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Original Paper

Upgrading Level of Industrial Structure and Resource Dependence

Siyu Wang[1*]

[1*] Siyu Wang, Business School, Shandong University of Technology, Zibo, China

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Abstract

How to lessen regional resource dependency by raising the level of industrial structure has emerged as the key concern for nations seeking sustainable development in the face of the dual pressures of resource constraints and the acceleration of global climate change. This analysis was conducted using panel data from 265 prefecture-level cities from 2006 to 2022. First, this paper uses the benchmark regression model to investigate how regional resource reliance is directly impacted by the degree of industrial structure upgrading. Second, the intermediate effect model is used to analyze the course and procedure of the upgrading level of industrial structure on resource reliance. The results show that the upgrading level of industrial structure has a significant positive direct effect on resource dependence, and the effect is characterized as "East > Central and Western regions". The upgrading level of industrial structure can indirectly restrain regional resource dependence by increasing the degree of government intervention and breaking the "resource curse". This paper provides some scientific basis and theoretical reference for the region to break the resource curse and realize the efficient use of resources.

Keywords

upgrading level of industrial structure, resource dependence, mediating effect

1. Introduction

As the world's second-largest economy, China has long relied on the traditional industrial model of high resource consumption and high carbon emissions and is faced with severe challenges such as low resource utilization efficiency and high environmental pressure. Upgrading the industrial structure has emerged as a crucial means of resolving the resource reliance conundrum in recent years, driven by the "dual carbon" aim and the high-quality development plan. More than 65% of all energy is being consumed by the industrial sector, and high-energy-consuming industries like steel and non-ferrous

metals continue to have high carbon emission intensities. Taking coal as an example, the country's raw coal output in 2023 reached 4.71 billion tons, and imports reached 474 million tons, a record high, highlighting the deep dependence of the energy structure on traditional resources. At the same time, despite a 16% drop in energy usage per unit of industrial added value throughout the "13th Five-Year Plan" timeframe, the unit energy consumption of industries above the designated size still needs to be further reduced by 13.5% in 2023 to achieve the target of carbon peak. Circular economy significantly reduces the demand for native resources through resource reuse: In 2023, for instance, 320 million tons of scrap steel will be used, which would replace around 510 million tons of iron ore and cut carbon dioxide emissions by 512 million tons. However, the overall utilization rate of renewable resources in China is still about 15 percentage points lower than that in developed countries, especially in the field of construction waste (comprehensive utilization rate of 60%) and low-value waste, there is a lot of room for improvement.

The "14th Five-Year Plan" circular economy development plan proposes that by 2025, the output value of the resource recycling industry will reach 5 trillion yuan, the output of renewable non-ferrous metals will exceed 20 million tons, and the resource production rate will be increased by 20% compared with 2020. In addition, the deep integration of digital technologies (such as industrial Internet and AI) has improved the energy consumption monitoring accuracy of high-energy-consuming enterprises by 30%, supporting the implementation of the industrial process's low-carbon rebuilding. Significant regional variations exist in resource reliance, notwithstanding the fact that the upgrading of industrial structure has produced results in phases. for instance, has emerged as a new growth pole through "coal export" exceeding 100 million tons, while the southeast coastal areas rely on high-end manufacturing to reduce energy consumption per unit of GDP. This study will focus on the heterogeneity of regional industrial structure upgrading, and combine multi-dimensional factors such as resource endowment, policy orientation and technology penetration to quantitatively analyze the dynamic impact of upgrading level on resource dependence, to provide theoretical support for the construction of differentiated transformation paths. To sum up, reducing resource dependence is not only an inevitable choice to cope with environmental constraints but also the core driving force for high-quality economic growth. China is changing from a "resource-dependent" to an "innovation-driven" model through the upgrading of its industrial structure, and the data and real-world experience gained from this process will serve as a crucial guide for the sustainable growth of resource-intensive economies worldwide.

The structure of the remaining papers is as follows: The second part combs the related research on the upgrading level of industrial structure and resource dependence; The paper's theoretical analysis and research hypotheses are further upon in the third section. The data source, the model that was built, and the measurement of relevant variables are all introduced in the fourth section. The fifth part makes a comprehensive analysis of the empirical results of this paper; Finally, we draw the main conclusions of this paper and the prospect of the future.

2. Literature Review

2.1 Research on Upgrading of Industrial Structure

The upgrading of the industrial structure is a key factor to encourage the growth of the local economy in a more sustainable and effective manner. The existing reasons for upgrading the industrial structure mainly focus on its effects and influencing factors. In terms of effect, the effectiveness of local green technology can be increased by modernizing the industrial structure (Wang et al., 2025), reduce the level of regional crime (Huang et al., 2025), promote the improvement of environmental quality (Qiang et al., 2024), and restrain carbon emissions (Zheng et al., 2025), and plays a role in influencing the Marine economic quality of neighboring regions (Zhang & Li,2024). In terms of influencing factors, informatization (Cha & Zuo, 2017), R & D innovation (Song & Jiang,2024), green finance (Zhang, 2023), fluctuation of local government financial behavior (An & Wang, 2012), granting of financial receipt power and economic autonomy (Wang & Gao, 2017). 2018) will affect the upgrading of the industrial structure.

2.2 Research on Resource Dependence

At present, the research on resource dependence mainly focuses on its mitigation methods and impact paths. In terms of mitigation methods, Both research and green finance can alleviate the resource curse by promoting green technology innovation (Wang & Li, 2025), increasing investment in artificial intelligence research and application can effectively alleviate the resource curse (Zhang et al., 2024), and government environmental target constraints can also effectively alleviate the curse. In terms of influence paths, economies rich in natural resources can potentially insulate them from the resource curse by promoting innovation (Namazi & Mohammadi, 2018). Studies have shown that natural resource dependence significantly hindered the growth of regional carbon total factor productivity (Liu & Huang, 2025), however, the average yearly growth rate of regional per capita GDP would be hindered by the increased reliance on resources (Nan et al., 2024). In addition, the intensification of government intervention will increase the risk of a resource curse (Shao et al., 2013).

As for the research on the upgrading level of industrial structure and resource dependence, there is still much room for improvement: Firstly, the in-depth analysis of the deeper relationship between the upgrading level of industrial structure and resource dependence is made. Secondly, existing studies mostly discuss the relationship of a single aspect from the perspective of resource dependence, while few studies explore resource dependence from the perspective of the upgrading level of industrial structure. Thirdly, more research is required to fully understand the intricate nonlinear link between resource reliance and the upgrading degree of industrial structure.

3. Mechanism Analysis and Research Hypothesis

3.1 Direct Conduction Mechanism and Research Hypothesis

Based on the theory of industrial structure evolution, modernizing the industrial structure can hasten the process of factor substitution and technological innovation. First, the transformation of the

industrial structure to technology—and knowledge-intensive encourages enterprises to improve total factor productivity through R&D investment. At the same time, emerging industries represented by intelligent manufacturing and digital technology have a substitution effect on traditional production factors, making the resource consumption intensity per unit output significantly decrease, which effectively inhibits the resource dependence of the region. Secondly, the increase in the proportion of the modern service industry has reconstructed the allocation pattern of regional economic factors. The producer service industry represented by finance and information can reduce the resource loss of intermediate links by improving the synergistic efficiency of the industrial chain, thus breaking the regional resource dependence. From the perspective of factor flow, the improvement of the upgrading level of industrial structure will attract high-end industrial agglomeration then attract high-quality human capital inflow, and promote enterprises to adopt cleaner production technology. In addition, the capital market's preference for green industries has accelerated the technology substitution process of resource-dependent enterprises, which effectively forces enterprises to implement process innovation, which can directly reduce the mining demand for mineral resources and restrain regional resource dependence.

Hypothesis 1: The upgrading level of industrial structure can directly reduce regional resource dependence.

3.2 Indirect Conduction Mechanism and Research Hypothesis

Government intervention mainly reduces regional resource dependence through the dual path of energy consumption transformation and price signal guidance. Specifically, on the one hand, the government directly promotes the energy consumption structure from coal and oil to renewable energy such as wind and solar energy through clean energy subsidies, carbon tax policies and "dual carbon" target constraints, forcing the traditional fossil energy mining industry to shrink capacity; On the other hand, market-based tools such as ladder electricity prices and carbon emission rights trading are used to raise the cost of high-energy-consuming products, inhibit downstream demand and transmit to upstream resource exploitation, forcing the scale of resource-based industries to shrink. These two types of interventions jointly drive the transfer of capital and labor to emerging industries such as new energy equipment manufacturing and smart grid, and promote the increase of the proportion of tertiary industry and high-tech industry, thereby ultimately reducing regional resource dependence.

Hypothesis 2: The level of industrial structure upgrading inhibits regional resource dependency, and the degree of government intervention mediates this effect.

4. Model Building and Variable Measurement

4.1 Model Construction

To verify the two hypotheses proposed in this paper, the fixed effect model is used to examine the direct and indirect impacts on regional resource reliance of the industrial structure's upgrading level. In order to do this, this research builds the following simple regression model:

$$RD_{it} = \beta_0 + \beta_1 Ind_{it} + \beta_n X_{it} + \gamma_t + \mu_i + \varepsilon_{it} \quad (1)$$

Where, i and t stand for region and year respectively, stands for resource dependence, and stands for industrial structure upgrading level, represents the control variables in the model, including human capital level (Hum), and human capital investment (Inv). Urbanization level (Urb) and Per capita gross regional product (Per) are four variables. In addition, equation (1) represents the intercept term, which is the year-fixed effect; the Urban fixed effect; Is a random disturbance term. In addition, formula (1), represents the intercept term, and represents the year fixed effect; is urban fixed effect; is a random disturbance term.

4.2 Measurement and Description of Variables

4.2.1 Explained Variables

In this paper, referring to the research of Shao et al. (2010), the ratio of the number of employment in the mining industry to the number of employees is taken as the explained variable.

4.2.2 Core Explanatory Variables

Concerning the literature study of Ji et al. (2024), this paper takes the level of industrial structure upgrading as the explained variable and expresses it with the value of the added value of the primary industry as the proportion of GDP *1+ the added value of the secondary industry as the proportion of GDP *2+ the added value of the tertiary industry as the proportion of GDP *3.

4.2.3 Control Variables

To control the influence of other factors on resource dependence, this paper refers to the studies of Tang and Guo (2021) and Xie et al. (2024) and adds a series of control variables. Human capital level (Hum): as determined by the proportion of students enrolled in traditional colleges and universities to the overall population at the conclusion of the year. Human capital investment (Inv): calculated as public education expenditure as a share of GDP. Urbanization level (Urb): the proportion of people living in permanent cities to all people living in permanent cities; Gross regional product per capita (Per): ratio of gross regional product to local population.

4.3 Data Sources and Descriptive Statistics

In this paper, 265 prefecture-level cities from 2006 to 2022 are selected as research samples, and data

samples from Hong Kong, Macao, Taiwan and Tibet are excluded. Data sources: National Patent Office, National Bureau of Statistics, *China Statistical Yearbook*, etc. The missing data were supplemented by linear interpolation. Table 1 displays each variable's descriptive statistical findings.

Table 1. Descriptive Statistics Of Variables

VarName	Obs	Mean	SD	Min	Median	Max
RD	4505	5.19	8.44	0.00	1.43	40.08
Ind	4505	2.28	0.15	1.96	2.27	2.68
Hum	4505	5.35	1.31	2.90	5.18	9.48
Inv	4505	0.02	0.02	0.00	0.01	0.12
Urb	4505	0.54	0.17	0.20	0.52	0.95
Per	4505	47305.17	32684.68	6605.00	39072.00	164889.00

5. Empirical Results and Analysis

5.1 Analysis of Benchmark Regression Results

Table 2 shows the results of upgrading the degree of resource reliance and industrial structure. It is evident from the findings in the table that when control variables are added and time and individual effects are fixed, the influence coefficient of industrial structure upgrading level on regional resource dependence is -3.719, and the negative effect is significant at a 1% level, which indicates that the improvement of industrial structure level inhibits regional resource dependence, and verifies the hypothesis proposed in hypothesis 1 of this paper.

Table 2. Results of Baseline Regression

	(1)
VARIABLES	RD
Ind	-3.719***
	(1.337)
Hum	-0.052
	(0.071)
Inv	4.198
	(5.220)
Urb	-0.146
	(0.948)
Per	0.000***
	(0.000)
Constant	12.806***

	(3.127)
Year-fix	YES
Id-fix	YES
Observations	4,505
R-squared	0.913

5.2 Heterogeneity Analysis

As China's economic pioneer region, the industrial system of the eastern region has entered the post-industrialization stage dominated by the service industry and high-tech manufacturing industry, but some industrial upgrading may be accompanied by the implicit dependence on high-end resources (such as rare metals and energy required by technology-intensive industries). The western and central areas, however, are still in the middle to late phases of industrialization, and the traditional resource-based industries account for a relatively high proportion. The upgrading of industrial structure is more likely to directly reduce the explicit dependence on natural resources through technological substitution or industrial diversification. Therefore, this paper discusses the effect difference of industrial structure upgrading levels on regional dependence in different regions through the analysis of eastern and western regions respectively.

Additionally, the inhibition effect is much greater in the central and western areas than in the eastern region, indicating that the upgrading level of industrial structure has a more substantial inhibition effect on resource reliance in the central and western regions. This may be because the central and western regions, with the upgrading of the industrial structure, have successively undertaken the transfer of enterprises from the east, and introduced manufacturing enterprises including equipment manufacturing and electronic information, gradually replacing some traditional resource-based industries such as coal and steel. In addition, relying on green policy support, the central and western regions have promoted the application of resource recycling technology and reduced the intensity of resource consumption per unit of output. In the eastern region, the increase in the proportion of the service industry may indirectly stimulate the regional demand for resources through the correlation of the industrial chain, and weaken the inhibitory effect of the upgrading level of industrial structure on resource dependence. From this point of view, the strength and effect of the central and western regions are more obvious, helping to accelerate the reduction of resource dependence.

Table 3. Heterogeneity Test

	(1)	(2)
	Eastern	Central and Western
Ind	0.157	-3.597**
	(0.10)	(-2.00)

Hum	-0.349***	0.0448
	(-2.93)	(0.52)
Inv	6.925	4.548
	(1.21)	(0.61)
Urb	-4.426**	2.510**
	(-2.50)	(2.03)
Per	0.0000252***	0.0000188***
	(5.37)	(2.79)
Constant	5.395	12.10***
	(1.48)	(2.87)
Year-fix	Yes	Yes
Id-fix	Yes	Yes
Observations	1547	2958
R-squared	0.900	0.913

5.3 Lag Analysis

To analyze the dynamic effect of the upgrading level of industrial structure on resource dependence more precisely, the paper considers the different possible lag times of its effect. Therefore, the effects of the first, second and third stages of lag are further examined in this paper. Specifically, the effect of upgrading the level of industrial structure may be reflected in the short term, but it may also gradually appear in the medium and long term. By analyzing the influence of the upgrading level of industrial structure in different periods, this paper examines the time lag of one, two and three periods, and reveals the timeliness and persistence of the upgrading level of industrial structure in inhibiting resource dependence. This test helps to effectively eliminate the interference of short-term fluctuations and provides a more detailed time dimension analysis basis for subsequent adjustment.

According to the results in the table, after the lag test of one, two and three periods, the inhibitory effect of the upgrading level of industrial structure on regional resource dependence still maintains a significant level. The results show that the inhibitory effect of industrial structure upgrading level on regional resource dependence is more significant in different stages after implementation, and this effect has continuity and lag.

Table 4. Hysteresis Test

	(1)	(2)	(3)
	lag1	lag2	lag3
Ind	-4.219***	-4.177***	-2.543*
	(-3.13)	(-2.94)	(-1.65)

Constant	13.85***	13.61***	9.640***
	(4.41)	(4.12)	(2.69)
Control	Yes	Yes	Yes
Year-fix	Yes	Yes	Yes
Id-fix	Yes	Yes	Yes
Observations	4240	3975	3710
R-squared	0.912	0.911	0.909

5.4 Mechanical Analysis

In this study, the mediation effect testing method is employed, and the mediation effect analysis framework proposed by Jiang (2022) in the context of causal inference research is referenced. This study investigates the mechanism through which the upgrading level of industrial structure influences regional resource dependence, as outlined in the preceding theoretical analysis section. To test the mediation effect, Model (3) is specified in this paper.

$$mediation_{it} = \vartheta_0 + \vartheta_1 Gov_{it} + \vartheta_n X_{it} + \gamma_t + \mu_i + \varepsilon_{it} \quad (2)$$

Degree of Government Intervention ($^{\mathrm{Gov}}$): This paper draws on the study by Xie et al. (2024) and employs the ratio of regional fiscal budget expenditure to regional GDP as a proxy for this concept.

According to the results in column (1) of Table 5, when is the explained variable, the coefficient of is significantly negative at the 1% level. Government intervention plays a key role in the transmission between industrial structure upgrading and resource dependence and forms a sustainable green development path. Through policy interventions such as setting energy efficiency standards, and providing subsidies and incentives, the government encourages enterprises and residents to improve energy efficiency and promote the upgrading of industrial structure. By optimizing the allocation of factors, guiding the transformation of market consumption structure, and encouraging technological innovation and green industry development, this upgrade reduces the dependence on single energy and resources, thus effectively curbing regional resource dependence.

Table 5. Mechanical Test

	(1)
	Gov
Ind	-0.0953***
	(-5.22)
Hum	0.000791
	(1.49)

Inv	-0.208***
	(-3.40)
Urb	-0.0280**
	(-2.49)
Per	-0.00000118***
	(-6.44)
Constant	0.472***
	(10.30)
Year-fix	Yes
Id-fix	Yes
Observations	4505
R-squared	0.832

6. Conclusions and Recommendations

Using the panel data of 265 cities at the prefecture level from 006-2022, this paper uses a bidirectional fixed model and benchmark regression model to discuss the effect of industrial structure upgrading level on regional dependence on natural resources and expounds the impact of industrial structure upgrading level on regional resource dependence from both direct and indirect effects. The main conclusions are as follows: (1) The improvement of the upgrading level of industrial structure can effectively restrain regional resource dependence; (2) The level of industrial structure upgrading can effectively restrain regional resource dependence by strengthening the degree of government intervention; (3) It presents the heterogeneity of "eastern region > Central and western region". Based on the above research, to better achieve regional development, this paper puts forward the following suggestions.

(1) Strengthen policy regulation: In addition to improving the energy efficiency standard system, implementing differentiated fiscal and tax policies, and promoting the market-oriented reform of resource prices, the government should also strengthen the supervision and guidance of key industries and enterprises. Policy regulation can be combined with regional development characteristics to promote differentiated green transformation in different regions according to their resource endowments. At the same time, the government can increase investment in green technology research and development, especially in the field of new energy, energy conservation and environmental protection, to further stimulate the growth and development of innovative enterprises, promote the expansion of green industries, and form new momentum for green development.

(2) Improve the market incentive mechanism: the government can guide enterprises to develop in the direction of low-carbon and energy-saving through market-oriented means such as green tax incentives and carbon emission trading systems. At the same time, we will improve green financial services, promote innovation in green bonds and green funds, and provide more financial support for green

projects. In addition, by promoting the construction of green industrial parks, strengthening the certification and identification of green products, enhancing consumers' awareness of green purchases, and further promoting the development of green consumption and green market.

(3) Increase support for technological innovation: technological innovation is the core driving force of green transformation, and the government can encourage the research development and application of green technologies by setting up special funds, promoting deep cooperation between scientific research institutions and enterprises, and supporting cross-field innovation platforms. At the same time, in terms of the integration of industry and education, in addition to cultivating green technical talents, attention should also be paid to the skills upgrading and transformation training of existing employees, so as to help workers in traditional industries transition smoothly to new green industry positions. In the process of industrialization of green technology, the government should strengthen cooperation with enterprises, encourage enterprises to increase the transformation of technological achievements and promote the market-oriented application of achievements through policy guidance. Improve the evaluation system, establish a technology maturity evaluation model and innovation points system, and give priority to high-potential projects; In the market transformation link, through the first set of insurance compensation, government procurement of green products and other mechanisms to break down application barriers, and develop green technology bank to promote patent transformation; Build a carbon account system simultaneously, incorporate technological emission reduction into enterprise credit evaluation, form a positive cycle of "innovation-carbon-reduction - benefit", and promote the deep integration of technological innovation and industrial transformation.

(4) Focus on regionally differentiated policies: For the green transformation of resource-based areas, the government can help these areas break through the dilemma of resource dependence through special financial support, tax incentives, and the introduction of low-carbon technologies. In addition, the government can also establish a green industrial chain compatible with resource-based areas, develop sustainable green industries and clean energy projects, and promote industrial diversification and high value-added. At the same time, it is necessary to formulate personalized ecological compensation and environmental protection policies according to the ecological environment characteristics of different regions to ensure the coordinated promotion of green transformation and ecological protection. At the level of industrial restructuring, the "chain length system" investment model should be implemented, and the digital map of the industrial chain should be drawn around green basic industries such as solar energy hydrogen storage, and the targeted introduction of chain supplement enterprises should be introduced. Simultaneously building "industrial heritage + cultural tourism science and innovation" integration demonstration zone, policy tools need to pay attention to gradient design, such as resource-based cities to apply "zero land cost + negative income tax" entrepreneurial incentives, ecological reserves to implement "carbon ticket trading + franchise" system, and through "satellite remote sensing + big data" to establish a dynamic evaluation system of transformation performance. Ensure a dynamic balance between regional development rights and

ecological responsibilities.

(5) Establish a long-term monitoring system: To guarantee the efficacy and durability of initiatives, the government should build a sound long-term monitoring mechanism to dynamically track and analyze the adjustment of industrial structure, the application of green technology, and the change of resource dependence. At the same time, the transparency of policy implementation should be strengthened, a mechanism for public participation should be established, and all sectors of society should participate in the supervision and feedback of policies to ensure that the implementation of policies meets actual needs. In the monitoring process, the sharing of data and the application of intelligent means will provide a more scientific and accurate basis for policy adjustment. A tripartite interaction platform between the government, enterprises and the people has been established, a policy observer system has been established, and online political consultation meetings have been held regularly to incorporate public feedback into the policy iteration model. Through blockchain technology to achieve the whole process of regulatory data retention, to ensure that policy implementation can be traced and quantifiable, forming a "monitor-early-warning - response - optimization" closed-loop management chain.

There are still certain limits even though this study examines the process by which the upgrading level of industrial structure affects resource reliance and offers pertinent recommendations based on the current circumstances: (1) This study is based on 265 cities across the country, and the research level can be further refined in the future, and micro-data of industries or enterprises can be used for more in-depth discussion. (2) This paper mainly discusses the mechanism of industrial structure upgrading on resource dependence, and further studies may consider introducing other mediating or regulating variables, such as energy consumption structure, to reveal the relationship between industrial structure upgrading and resource dependence in a more comprehensive way.

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