The Effects of Big Data Regulations on Industrial Modernization in Resource-Based Cities: A Semi-Natural Study Using a State-Level Big Data Coordination Zone

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Abstract. As a core component of the digital economy, big data provides resource-based cities with a new impetus for upgrading their industrial structures. This paper employs a double difference method with panel data from 86 resource cities in China from 2009 to 2020 in order to investigate the effects of big data policies on resource cities' upgrading of their industrial structures objectively. Quasi-control groups are the quasi-natural trials of two batches of 19 resource cities in national big data comprehensive experimental zones. The empirical results demonstrate that the nationwide comprehensive experimental zone for big data exerts a considerable influence on the industrial upgrading of resource-based cities. This conclusion remains robust even after putting it through a series of tests, including the consolidation test and the stability test. Ultimately, this study offers a novel approach to catalyzing industrial upgrading in a big data context, shedding light on crucial issues such as economic instability in resource-based cities.

Keywords: national-level big data comprehensive experimental zone, resource-based cities, industrial upgrading, double-difference scores.

1. Introduction

As an important guarantee base for China's resources and energy, the promotion of sustainable economic development in resource-based cities is an essential part of the country's high-quality economic development. In traditional economic growth theory, abundant resources and energy as economic potential capacity endows the economy with a high level of growth. In recent times, there have been many countries that have achieved leapfrog economic growth by making full use of their natural resources, with China being a typical example.

However, based on the patterns of economic development observed in numerous nations and global cities, since the end of the twentieth century, the original resource advantages of resource-based cities have instead become a burden for economic development. The high dependence of traditional resource cities on the exploitation and use of natural resources has not only caused serious environmental problems, but also led to the solidification of their industrial structure, inhibiting the modernization of tertiary industries such as the service industry, and the serious incoherence of the industrial structure of resource cities, which has led to their economic development in a state of depression.

Auty puts forward the idea behind the "resource curse", that is, the increase in the endowment of wealthy cities' economies has fallen into a stagnant state, while the economic growth of cities with low resource endowment is rapid, and resource abundance has an inverse correlation with economic growth [1,2]. In addition, according to the analysis of Su Weizhou et al, it was found that the phenomenon of "natural resource wealth" exists through government intervention policies [3]. The industrial structure is a significant determinant of the extent and caliber of regional economic development [4]. Its modernization is critical to the economy's high-caliber growth [5].

Big data, as an indispensable treasure for digital transformation, is of high social value to look into how resource cities' industrial structure is affected by big data rules by taking advantage of the government's promulgation of relevant big data policies.

However, the sample size of most of the articles is too small in terms of area and time, and the data is not universal, and most of the articles on resource cities are only theoretical analyses of the current situation and outlook, but do not provide specific measures and empirical analyses. The industrial upgrading of resource cities has not received as much attention from academics as other aspects of the digital economy and big data's effects on city industrial restructuring enhancement. Based on the research that is currently available, investigating the upgrading of resource-based industrial structure has significant implications for the high-quality development of the national economy. As a result, utilizing new technologies and innovative approaches to support the upgrading of industrial structure is crucial for both the balanced and high-quality development of the economy. This paper adopts the double-difference method for empirical analysis, takes panel data of 87 resource-based prefecture-level cities from 2009 to 2020, and investigates how big data policy affects resource-based communities' industrial upgrading.

2. The Research Idea and the Institutional Backdrop

2.1. Background of Institutions

The 18th Party Congress report states that raising the standard and effectiveness of the economy is the first step in fostering economic development, stimulating the vitality of economic entities by strengthening the new impetus of innovation, putting network power and big data strategies into practice, encouraging the strategic reorganization of the economy. Based on the demand for the implementation of the big data strategy, in 2015, the State Council issued the Outline for Action to Promote the Development of Big Data, which repeatedly pointed out the need to build strong data power, promote industrial upgrading and transformation, and overcome obstacles to high-quality development in a way that promotes open sharing of information and technological innovation. In the same year, in response to the outline, the first set of nationwide comprehensive big data pilot zones was implemented in Guizhou. In October the following year, a total of seven pilot regions were established as the second batch of national-level comprehensive big data pilot zones to promote big data policy innovation. Shanghai, Henan, Chongqing, Shenyang, Inner Mongolia, Beijing-Tianjin-Hebei, Pearl River Delta, and Guizhou are among the pilot regions. However, Resource-based prefectures are absent from the Pearl River Delta, Shanghai, Henan, Chongqing, and Shenyang, so the experimental group excluded the exploration of resource-based cities in eastern cities and focused on the other three regions: central, western and northern, which are also important for promoting regional integration.

2.2. Research Hypothesis

Open and transparent information and data sharing are important elements of the nationwide comprehensive pilot zone for big data. The wide application of big data technology can accelerate the integration and openness of information resources, use data information as a medium to make traditional industry information sharing, and then promote industrial upgrading.

Proposed hypothesis: Direct effects are shown via the national big data comprehensive pilot zone strategy on the industrial upgrading of resource cities through industrial policy.

3. Investigational Plan

3.1. Model Selection

The Industrial Structure is affected by the National Big Data Comprehensive Pilot Zone Policy, which breaks the information barrier and promoting information sharing. To assess this policy's effects on the industrial structure scientifically, this paper employs a multi-level double-difference approach. The experimental group comprises 19 resource cities in the Comprehensive National Big Data Pilot Zone, while the control group consists of resource prefectures in the provinces that border

the experimental group. The two groups are then compared to ascertain the effect on industry structure of the National Big Data Comprehensive Pilot Zone strategy. The model is designed as follows.

$$upindustry_{it} = \beta_0 + \beta_1 treat_i \times post_t + \gamma_t + \beta_2 X_{it} + \varepsilon_{it}$$

$upindustry_{it}$denotes the level of industrial structure upgrading in city i in year t,$treat_i$is a group dummy variable,$post_t$is a period dummy variable, $treat_i \times post_t$the interaction term is the net effect of policy implementation, $X_{it}$the control variable, $\gamma_t$denotes the time fixed effect, γ_{it}denotes the random perturbation term, and$\beta_1$is the core estimation parameter of this paper, which illustrates how the national-level comprehensive experimental zone of big data policy has affected the upgrading of resource-based cities' industrial structures overall.

3.2. Descriptive Statistics and Variable Selection

3.2.1. Selection of variables

Expressed as the percentage of value added in the secondary sector of the city's GDP, the explainable variables represent the degree of upgrading of industrial structure.

Explanatory Variables: The main explanatory variable is the national-level big data comprehensive experimental zone policy (treat×post), with the following particular settings for the interaction terms: Additionally, treat×post is indicated as the interaction term. Treat means the policy dummy variable, which is set to 1, or 0 otherwise, and post denotes the time dummy variable, which is also set to 1, or 0 otherwise.

This study, which draws from Fan Rui et al., uses the logarithm of the number of college students per 10,000 students as the control variable for human capital [6]. The percentage of the population living in urban areas relative to all residents is the control variable's expression of the urbanization level. Government size control variable represented as general budget expenditure to regional GDP.

3.2.2. Detailed statistics

Table 1 illustrates the descriptive statistics this study ran on the experiment's data.

Table 1. Detailed Statistics

	N	Mean	Std. Dev.	min	max
upindustry	782	43.759	8.862	22.5	68.18
urban	782	51.477	14.175	20	94.849
govern	782	.22	0.107	.044	.688
human	782	1.755	0.509	.314	2.797

3.3. Data Sources

All of the data utilized in this study were taken from prior editions of the China Urban Statistics Yearbook, China Environmental Statistics Yearbook, China Statistical Yearbook, Statistical Bulletin, CECN, and National Bureau of Statistics. In order to maintain data completeness and consistency, some cities with serious missing data are not included in the study sample, and balanced panel data for 89 prefecture-level cities in China from 2009 to 2020 are finally obtained.

4. Empirical Analysis

4.1. Benchmark Regression Wquations

The outcomes of the benchmark regression for the previously indicated double-difference model are shown in Table 2. Column (1) regulates the temporal fixed effects, and columns (2) through (4) in the first column are based on the addition of control variables gradually.

The industrial upgrading policy based on big data is established as a positive promotion effect by the policy pilot's regression coefficients, all of which are positive at the 1% level of significance. The policy regression coefficients in column (4) show that compared to the control group, the experimental group had a higher industrial upgrading level.

The benchmark regression of this paper concludes that the level of industrial upgrading of the control group is lower than that of the experimental group after the implementation of the policy, and the significance level of the regression coefficients of the control variables is also in line with the expectation, which verifies hypothesis one. Hypothesis one, as shown in table 2.

Table 2. Preliminary regression findings

	(1)	(2)	(3)	(4)
	m1	m2	m3	m4
VARIABLES	upindustry	upindustry	upindustry	upindustry
did	11.014***	10.964***	11.306***	10.886***
	(9.480)	(9.460)	(9.758)	(9.461)
urban		-0.044**	-0.024	-0.017
		(-2.251)	(-1.150)	(-0.837)
govern			7.905***	13.322***
			(2.988)	(4.567)
human				2.426***
				(4.209)
Constant	43.083***	45.364***	42.550***	36.784***
	(158.059)	(43.246)	(30.270)	(18.845)
Observations	782	782	782	782
R-squared	0.321	0.326	0.334	0.349
r2_a	0.311	0.314	0.321	0.336
F	89.86	47.70	35.10	31.33

t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4.2. Policy Dynamic Effects

The policy dynamic effect is used to measure the time evolution process of the impact of policy measures on the level of industrial upgrading. The level of industrial upgrading in each resource-based prefecture-level city is depicted in Figure 1 before the policy treatment group and the control group were implemented. Following the policy treatment group and the control group were implemented, the trend was very different, and the experimental group showed a positive trend for the level of industrial upgrading, with the passage of time, this positive promotion effect is more apparent.

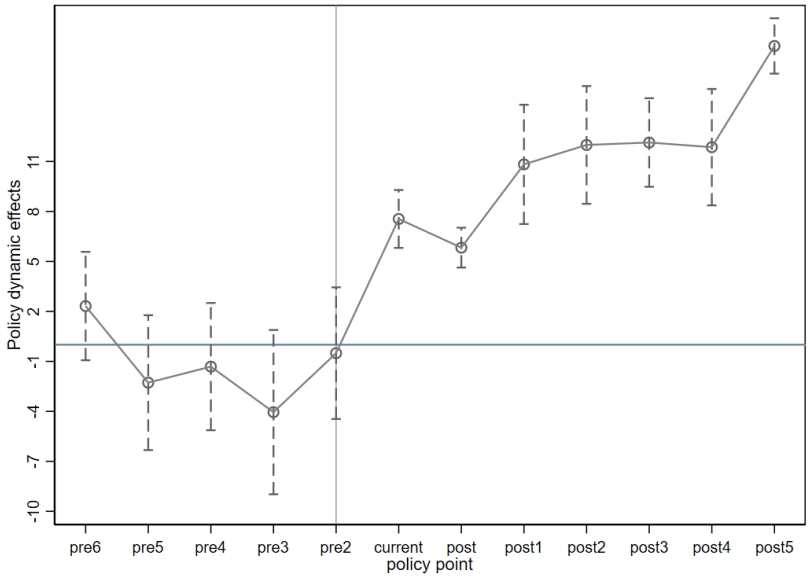


Figure 1. Policy dynamic effect

4.3. Placebo Test

The basis for the test of placebos is the random assignment of 1000 samples to the treatment group. If, at this time, the national-level comprehensive large-scale data trial area variable begins to trend significantly favorably, so it is improbable that the creation of the comprehensive big data experimental zone at the national level is what led to economic advancement. Rather, it might be the outcome of previous policy modifications or chance occurrences. If the complete experimental zone variable by country for big data is not now significantly positive, the additional contribution of economic development can be attributed to the establishment of the zone.

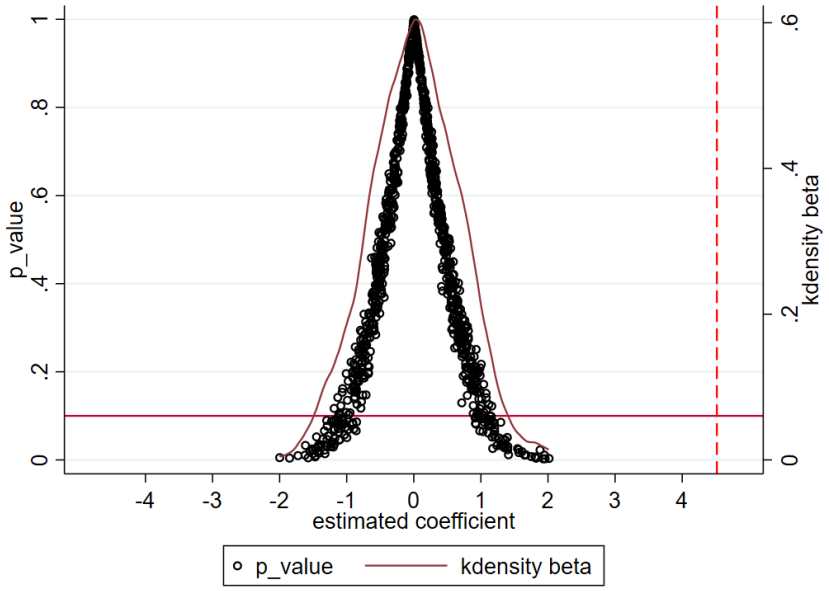


Figure 2. Placebo test

4.4. Robustness Test

This paper re-estimates the benchmark regression using quantile regression. Quantile regression is a non-parametric regression method, which can be used to obtain the regression coefficients under different quantiles, which helps to test stability of the benchmark regression findings. Specifically, in this work, the explanatory variable economic development is taken at 25%, 50%, and 75% quantile points, respectively, in order to re-estimate the benchmark regression. Columns (1) to (3) in the table reveal that the national big data comprehensive experimental zone policy has considerable influence on the degree of industry upgrading at various economic development quartiles. This suggests that the model's conclusions are quite reliable, as table 3 illustrates.

Table 3. Robustness test

	(1)	(2)	(3)
VARIABLES	y	y	y
did	12.2217***	10.6419***	8.4980***
	(1.3731)	(1.8166)	(1.8376)
urban	-0.0144	-0.0441	-0.0112
	(0.0245)	(0.0324)	(0.0328)
govern	13.6019***	10.5378**	14.5476***
	(3.4807)	(4.6051)	(4.6582)
human	2.5340***	2.4957***	2.9886***
	(0.6876)	(0.9097)	(0.9202)
Constant	27.9787***	33.8859***	37.0630***
	(2.7074)	(3.5820)	(3.6233)
Observations	782	782	782
Year FE	YES	YES	YES

5. Conclusion

The growth of big data has a profound impact on the superior restructuring of the social sector, and the construction of nationwide extensive experimental zones for big data aims to promote the superior economic growth in the pilot cities, and to empower the new power of industrial upgrading with big data policies. This paper quasi-natural experiments with the pilot nationwide extensive experimental zones for big data in 2015 and 2016, respectively, constructed a multi-period double-difference model, and selected the panel data of 89 resource cities from 2009 to 2020 to explore the impact of big data policies on industrial upgrading. It is found that the national-level big data comprehensive experimental zone policy hasa direct influence of industrial strategy on resource city industrial upgrading, and this conclusion still holds through policy effect and placebo test. Drawing from the aforementioned results, this article proposes the subsequent policy recommendations:

Based on the empirical results, the national-level big data comprehensive experimental zone policy has a significant enhancement on the industrial upgrading of pilot cities. Therefore, on the one hand, the state should expand the scope of the pilot cities of the policy based on the in-depth implementation of the policy to each pilot city and the improvement of the policy based on the inadequacy of the original policy implementation. On the other hand, the state should promulgate relevant welfare policies to assist the digital transformation of resource cities, promote the transparency of industrial information, and gradually adjust the industrial structure.

By introducing advanced data analysis and processing technologies, the comprehensive experimental zone policy on big data provides powerful technical support for enterprises and industrial sectors in pilot cities. Big data technology can help enterprises achieve accurate market analysis, consumer behaviour prediction and supply chain optimization, thereby improving production efficiency, reducing costs and promoting industries to move towards high value-added and high-tech content. In addition, the implementation of the policy not only focuses on technological innovation, but also on data-driven decision-making. Pilot cities can use big data analysis to gain accurate insight into market demand and trends, respond quickly to market changes, optimise industrial structure, and enhance the market competitiveness and risk resistance of enterprises. To sum up, the national-level big data comprehensive experimental zone policy has significantly enhanced the industrial upgrading of pilot cities, which not only brings significant results in technological innovation and industrial optimisation, but also plays an important role in economic development and social progress.

Finally, there are still objective limitations due to problems such as uneven technology application, data privacy and security risks, and long-term sustainability challenges, so future research can study and improve on balanced and sustainable development of technology.

References

[1] Auty R, Warhurst A. Sustainable development in mineral exporting economies. Resources Policy, 1993, 19 (01): 14 - 29.

[2] Su CW, Khalid K, Tao R, et al. A review of resource curse burden on inflation in venezuela. Energy, 2020, 204: 117925.

[3] Su WZ, Lei GW, Wang Y, Guo SD. Research on the influence mechanism of the formation mode of resource-based cities on the upgrading of industrial structure. Soft Science, 20231201: 2 - 3.

[4] Qu SH. The revolutionary significance of big data and artificial intelligence in promoting industrial transformation and upgrading. Industrial Innovation, 2024, (08): 28 - 29.

[5] Zhu FH, Liu LF. China's industrial structure upgrading and economic high-quality development - based on empirical data of prefecture-level and above cities. Journal of Yunnan University of Finance and Economics, 2020, 36 (06): 42 - 43.

[6] Fan R, Mao CG. Study on the effect of "Comprehensive Reform Zone" in promoting the transformation and upgrading of industrial structure in resource-based regions---Experiential evidence from 109 resource-based cities. Commercial Research, 2022, (03): 39 - 41.