The Impact of Power Industry Regulation on Regional Economy: From the Perspective of Industrial Structure Optimization and Upgrading in Jiangsu Province

Kun Xing*

Nanjing University of Science and Technology, Nanjing, China

*Corresponding author: 18238449745@163.com

Abstract. As a supporting industry of the national economy, the development level of the power industry is closely related to the development of other industries. This paper summarizes that the power industry is mainly subject to three types of regulatory policies: market access control, price control and environmental control, and uses the statistical data of Jiangsu Province from 2004 to 2021 to study the impact of power industry regulation on the regional economy from the perspective of industrial structure optimization and upgrading in Jiangsu Province. The two indicators of comprehensive power generation and investment in power production and supply industry in Jiangsu Province play a positive role in promoting the evolution of industrial structure in Jiangsu Province to the level of upgrading, while the power price index and the proportion of installed thermal power generation capacity will inhibit the evolution process of the optimization and upgrading of the industrial structure of Jiangsu Province to a certain extent.

Keywords: industry regulation; optimization and upgrading of industrial structure; principal component analysis; OLS regression; Multicollinearity.

1. Introduction

As a basic public utility for China's national economic and social development, China's power industry started late compared with Western countries, but with the continuous enhancement of China's comprehensive national strength and the continuous advancement of power industry reform, China's power industry has developed rapidly. Especially since the reform and opening up, new breakthroughs and innovations have been made in power generation technology, which has enabled China to get rid of the dilemma of general power shortage in the last century and turn into a power power. Relevant state departments have continuously introduced relevant policies related to the power industry, and the reform of the power system has continued to advance. In recent years, with the deterioration of the natural environment on a global scale, the state has continued to introduce relevant policies to encourage clean energy power generation, and the power generation mode has also been successfully transformed from the traditional single mode of thermal power generation to thermal power generation, wind power generation, hydropower generation and other power generation modes in parallel, the industrial structure of the power industry has been continuously optimized and upgraded, and the intensity of market-oriented reform has been continuously increased, which has promoted the development of related enterprises in the power industry to a certain extent. At the same time, the power industry, as a basic industry, will also drive the development of other industries in the national economy under the linkage effect, and has made great contributions to the national economic development. At the same time, with the development of social economy, the disadvantages of the institutional model of the power industry at a specific stage are gradually revealed, and the monopoly problems caused by the special attributes of the power industry have hindered the development of the power industry to a certain extent, and it is particularly necessary for the relevant state departments to carry out appropriate control of the power industry. Therefore, from the perspective of the optimization and upgrading of the industrial structure of Jiangsu Province, this paper discusses the impact of power industry regulation on the regional economy, and promotes the continuous optimization of the industrial structure and institutional innovation of the power industry,

so as to make the power industry show new vitality in the new era and inject a steady stream of impetus into the realization of high-quality development of the regional economy.

2. Text Literature Review

2.1. Research on the Theory of Government Regulation

The research on government regulation can be traced back to the last century, with the development of some natural monopoly industries, social contradictions have gradually emerged, and the relevant theories of regulatory economics have first been formed abroad. Because the public power of the government is authoritative and coercive, and at the same time, relevant industries can capture the government through lobbying and other means to maximize their own interests (Stigler, 1962). At the same time, people are gradually realizing that the market is fragile, and relying only on the automatic adjustment of the market will inevitably fail to achieve the effective allocation of resources due to market failure and other problems, and the government can formulate regulatory policies based on the level of public interest to achieve fairness and efficiency (Posner, 1974). However, the achievement of efficiency and fairness requires the government to meet three basic conditions: first, the government regulatory agency must be independent, but the government must have complete information, and third, the government is difficult to capture (Posner, 1974). Therefore, due to the lack of complete information in the government market and the frequent occurrence of rent-seeking and lobbying, the focus of theoretical research on regulatory economics has begun to shift to how to carry out government regulation, and at the same time, game theory and other contents have been applied to the efficiency research under the problem of information asymmetry, in an attempt to improve market efficiency by giving appropriate incentives to enterprises (Kahn, 1970). With the reform and opening up, domestic related problems have become increasingly severe, and Chinese scholars have put forward the idea of government regulation on how to deal with the relationship between the government and enterprises in the process of strengthening government regulation based on foreign government regulation theories (Yu Hui, 1995). In order to promote the development of China's power industry, some scholars have conducted a deep analysis of the electricity price formation mechanism, and put forward the ideas of constructing the power market and improving the price formation mechanism of power products (Fan Bin et al., 2002).

2.2. Research on the Upgrading of Industrial Structure

The upgrading of industrial structure belongs to the category of industrial structure change, which refers to the change of factor input and output between the three industries, so the change of industrial structure emphasizes quantitative change, and the result may not be favorable development. At present, the relevant research on industrial structure change in the academic circles mainly focuses on the field of industrial institution optimization, and the upgrading of industrial structure includes two aspects: industrial structure rationalization and industrial structure upgrading, and the research focus of this paper is on the upgrading of industrial structure. With the increase of per capita national income, the labor force gradually shifted from the primary industry to the secondary and tertiary industries, and the proportion of employment changed with the change of output value (Clark, 1940). In this process, the share of agriculture in the national economy decreases, the share of industry in the national economy rises first and then declines, and the share of services in the national economy rises (Kuznets, 1941). In summary, the industrial structure is gradually evolving towards the "three-two-one" model, which is the embodiment of the optimization and upgrading of the industrial structure.

At present, scholars at home and abroad are usually limited to the regulatory policies of the industry and the performance of the regulatory policies on the industry, and are committed to solving the problems of the industry. At present, there is no research on the combination of industry regulation and industrial structure upgrading, and the linkage economic effect of industry regulation on other industries, so this paper has certain significance by studying the impact of power industry regulation

policies on the optimization and upgrading of industrial structure in Jiangsu Province, and also provides ideas for industry regulation to help regional economic development.

In the existing literature, scholars usually measure the industrial structure from two dimensions: the rationalization of the industrial structure and the upgrading of the industrial structure. On the basis of learning from other scholars, the indicators in this paper are selected from several different dimensions, taking into account the relevant requirements for industrial development in the 13th Five-Year Plan and the 14th Five-Year Plan, and based on the new development concept.

3. Analysis of China's Power Sector Reform Process and Regulatory Policies

3.1. The First Stage

The first stage was from the founding of the People's Republic of China to the eve of reform and opening up. At this time, China's power industry is in its infancy, under the leadership of the Party Central Committee, China's power industry has implemented the industry control policy of centralized control and unified regulation of electricity. The power supply system has been continuously improved, the power industry system has been continuously improved, and most urban areas have achieved power supply, but relatively backward areas such as rural areas are still in the dilemma of lack of electricity.

3.2. The Second Stage

The second stage is from the beginning of reform and opening up to the end of the twentieth century. In order to change the grim situation of power supply shortage in China at that time and solve the problem of insufficient funds for power construction, in line with the principle of "who invests, who benefits, according to the investment in electricity", the financing model of "raising funds to run electricity" has been rapidly promoted throughout the country, and has opened up an innovative road for improving China's power supply system and speeding up the construction of the power industry. With the solution of the problem of power supply shortage, the disadvantages of the integration of government and enterprises in the power industry have gradually emerged, which has led to the industry authorities focusing on their own interests and making the power industry inefficient, which has seriously hindered the development of China's power industry. In order to solve this problem, the State Council put forward in 1897 the policy of "separating government from enterprises, taking the province as an entity, uniting the power grid, unified dispatching, and raising funds to run electricity" and "adapting measures to the province and the grid", which played a great role in promoting the efficiency of the government and the power industry and the enthusiasm of enterprises to run electricity. At the same time, with the wave of reform and opening up, in order to speed up the transformation of China's power industry from a planned economy to a socialist market economy, in 1993, with the approval of the State Council, under the leadership of the Ministry of Energy, the original electric power joint company was formally reorganized into a power group company, and the formation of North China, Northeast China, East China, Central China, Northwest five major power groups, and in 1997 the establishment of the China State Power Corporation, with the above series of reforms, the power industry gradually realized the separation of government and enterprises, It has got rid of many problems caused by the integration of government and enterprises.

3.3. The third stage

The third stage is from the end of the 20th century to the eve of the 18th National Congress of the Communist Party of China. In order to further optimize the development pattern of China's power industry, the State Council issued the "Power System Reform Plan" in 2002, and put forward the 16-character policy of "separation of power plant and network, separation of main and auxiliary, separation of transmission and distribution, and bidding for grid access", introducing competition on the power generation side, pushing competitive business to the market, breaking the original monopoly state of the power industry, reducing the seller's market power in the power industry,

thereby improving the operation efficiency of the power industry, and promoting the development of China's power industry to a certain extent. With the promotion of the "power system reform plan", the "separation of power plants and grids" has been gradually realized, but because the power grid acts as a middleman between power plants and ordinary users, cutting off the connection between supply and demand, and at the same time the power grid as the only seller, so that the power grid has market power in the circulation link and causes a monopoly, so the reform plan of "bidding for the grid" has not been smoothly promoted due to the particularity of the power industry.

3.4. The Fourth Stage

The fourth stage is from the 18th National Congress to the presentIn order to solve the above remaining problems and realize the bidding for the Internet, the State Council issued the "Several Opinions of the Central Committee of the Communist Party of China and the State Council on Further Deepening the Reform of the Electric Power System" in 2015, and put forward the institutional framework of "controlling the middle and letting go of the two ends", adhering to the principles of safety and reliability, market-oriented reform, ensuring people's livelihood, energy conservation and emission reduction, and scientific supervision, deepening the reform of the power system, standardizing the operation mode of power grid enterprises, and transforming the original profit model of the power grid into a network fee as the main source of income. It has broken the monopoly of the power grid in the intermediate links, and at the same time liberalized the price of electricity in the competitive links, and improved the pricing mechanism of the power industry. Since then, the reform of the power system has been continuously promoted, relevant policies have been introduced, and the speed of marketization of the power industry has been accelerating.

3.5. Analysis of the Types and Causes of Regulation of China's Power Industry

The operation mode of the power system is divided into four links: power generation, transmission, distribution and sales, and the four links operate in a coordinated manner, and finally smoothly send power to the demand side. With the acceleration of the reform of the system and the marketization of China's power industry, the problems of various links in the power circulation have gradually been revealed, and it is particularly important for the relevant state departments to control the power industry.

3.5.1 Entry Regulation

Entry regulation, also known as market access regulation, refers to the government's practice of raising the barriers to entry in the electric power industry by issuing entry permits, conducting administrative approvals, and raising entry standards for relevant enterprises in the industry. These measures form market entry barriers and restrict the entry of related enterprises within the electric power industry. By implementing market access regulation, government departments can limit and regulate the number and quality of enterprises in the electric power industry, which is conducive to the optimization and upgrading of the industry's structure. Electric power products, as a special commodity, show no difference among those produced by different power generation enterprises. They usually enter the public eye in the form of public services to meet the society's demand for electricity. Therefore, the quality of electric power products is generally unrelated to the power generation process; instead, the national grid system is the decisive factor in determining the quality of electric power services. The grid system plays a crucial role in the circulation of electric power products by processing them. Meanwhile, the transmission and distribution links have extremely high requirements for equipment, necessitating substantial investments to build the grid system. Therefore, ordinary-sized enterprises are unable to meet these requirements. Once a company establishes a foothold in this sector, it can leverage its economies of scale to reduce production costs and quickly achieve profitability. Hence, the transmission link exhibits natural monopoly characteristics. Additionally, since the transmission and distribution links are vital to national economy and people's livelihood, government regulation is necessary. Furthermore, market access regulation can control

the number of regional transmission and distribution enterprises, preventing issues such as repeated construction of transmission and distribution equipment, confusion in transmission and distribution due to an excessive number of enterprises, and malicious competition among grid enterprises.

3.5.2 Price Regulation

Price regulation refers to the government's control over electricity prices from the perspectives of resource allocation and social efficiency, aiming to prevent enterprises in a particular circulation link within the electricity industry from exploiting their monopoly position to manipulate market prices arbitrarily and thereby obtain excessive monopoly profits, which could harm the interests of the public. Therefore, price regulation in the electricity industry is particularly important. China's price regulation policies for the electricity industry date back to the 1950s, when a vertical electricity regulation system integrating government and enterprise functions was established under the leadership of the Electricity Industry Administration. Electricity price policies were mainly implemented according to the "Notice on Electric Power and Heat Prices" issued by the Ministry of Water Resources, with the government having the decision-making power over electricity prices and implementing a unified national electricity price. Under the macroeconomic regulation and control of the state, electricity prices fluctuated little. Based on the planned economic system at that time, implementing a unified national electricity price alleviated the supply-demand contradiction in China's electricity industry to a certain extent. However, due to the rigidity of the planned electricity price system, enterprises could not set prices based on costs, which greatly dampened the enthusiasm of electric power enterprises for production, reduced their production efficiency, and significantly hindered the development of the electricity industry. As time went on, the State Grid Corporation of China was formally established, and China's electricity system transitioned from a planned economy to a market economy. In 1985, the National Price Bureau, together with the Ministry of Water Resources and Electric Power, issued the "Interim Provisions on Encouraging Fund-Raising for Power Generation and Implementing Multiple Electricity Prices". Different regions could develop time-of-use pricing strategies based on fluctuations in electricity consumption. Since then, China's electricity prices transitioned from the previous planned pricing system to a classified pricing system. In 1994, China's electricity price policy was further optimized, with the introduction of a combination of electricity prices nationwide, namely a pricing method combining user categories and time periods. Subsequently, in 1997, a unified national sales electricity price catalog was formulated, achieving the integration of mandatory and guidance electricity prices in various regions. After entering the 21st century, the country successively issued price regulation policies such as the "Electricity System Reform Plan", "Electricity Price Reform Plan", "Interim Measures for the Administration of On-Grid Electricity Prices", "Interim Measures for the Administration of Transmission and Distribution Prices", "Interim Measures for the Administration of Sales Electricity Prices", and the "Opinions on Further Unleashing Consumer Potential to Promote Sustained Consumption Recovery". These policies cleaned up unreasonable price increases in the transmission and distribution links, further refined pricing policies for different circulation links within the power system, and continued to implement government-set pricing for intermediate transmission and distribution links. Electricity prices transitioned from the previous government-set pricing model to a market bidding model, ultimately evolving into the current flexible and diverse pricing models. The electricity industry began to fully evolve in the direction of marketization.

3.5.3 Environmental regulation

Environmental regulation, as a crucial regulatory tool in industry regulation, is also widely adopted in the electricity industry. As a pillar industry supporting national economic operations, the efficient operation of the electricity industry can safeguard China's economic development. On the other hand, the pollution generated during power generation has negative externalities on the national economy and people's health. Therefore, implementing environmental regulation policies in the electricity industry can regulate the economic activities of related enterprises, promote harmony between humans and nature, and coordinate the natural environment with economic development. Currently,

China's environmental regulation policies in the electricity industry can be summarized in two aspects. The first aspect focuses on pollution reduction and emission reduction from the source by increasing investments in pollution control equipment. The second aspect provides preferential policies to related power generation enterprises to encourage the use of less polluting power generation resources, thereby transforming China's traditional power generation methods into a coexistence of thermal, nuclear, wind, and hydroelectric power generation. China's traditional power generation method is thermal power. Since the reform and opening-up, with the acceleration of structural reforms and marketization in the electricity industry, industrial emissions, dust, and other pollutants have increased significantly, leading to increasingly severe pollution problems. Against this backdrop, China has introduced a series of environmental regulation policies in recent years and increased subsidies for renewable energy power generation methods such as photovoltaic and wind power. In 2009, the government issued the "Notice on Implementing the Golden Sun Demonstration Project" to provide subsidies for photovoltaic power generation. In 2010, relevant ministries and commissions released the "Power Demand Side Management Approach" to provide energy-saving subsidies to the demand side in the electricity market. During the "Twelfth Five-Year Plan" period, the country further increased special funding for energy conservation and emission reduction, which involved the electricity industry. In 2022, the National Energy Administration released the "14th Five-Year Plan for Scientific and Technological Innovation in the Energy Sector," aiming to optimize resource allocation in the power system, promote renewable energy generation and comprehensive utilization, and enhance the supply guarantee capacity of renewable energy.

4. Method

4.1. Selection of Indicators

During the "13th Five-Year Plan" period, green development was first included in the national five-year plan, with intensified pollution prevention and control efforts, significantly improved resource utilization efficiency, and notable enhancements in the ecological environment. Entering a new stage of development, the "14th Five-Year Plan" outline once again emphasizes the important strategic position of green development in the overall picture of China's modernization drive. The "13th Five-Year Plan" strives to open up a new situation for development, increase the technological content and added value of export industries, effectively introduce foreign capital and advanced technology, support enterprises in outbound investment, and deeply integrate into the global industrial chain, value chain, and logistics chain. Meanwhile, the "14th Five-Year Plan" emphasizes placing innovation at the top of specific tasks, clearly requiring adherence to innovation's core position in the overall picture of China's modernization drive, treating self-reliance as the strategic support for national development, deeply implementing the strategy of rejuvenating the country through science and education, the strategy of strengthening the country by utilizing talents, and the innovation-driven development strategy, improving the national innovation system, and accelerating the construction of a powerful country in science and technology. Research and development (R&D) activities are the premise and foundation for the optimization and upgrading of industrial structure. Investments in R&D expenditures and the participation of scientific research institutions contribute to cultivating independent technological innovation capabilities and the ability to absorb advanced technologies. Finally, this paper measures changes in industrial structure from the dimension of rationalization and sophistication of industrial structure. The degree of industrial structure sophistication can be measured by the proportion of primary, secondary, and tertiary industries in GDP. Currently, there are multiple measurement methods for the rationalization of industrial structure in academic circles. This paper utilizes and revises the measurement method proposed by scholars such as Han Jian, and integrates the output values of the primary, secondary, and tertiary industries to obtain the following measurement indicators:

$$THEI_t = \ln \sum_{i=1}^{3} y_{it} \times i \quad (1)$$

The yit indicates that the actual output value of industry i in the city in the year t is y. Through the analysis of this index, it can be found that with the evolution of industrial structure to the advanced direction, the index gradually becomes larger, which can reasonably reflect the logical order of the evolution of industrial structure from low level to high level.

Relevant indicators of industry regulation. Through the previous analysis, the electric power industry related regulation policy through role and related economic variables to affect regional industrial structure, this paper mainly selects the following three indicators: Jiangsu province power grid comprehensive generation ELEC, power production and supply investment INVE and power price index PRIC, thermal power installed quantity proportion FIMA.

Based on the above analysis, the indicators selected in this paper are as follows.

Table 1. Related Indicators

Indicators	Indicator Meaning
IE	Total export-import volume
FI	Total investment of foreign-invested enterprises
RE	Research and development investment
AG	Number of scientific research institutions
WE	Industrial wastewater discharge volume decline rate index
RU	Industrial solid waste production rate of decline index
RA	Industrial structure rationalization index
HI	Industrial structure advanced index
ELEC	Comprehensive power generation capacity of Jiangsu Province power grid
INVE	Investment in electric power production and supply industry
PRIC	Electricity price index
FIMA	The proportion of installed thermal power generation capacity

5. Empirical Analysis

5.1. Feasibility Test

The raw data is first evaluated for adaptation to determine whether it is applicable to PCA. In this paper, KMO and Batley value tests were mainly used for the principal components analysis. Generally, whenever the KMO value is greater than 0.5. The results of KMO and Batley tests obtained using SPSS operation software are shown in the table below.

Table 2. KMO and Bartlett Tests

Test	feature	Result
Number of KMO sampling suitability quantities		0.627
The Batley sphericity test	Approximate chi square	848.124
	DF	28
	significance	0.00

Based on the table above, the degrees of freedom are 28, the approximate chi-square value is 847.104, and the KMO value is 0.637. Generally, when the KMO value is greater than 0.5, it can be considered that the original data passes the suitability assessment. Therefore, according to the above test results, the data indicators possess original correlation, indicating that the data indicators selected in this paper are suitable for factor analysis.

5.2. Principal Component Analysis

Principal component analysis using SPSS, common factors are automatically extracted from the software. The total variance is explained in the following table.

Table 3. Explanation of Total Variance

Components	Initial Eigenvalues			Extract the sum of squares of loadings			Sum of Squares of Rotated Loadings		
	Total	variance%	cumulative%	Total	variance%	cumulative%	Total	variance%	cumulative%
1	3.011	37.641	37.641	3.011	37.641	37.641	2.449	30.612	30.612
2	2.621	32.763	70.404	2.621	70.404	70.404	2.192	27.406	58.017
3	1.099	13.736	84.140	1.099	84.140	84.140	1.165	20.186	78.203
4	0.708	8.853	92.993	0.708	92.993	92.993	1.183	14.790	92.993
5	0.304	3.801	96.794						
6	0.221	2.760	99.554						
7	0.029	0.366	99.920						
8	0.006	0.080	100.000						

In general, a common factor can be considered as a principal component when its initial eigenvalue is greater than 1 and the cumulative variance exceeds 80%. According to the table above, there are three common factors with initial eigenvalues greater than 1. However, the cumulative variance of these three common factors is only 78.203%, which does not meet the 80% threshold. Therefore, to enhance the effectiveness, the fourth common factor with an initial eigenvalue of 0.708 is considered as the fourth principal component. The results from the table above indicate that the cumulative variance of the four principal components reaches 92.993%, suggesting that these four principal components can strongly represent the situation of industrial structure optimization and upgrading.

To more accurately assess the degree of correlation between the four common factors and the original data, the SPSS analysis software was used to perform the Kaiser-Normalized Varimax Orthogonal Rotation method to test the correlation among the four common factors. The results are presented in the following table.

Table 4. Rotated Component Matrix

Variable	Components			
	1	2	3	4
RE	0.150	0.955	-0.197	0.089
AG	0.125	0.957	-0.202	0.105
WE	0.012	0.167	-0.105	0.952
RU	0.780	-0.084	-0.009	0.484
IE	0.917	0.228	0.148	-0.057
FI	0.953	0.102	0.180	-0.086
HI	0.039	-0.475	0.788	-0.098
RA	0.229	-0.998	0.922	-0.060

In the first column of Table 4, the factor loading coefficients for the total import and export volume and the total investment of foreign-invested enterprises are 0.917 and 0.953, respectively, far exceeding 0.7. Therefore, these two indicators are selected to represent Principal Component 1. Both indicators reflect the degree of openness in industrial development, so Principal Component 1 is named the Industrial Openness Index Factor. In the second column, the factor loading coefficients for the two stock indicators, namely Jiangsu's research and development investment and the number of scientific research institutions, are 0.955 and 0.957, respectively. Therefore, these two indicators can be selected to represent Principal Component 2. Both indicators reflect the basic situation of innovation in Jiangsu Province, so Principal Component 2 is named the Industrial Innovation Index Factor. In the third column, the factor loading coefficients for both the advanced industrial structure indicator and the rationalized industrial structure indicator exceed 0.7. Therefore, both are selected to represent Principal Component 3. Both indicators reflect the state of industrial structure, so Principal

Component 3 is named the Industrial Structure Factor. Finally, Principal Component 4 has only one indicator, namely the year-on-year decline rate index of industrial wastewater discharge, which reflects the basic situation of environmental protection in the industrial development process of Jiangsu Province. Therefore, Principal Component 4 is named the Industrial Green Index Factor.

Table 5. Principal Component Table: Factor Scores and Final Scores

Variable	Principal Component			
	1	2	3	4
RE	-0.076	0.512	0.153	-0.012
AG	-0.091	0.515	0.159	0.005
WE	-0.123	0.029	0.146	0.861
RU	0.365	-0.240	-0.169	0.352
IE	0.385	0.054	-0.026	-0.155
FI	0.437	-0.061	-0.083	-0.174
HI	-0.092	-0.015	0.522	0.074
RA	-0.115	0.239	0.742	0.095

Based on the above table, Principal Component 1 can be expressed in the following form.

$$FAC_1 = -0.076RE - 0.091AG - 0.123WE + 0.365RU + 0.385IE + 0.437FI - 0.092HI - 0.115RA \quad (2)$$

$$FAC_2 = 0.512RE + 0.515AG + 0.029WE - 0.240RU + 0.054IE - 0.061FI - 0.015HI + 0.239RA \quad (3)$$

$$FAC_3 = 0 + 153RE + 0.159AG + 0.146WE - 0.169RU - 0.026IE - 0.083FI + 0.522HI + 0.742RA \quad (4)$$

$$FAC_4 = -0.012RE + 0.005AG + 0.861WE + 0.352RU - 0.155IE - 0.174FI + 0.074HI + 0.095RA \quad (5)$$

Based on the four principal components, the overall factor for the optimization and upgrading of industrial structure can be further derived.

$$STR = (FAC_1 \times 30.61 + FAC_2 \times 27.41 + FAC_3 \times 20.19 + FAC_4 \times 14.80) / 92.99 \quad (6)$$

5.3. OLS Estimation and Multicollinearity Testing

Using SPSS software, we conducted research and analysis on relevant data from Jiangsu Province between 2004 and 2021 (sourced from the "Annual Statistical Yearbook of Jiangsu Province"). Firstly, a regression model was established for the overall factor of industrial structure optimization and upgrading, with the proportion of thermal power installed capacity, total comprehensive power generation of Jiangsu's power grid, investment in the electricity production and supply industry, and the electricity price index as the explanatory variables.

$$STR = C + \beta_1 ELEC + \beta_2 INVE + \beta_3 PRIC + \beta_4 FIMA + \varepsilon \quad (7)$$

The results of the OLS (Ordinary Least Squares) regression analysis and the test for multicollinearity are presented in Table 6.

Table 6. Regression Analysis Results

Variable	coefficient	t	Statistical significance	Collinearity Statistics	
				tolerance	VIF
C	24.141	1.383	0.213		
ELEC	0.121	0.972	0.374	0.926	1.079
INVE	0.104	0.935	0.368	0.828	1.206
PRIC	-0.148	-1.229	0.232	0.957	1.044
FIMA	-0.154	-1.223	0.226	0.759	1.319

Based on the collinearity results in the last column of the above table, the Variance Inflation Factor (VIF) values are close to 1, indicating that there is no multicollinearity among the variables. This makes the analysis results reliable. Meanwhile, the regression results reveal that there is a positive correlation between Jiangsu's total electricity generation, investment in the electricity production and supply industry, and the optimization and upgrading of the industrial structure. In contrast, the electricity price index and the installed capacity of thermal power generation have a negative correlation with the optimization and upgrading of the industrial structure. Based on this analysis, the effects of electricity industry regulation policies will impact the two indicators of total electricity generation and investment, which in turn will affect the industrial development of the entire region, promoting the optimization and upgrading of the industrial structure. On the other hand, under the influence of electricity industry regulation policies, the electricity price index and the proportion of thermal power installed capacity tend to become more rational. Through a linkage effect, this drives the optimization and upgrading of the regional industrial structure.

6. Conclusion and Policy Suggestions

6.1. Conclusion

Based on the previous research, the following conclusions can be drawn: (1) Regulation policies in the electricity industry impact comprehensive electricity generation, investment in the electricity production and supply industry, and the electricity price index, which then affect other industries and influence regional economic development. (2) Further analysis reveals that with the implementation of regulation policies in the electricity industry, investment in the electricity production and supply industry increases, subsequently influencing an increase in comprehensive electricity generation in Jiangsu Province. Given the pivotal role of electricity in industrial development, this ultimately leads to the optimization and upgrading of Jiangsu's industrial structure. This is the first transmission path through which regulation policies promote industrial structure advancement. Price regulation policies aim at marketization, breaking the monopoly of power grids in intermediate links and preventing them from leveraging their monopoly to charge high electricity prices. Therefore, the implementation of price regulation policies has reduced Jiangsu's electricity price index to a certain extent, benefiting different industries as major electricity users and facilitating the optimization and upgrading of Jiangsu's industrial structure. This is the second transmission pathway through which regulation policies in the electricity industry influence changes in Jiangsu's industrial structure. (3) Jiangsu's comprehensive electricity generation and investment in the electricity production and supply industry positively promote the evolution of Jiangsu's industrial structure towards advancement, while the electricity price index and the proportion of thermal power installed capacity inhibit the progress of Jiangsu's industrial structure optimization and upgrading to a certain extent.

6.2. Policy Suggestions

Currently, the development of the coal-fired power industry in China is characterized by high carbon emissions, large-scale installed capacity but short service life, which to some extent hinders the optimization of the coal-fired power industrial structure, increases the difficulty of transformation, and elevates structural risks. Meanwhile, with the proposal of carbon emission targets, based on the

current development status of China's coal-fired power industry, the goals of controlling total capacity, shifting positioning, and optimizing layout should be pursued. Backward production capacity should be eliminated, investment in pollution purification should be increased, flexibility retrofits should be carried out in the coal-fired power industry, and the transformation and upgrading of the coal-fired power industry should be accelerated to drive regional industrial structure upgrading through thermal power industry transformation.

Facing the deteriorating global environment, efforts should be accelerated to build a modern energy system that is clean-energy-dominated, electricity-centered, and interconnected. Clean energy generation methods such as wind power and hydropower should be vigorously promoted to facilitate the green transformation of the electricity industry. China's clean energy resources, such as wind power, are concentrated in the western and northern regions, while electricity consumption is mainly concentrated in the central and western regions. With the development of China's socio-economic situation, electricity demand is expected to increase significantly and stably. Therefore, the difference in the distribution of clean energy and electricity demand determines the unchanged pattern of "electricity transmission from west to east." Meanwhile, the construction of UHV power grids should be accelerated to form a clean energy generation pattern with wind power in the west and hydropower in the southwest, accelerating the green transformation of the power industry, promoting the construction of China's energy internet, and providing continuous and efficient impetus for regional industrial development.

Guided by the "Notice on Further Deepening the Market-Oriented Reform of On-Grid Electricity Prices for Coal-Fired Power Generation" issued by the National Development and Reform Commission in 2021, reforms on the electricity sales side should be continuously carried out to advance the market-oriented reform of electricity prices. However, the economic attribute of natural monopoly in the electricity industry should also be respected, and achieving complete competition should not blindly be the ultimate goal in promoting the market-oriented reform of the electricity industry. It is necessary to promote full competition while taking into account fairness. Supply-side reform should drive the development of other industries on the demand side.

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