Co-integration Relationship between Electric Power Development of Ningxia and Social Economy

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Abstract
This paper uses unit root test, co-integration test, Granger test, error correction model and other methods to study the relationship between power consumption and economic growth in Ningxia Autonomous Region, and draws the relationship between power consumption and economic growth in the three industries in Ningxia Autonomous Region. Among them, for every 1% increase in the output value of the first production, the power consumption of the first production increases by 3.11%; for every 1% increase in the power consumption of the second production, the output value of the second production increases by 0.225%.

Key words: *electric power development, social economy*

1. Introduction

Energy provides a driving force for economic and social development, as an important resource for material and social development. Economic growth and consumption present periodic fluctuation in the process of development. In view of the co-integration and cyclical relationship between power consumption and economic growth, domestic and foreign scholars have conducted extensive studies [1-2]. Based on Co-integration theory, Chen Bin and Chen Yinfeng respectively analyzed the relationship between economic growth and electricity consumption [3-4]. Based on empirical research, Yuan Jiahai and others show that there is a co-integration relationship between the trend series and the cycle series of power consumption and GDP [5-7]. This paper analyzes scientifically and reasonably the long-term equilibrium relationship between economic development and electricity consumption in Ningxia Autonomous Region.

2. Development Trend of Electric Power Consumption and Economy in Ningxia

2.1. Economic development in Ningxia

The total social GDP of Ningxia Hui Autonomous Region consists of the added value of three industries. Table 1 shows the proportion of the added value of various industries in the total social GDP of Ningxia Hui Autonomous Region from 1996 to 2019. The following is an analysis of the industrial structure in Ningxia's GDP.

TABLE 1. Ningxia's GDP and industrial composition

Year	Gross Regional Product (100 million yuan)	Primary industry (100 million yuan)	Secondary industry (100 million yuan)	Tertiary industry (100 million yuan)
1996	202.91	43.28	80.54	79.09
1997	224.59	44.87	88.67	91.05
1998	245.45	48.75	95.11	101.59
1999	264.58	48.08	103.83	112.67
2000	295.02	46.03	121.43	127.56

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2001	337.44	49.67	135.88	151.89
2002	377.16	52.96	153.06	171.14
2003	442.61	55.63	191.75	195.23
2004	519.92	65.33	232.58	222.01
2005	579.89	69.81	259.79	250.29
2006	683.28	76.84	321.89	284.55
2007	877.59	92.89	422.01	362.69
2008	1139.16	112.94	558.06	468.16
2009	1266.66	120.44	592.98	553.24
2010	1571.68	151.41	733.36	686.91
2011	1931.83	175	919.84	836.99
2012	2131	189.03	992.46	949.51
2013	2327.68	210.72	1059.5	1057.46
2014	2473.94	216.92	1113.67	1143.35
2015	2579.38	236.82	1116.78	1225.78
2016	2781.39	241	1179.74	1360.65
2017	3200.28	250.62	1405.99	1543.67
2018	3510.21	279.39	1488.13	1742.69
2019	3748.48	279.93	1584.72	1883.83

3. Coordinated Relationship between Ningxia Electric Power Development and Social Economy

The Ningxia Hui Autonomous Region witnessed rapid economic growth between 1996 and 2020. At the same time, the whole society's electricity consumption is also rising. This section studies the harmonious relationship between Ningxia electric power development and social economy. First of all, the annual GDP and the GDP of the three industries of Ningxia Autonomous Region are converted at comparable prices. Then it studies the coordination relationship between the power consumption of the three industries and the GDP of the three industries in Ningxia Autonomous Region. Finally, the paper studies the coordination relationship between power consumption and per capita disposable income in Ningxia Autonomous Region.

3.1. Data processing

In order to exclude the influence of price factors, it is necessary to adjust the current price GDP of Ningxia to constant price GDP in econometric analysis. According to Ningxia Statistical Yearbook 2020, the GDP index and three industrial indexes with the parameter of 100 in the above years are found.

3.2. Coordination relationship between power and economy in primary industry

Selecting the annual electricity consumption and gross production of the primary industry in Ningxia Autonomous Region, this paper discusses the relationship between them. The annual electricity consumption of the primary industry is expressed as variable E_1, and the total production value of the primary industry is expressed as variable GDP_1.

(1) Logarithmic processing

In order to eliminate heteroscedasticity, the natural logarithm of the variable is taken before unit root test.

(2) Unit root test

According to the ADF test and analysis results of Eviews, there is a unit root in the time series of the output value of Ningxia's primary industry, which is not stable. After the first-order difference, the first-order difference series passes the unit root test, with p value =0.0141<0.05, and the first-order difference series is stable. There is a unit root in the electricity consumption time series of Ningxia's primary industry, which is unstable. After the first-order difference, the p-value of the first-order electricity consumption series =0.0033<0.05, which passes the unit root test, and the first-order difference series is stable.

(3) Granger causality test

Use Eviews to do the Granger causality test of the output value of a production and the electricity of a production. The results showed that p=0.0006<0.05, rejecting the null hypothesis. The value of a generation is the Granger cause of a generation of electricity.

(4) Co-integration test

The time series of the primary industry output value and the electricity consumption output value are both first-order integration I (1), and the co-integration test can be carried out. Eviews EG co-integration test method is used to obtain the p value of Tau statistics =0.028<0.05, which pass the co-integration test.

(5) Error correction model

Eviews is used to construct an error correction model for the output value sequence and electricity consumption sequence of the first order difference primary industry, as shown in Figure 1.

Dependent Variable: D(LNE1)
Method: Least Squares
Date: 05/22/21 Time: 21:29
Sample (adjusted): 1997 2019
Included observations: 23 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.042073	0.167435	-0.251280	0.8042
D(LNGDP1)	3.110162	3.269267	0.951333	0.3528
ECM(-1)	-0.504400	0.205866	-2.450142	0.0236

R-squared	0.230911	Mean dependent var	0.101912
Adjusted R-squared	0.154002	S.D. dependent var	0.331735
S.E. of regression	0.305124	Akaike info criterion	0.584911
Sum squared resid	1.862013	Schwarz criterion	0.733019
Log likelihood	-3.726472	Hannan-Quinn criter.	0.622159
F-statistic	3.002397	Durbin-Watson stat	1.515381
Prob(F-statistic)	0.072405		

Figure 1 Calculation results of the error correction model

The calculation results of the error correction model are shown in Equation (1).

$$\Delta \ln E_1 = 3.110162 \Delta \ln GDP_1 - 0.042073 - 0.5044 ECM^{t-1} \quad (1)$$

Where, $\Delta \ln E_1$ represents the value after taking the first-order difference for the electricity consumption of the first production, $\Delta \ln GDP_1^{t-1}$ represents the first-order lag term after taking the first-order difference for the output value of the first production, and ECM^{t-1} represents the first-order lag error term. According to the error correction model constructed, the output value of the primary industry and the electricity consumption of the primary industry are in a positive growth state. For every 1% increase in the output value of the primary industry, the electricity consumption of the primary industry increases by 3.11%.

3.3. Coordination relationship between secondary industry power and economy

Select the annual electricity consumption of the secondary industry and the GDP of the secondary industry in Ningxia Autonomous Region to explore the relationship between the two. The annual electricity consumption of the secondary industry is represented by variable E_2, and the gross production value of the secondary industry is represented by variable GDP_2.

(1) Logarithmic processing

In order to eliminate heteroscedasticity, variables are processed logarithmically before performing unit root tests and other operations.

(2) Unit root test

According to the ADF test analysis results of Eviews, Ningxia's secondary industry output value time series and the first-order difference series have unit roots, and the series are not stable. After the second-order difference, the second-order output value series passed the unit root test, p-value=0< 0.05, and the second-order difference sequence is stationary. Ningxia's secondary industry electricity consumption time series and the first-order difference series have unit roots. The series is not stable. After the second-order difference, the second-generation electricity consumption series p-value=0<0.05, which passed the unit root test. The second-order difference sequence is stationary.

(3) Granger causality test

Use Eviews to do Granger causality test of the output value of the secondary production and the electricity of the secondary production, as shown in Figure 2-15. The results show that p=0.0178<0.05, rejecting the null hypothesis, the second-generation electricity is the Granger reason for the second-generation output value.

(4) Co-integration test

The time series of the output value of the secondary industry and the time series of the electricity consumption of the secondary industry are both second-order single integer I (2). Carry out second-order difference on the two sequences respectively, and do further co-integration test. Using the EG co-integration test method of Eviews, the p value of tau statistic was obtained=0.0011<0.05, which passed the co-integration test.

(5) Error correction model

Use Eviews to construct an error correction model for the first-order difference second industry output value sequence and the second industry electricity consumption sequence, as shown in Figure 2.

Dependent Variable: D(LNGDP2)
Method: Least Squares
Date: 05/29/21 Time: 17:04
Sample (adjusted): 1997 2019
Included observations: 23 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNE2)	0.224912	0.056017	4.015080	0.0007
C	0.079821	0.007054	11.31607	0.0000
ECM(-1)	0.111753	0.037972	2.943026	0.0080
R-squared	0.544299	Mean dependent var		0.103576
Adjusted R-squared	0.498729	S.D. dependent var		0.027210
S.E. of regression	0.019265	Akaike info criterion		-4.939997
Sum squared resid	0.007422	Schwarz criterion		-4.791889
Log likelihood	59.80996	Hannan-Quinn criter.		-4.902748
F-statistic	11.94420	Durbin-Watson stat		0.892596
Prob(F-statistic)	0.000386			

Figure 2 Calculation results of the error correction model

The calculation result of the error correction model is as formula (2)

$$\Delta \ln \mathrm{GDP}_2 = 0.224912\Delta \ln \mathrm{E}_2 + 0.079821 + 0.111753\mathrm{ECM}^{t-1} \quad (2)$$

where $\Delta \ln \mathrm{GDP}_2$ represents the first-order lag term after taking the first-order difference on the second-generation output value, $\Delta \ln \mathrm{E}_2$ represents the value after taking the first-order difference on the second-generation power consumption, and ECM^{t-1} represents the first-order lag error term. The constructed error correction model shows that the output value of the secondary industry and the power consumption of the secondary industry are in a positive growth state. For every 1% increase in the power consumption of the secondary industry, the output value of the secondary industry will increase by 0.225%.

3.4. Coordination relationship between electricity and economy in the tertiary industry

This article selects the annual electricity consumption of the tertiary industry and the gross output value of the tertiary industry in Ningxia Autonomous Region to explore the relationship between the two. The annual electricity consumption of the tertiary industry is represented by variable E_3, and the gross output value of the tertiary industry is represented by variable GDP_3.

(1) Logarithmic processing

In order to eliminate heteroscedasticity, variables are processed logarithmically before performing unit root tests and other operations.

(2) Unit root test

According to the ADF test analysis results of Eviews, Ningxia's tertiary industry output value time series and the first-order difference series have unit roots, and the series are not stable. After the second-order difference, the tertiary output value series passed the unit root test, p-value=0< 0.05, and the second-order difference sequence is stationary. The electricity consumption time series of the tertiary industry in Ningxia has unit roots, and the series is not stable. After the first-order difference, the p-value of the electricity consumption series for the tertiary industry = 0.0054<0.05, passing the unit root test, and the first-order difference series is stable.

(3) Granger causality test

Using Eviews to do Granger causality test of tertiary production value and tertiary production electricity, the results show that p=0.0228<0.05, rejecting the null hypothesis, tertiary production electricity is the Granger reason for tertiary production output value.

(4) Co-integration test

The output value time series of the tertiary industry is a second-order single integer I(2), and the electricity consumption time series of the tertiary industry is a first-order single integer I(1), so the co-integration test cannot be done.

4. Conclusion

This article uses unit root test, co-integration test, and Granger causality test and other econometric methods to analyze the situation and characteristics of power consumption in Ningxia in the past two decades, and analyze the relationship between power consumption and economic growth in Ningxia. Research from the three aspects of primary, secondary and tertiary production shows that for every 1% increase in the output value of the primary production, the electricity consumption of the primary production increases by 3.11%; for every 1% increase in the electricity consumption of the secondary production, the output value of the secondary production increases by 0.225%.

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