1614.1	3635.14	62.6	26879
2009	7147.61	1630.6	5033.53	80.86	26149
2010	8903.90	1802	6352.60	89.88	28180
2011	10894.41	1817	7373.06	113.39	30896
2012	11683.11	1834	9176.31	132.3	31085
2013	11987.23	1855	11200.24	155	33475
2014	12094.71	1842	12354.53	152.2	32056
2015	11836.39	1872.8	14137.16	132.5	28516
2016	11946.40	1832	14284.98	132.6	29355
2017	14484.27	1812	15184.94	148.2	31640
2018	15958.13	1789	16050.48	175.8	33480
2019	16961.61	1762	17543.17	191.2	34907
2020	17651.93	1738	19402.75	211.1	36186

Source: Shanxi Statistical Yearbook and Shanxi Scientific and Technological Funds Investment Statistical Yearbook from 2000 to 2020.

3. Data Processing and Model Setting

3.1. Descriptive Statistics and Correlation Analysis of Variables

Logarithmic processing was performed on the data, and descriptive statistics and correlation analysis were performed on the data using EViews. The results are shown in Table 3 and Table 4.

Table 3. Descriptive Statistics of Data

	$\ln x_1$	$\ln x_2$	$\ln x_3$	$\ln x_4$	ln y
Mean	7.413219	8.459196	4.155782	10.14968	8.872140
Median	7.460490	8.756619	4.498475	10.24637	9.094245
Maximum	7.535190	9.873170	5.352332	10.49643	9.778600
Minimum	7.238784	6.438008	2.292535	9.449672	7.520625
Std. Dev.	0.106066	1.165903	1.024437	0.306868	0.734634
Observations	21	21	21	21	21

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Table 4. Correlation Analysis

	lnx_1	lnx_2	lnx_3	lnx_4	lny
lnX_1	1.000000				
lnX_2	0.950708	1.000000			
lnX_3	0.953778	0.990893	1.000000		
lnX_4	0.898555	0.935447	0.959829	1.000000	
lnY	0.944086	0.992374	0.995556	0.961152	1.000000

Through covariance analysis, the correlation coefficients between lny and lnx1, lnx2, lnx3, and lnx4 are 0.9441, 0.9924, 0.9612, and 0.9612, respectively. The correlation coefficients between lny and these four items are all above 0.90, indicating that there is a significant positive correlation between lny and the number of employees, investment in fixed assets, R&D funds, and coal consumption. The correlation coefficients between lnx3 and the other three explanatory variables are large, and there may be multiple collinearity.

3.2. Model Setting

Because the influence of heteroscedasticity can be alleviated by reducing the variable scale by taking logarithms of the time series, a double logarithmic model is established in this analysis, and the expression is as follows:

$$\ln(y) = \beta_1 + \beta_2\ln(x_1) + \beta_3\ln(x_2) + \beta_4\ln(x_3) + \beta_5\ln(x_4) + \varepsilon$$

Where, β_1, β_2, β_3, β_4, β_5 is the parameter to be estimated, β_2, β_3, β_4, β_5 is the elasticity of each explanatory variable to economic growth, ε is a random error term.

4. Empirical Analysis

4.1. Model Parameter Estimation

Input data in Eviews, perform logarithmic processing, and perform regression analysis with ordinary least squares method. See Table 5 for the results:

Table 5. Common Least Squares Parameter Estimation

Variable	Coefficient	Std.Error	t-Statistic	Prob.
C	4.495759	3.506190	1.282235	0.2180
lnx_1	-0.425548	0.412051	-1.032757	0.3171
lnx_2	0.299153	0.090040	3.322432	0.0043
lnx_3	0.313884	0.135486	2.316727	0.0341
lnx_4	0.364152	0.165950	2.194345	0.0433
R-squared	0.995111	Prob(F-statistic)		0.000000
Adjusted R-squared	0.993889	S.D.dependent var		0.734634
F-statistic	814.1598	Durbin-Watson stat		1.887131

4.2. Statistical Inference Test

It can be seen from Table 5 that the decision coefficient is 0.9951, indicating that the model has a high goodness of fit for sample data. The revised determinable coefficient is 0.9939, which shows that the explanatory power of the four explanatory variables of Shanxi Province, namely, the number of employees, fixed asset investment, R&D funds and coal consumption, to GDP is 99.39%. F test shows that F=814.1598, and the given significance level is α= 0.05, F is greater than the critical value 3.01, and its P value is 0.0000 (obviously less than α= 0.05), indicating that each explanatory variable has a significant impact on the GDP of Shanxi Province, and the linear relationship of the model is significant. T test shows that the degree of freedom is 21, and the given significance level α= At 0.05, the critical value of the T test is 2.08, and the absolute

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value of the T value of the number of employees is less than 2.08, which is in the rejection domain, indicating that the number of employees in Shanxi Province has no significant impact on GDP. The absolute value of T value of other parameters is greater than 2.08, which indicates that other parameters have a significant impact on GDP of Shanxi Province. However, the model may have multiple collinearity, which will be subject to econometric test.

4.3. Econometric Test

4.3.1. Multiple Collinearity Test

To test whether the econometric model established has multiple collinearity, it is necessary to calculate the correlation coefficient matrix of the explanatory variables of the model. The results are shown in Table 6:

Table 6. Correlation of ExplanatoryVariables

	lnx_1	lnx_2	lnx_3	lnx_4
lnx_1	1.000000	0.950708	0.953778	0.898555
lnx_2	0.950708	1.000000	0.990893	0.935447
lnx_3	0.953778	0.990893	1.000000	0.959829
lnx_4	0.898555	0.935447	0.959829	1.000000

It can be seen from Eviews' calculation of correlation coefficient that the minimum correlation coefficient between its four explanatory variables is 0.8985, and it is preliminarily judged that the model has multiple collinearity.

4.3.2. Correction of Multicollinearity

The results of correlation analysis between explanatory variables and explained variables are shown in Table 7.

Table 7. Correlation between Explanatory Variables and Explained Variables

	lnx_1	lnx_2	lnx_3	lnx_4
lny	0.944086	0.992374	0.995556	0.961152

The correlation coefficient matrix of the explained variable and the explanatory variable is obtained by EViews command. It can be known that lnx3 is the closest to lny, so the following unitary regression model is established:

$$lny = a + blnx + \varepsilon$$

lnx1, lnx2 and lnx4 are respectively introduced into the unitary regression model, and the results are shown in Table 8.

Table 8. Analysis Results of Stepwise Regression Model

Model	lnx_1	lnx_2	lnx_3	lnx_4	R^2	$-R^2$
$lny=f(lnx_3)$			0.7139 (46.0833)		0.9911	0.9907
$lny=f(lnx_3,lnx_1)$	-0.4183 (-0.8334)		0.7552 (14.5316)		0.9915	0.9905
$lny=f(lnx_3,lnx_2)$		0.2045 (2.2224)	0.4833 (4.6159)		0.9930	0.9923
$lny=f(lnx_3,lnx_4)$			0.6651 (11.9955)	0.1699 (0.9181)	0.9915	0.9906
$lny=f(lnx_3,lnx_2,lnx_1)$	-0.5691 (-1.2641)	0.2205 (2.4126)	0.5214 (4.8581)		0.9936	0.9925
$lny=f(lnx_3,lnx_2,lnx_4)$		0.2933 (3.2579)	0.2741 (2.0962)	0.3914 (2.3840)	0.9948	0.9939

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By introducing the second variable into the unitary regression model, it can be concluded that if the model parameter of lnx1 is no, the economic test will not pass. The model introduced lnx4 T=0.9151, failed the test, the degree of freedom is 21, and the given significance level α= At 0.05, the critical value of T test is 2.08, and the absolute value of T value is less than 2.08, which is in the rejection field.

In addition, it is judged that the revised value of the decisiveness coefficient of the model introduced lnx3 has increased from 0.9907 to 0.9923, so a binary regression model is established based on this model.

The ternary regression is established in the same way. From the calculated data, it can be seen that the economic test of the model introduced lnx1 fails. The model introduced lnx4 passed the T test. Compared with the binary regression model, the modified determinability coefficient has improved from 0.9923 to 0.9939. Therefore, the variables lnx2, lnx3, and lnx4 were finally determined as the variables of the ternary regression model. The corrected regression analysis results are shown in Table 9

Table 9. Revised Regression Results

Variable	Coefficient	Std.Error	t-Statistic	Prob.
C	1.294055	1.641015	0.788570	0.4412
lnx_2	0.293339	0.090040	3.257869	0.0046
lnx_3	0.270597	0.129092	2.096160	0.0513
lnx_4	0.391355	0.164167	2.383881	0.0291
R-squared	0.994785	Prob(F-statistic)		0.000000
Adjusted R-squared	0.993865	S.D.dependent var		0.734634
F-statistic	1080.957	Durbin-Watson stat		1.549587

The model estimation results obtained by modifying multicollinearity are as follows:

$$lny = 1.294055 + 0.293339lnx_2 + 0.270597lnx_3 + 0.391355lnx_4$$
$$t = (0.788570) \quad (3.257869) \quad (2.096160) \quad (2.383881)$$
$$R^2 = 0.994785 \quad F = 1080.957 \quad DW = 1.549587$$

4.3.3. Heteroscedasticity Test

The parameters of the model after multiple collinearity correction are estimated and tested by white test. See Table 10 for the test results.

Table 10. White Test

F-statistic	1.259725	Prob.F(8,12)	0.3466
Obs*R-squared	9.585819	Prob(F-statistic)	0.346555

The F-test value of the model is 1.2597, at the significance level α=0.05, the number of explanatory variables in the auxiliary regression model is 8, $\chi_{0.05}2(8)=15.507>nR^2=9.5858$, P value is equal to 0.2953 and greater than the significance level of 0.05, so there is no heteroscedasticity.

4.3.4. Autocorrelation Test

In this paper, the partial correlation coefficient test method is used to test whether the model has autocorrelation. First, the parameters of the model are estimated, and the model residual sequence is calculated. Then, the correlation coefficient value AC, the partial correlation coefficient value PAC and the bar graph of the residual sequence are displayed in EViews.

By observing that the length of the partial correlation bar graph does not exceed the dotted lines on the left and right sides, and the absolute values of PAC are less than twice the standard deviation, it can be determined that the model does not have autocorrelation.

The final expression of the model is as follows:

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$$\ln y = 1.294055 + 0.293339\ln x_2 + 0.270597\ln x_3 + 0.391355\ln x_4$$

Where, y represents the gross product of Shanxi Province, x2 represents the investment in fixed assets, x3 represents R&D funds, and x4 represents coal consumption.

5. Conclusion and Suggestions

5.1. Conclusion

From the double logarithmic model, we can see that the economic growth of Shanxi Province mainly depends on material assets, technological progress and coal. Among them, coal consumption is the main force of economic growth. Each percentage point increase in coal consumption can contribute 0.3914 percentage points to economic growth. In the multi collinearity correction of the model, the influencing factor of the number of employees is eliminated. However, through research, it is found that the number of employees has a great impact on economic growth. From the basic data of this analysis, from 2000 to 2015, the number of employees has been increasing year by year, and GDP has also been growing at a high speed. Therefore, if we analyze the two separately, we can also judge the impact of the number of employees on GDP.

5.2. Suggestions

5.2.1. Create Employment Opportunities and Increase Employment

It can be seen from the collected data that the number of employees in the past three years has significantly decreased compared with the previous years. Through background analysis and research, it may be because of the impact of the COVID-19, which led to the closure of most industrial stores, the increase in the number of unemployed people, and the labor force population may not have changed, but the number of employees has decreased. It is believed that it has a certain impact on economic growth, so the Shanxi Provincial Government should issue a policy of benefiting the people, to help small and medium-sized enterprises develop and improve the employment environment, the current brain drain in Shanxi Province is serious, so attracting talents to work in the province has become the top priority of Shanxi's economic development.

5.2.2. Increase Investment in Research and Scientific and Technological Development

Science and technology are the primary productive forces. The investment of science and technology and research funds can have a great impact on the development of the whole country or society. It is the so-called rejuvenation of the country through science and education. If a region wants to achieve sustainable and efficient development, it must learn advanced technology. Compared with other provinces, the economic development level of Shanxi Province still has a big gap, so Shanxi Province must continue to increase the investment in research and experimental development, constantly develop and expand the research team, retain talents, and transform the economic growth mode into relying on technological development to achieve healthy and sustainable economic development.

5.2.3. Optimize the Energy Structure and Promote the Transformation of Coal Groups

From the empirical analysis, we can develop. The coal consumption has a great impact on the economic growth of Shanxi Province. Therefore, we need to make rational use of energy, optimize the energy structure, explore new energy, develop clean energy and renewable energy, and promote the green and low-carbon economic development path of Shanxi Province. The transformation and upgrading of coal and its industry is the key content for China to achieve the "dual carbon" goal. As a major energy province, Shanxi, especially the coal production, ranks first in the country and provides energy for many places in China. However, under the "dual carbon" development goal, Shanxi Coal Group can actively participate in the national energy

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transformation, carry out green coal mining and green development of coal mining areas, and actively explore new economic growth points.

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