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Economic Responsibility Audit, Regional Innovation Capacity and Low Carbon Development

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Abstract. Economic responsibility auditing can help promote regional economic development, but whether it helps enhance regional innovation capacity and low carbon development needs to be further tested. This paper examines the objectives of authenticity, legality, and effectiveness of economic responsibility audit. The results show that the increased scrutiny of the authenticity, legality and effectiveness of financial records, policy formulation and implementation, and major project activities of government leaders can definitely enhance the awareness of environmental protection and innovation among cadres, thus improving regional innovation capacity and helping to reduce carbon emissions, achieving the goal of double balance between economic growth and carbon reduction.

Keywords. Economic responsibility audit, regional innovation capacity, low carbon development

1. Introduction

Since the 1950s, countries have pursued efficient production while making extensive use of natural resources, causing environmental problems such as climate warming and biological extinction. As a result, 183 countries signed the Kyoto Agreement in 1998: developed countries assumed carbon reduction obligations from 2005 and developing countries assumed emission reduction obligations from 2012. By 2020, 53 countries have already achieved the carbon peak, and China has officially proposed the goal of "reaching the carbon peak in 2030 and achieving carbon neutrality in 2060"[2], which not only brings certain pressure on China's economic development, but also provides an opportunity to realize the organic combination of "low carbon" and "development",the exploration of new energy technology innovation, low-carbon development of new paths and other development opportunities, in December 2021 for the first time put forward the high-quality development, innovation-driven

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[2] General Debate of the 75th Session of the UN General Assembly in 2020

development strategy and "carbon peaking and carbon neutrality" goals closely linked[3], in August 2022 to achieve the goal of 2030 carbon peak of Low-carbon industrial process reengineering, dual-carbon management decision support system and other initiatives[4]. On the audit side, China emphasized that national audit should better serve in innovative operations and activities[5], and the newly revised Regulations include ecological environmental protection into the key areas of investigation[6] .

The existing studies on audit, innovation activities and low-carbon development show that national audit can promote low-carbon development[1], national audit and exit audit of natural resource assets can help improve regional innovation capacity[2][3], improving R&D intensity and innovation capacity can solve environmental problems[4], but whether strengthening economic responsibility audit of party leaders directly contributes to improving regional innovation capacity and the realization of the "carbon peaking and carbon neutrality" target needs to be specifically tested. Based on the importance and urgency of low-carbon development goals, this paper empirically investigates the mechanism of the three major goals of economic responsibility auditing affecting low-carbon development and the mediating effect of regional innovation capacity using data from 30 provinces in China from 2009-2022. This paper provides useful reference for enriching the research on the role of economic responsibility auditing, developing the application field of innovation capacity, and exploring the realization path of low-carbon development.

2.Theoretical analysis and research hypothesis

At this stage, although China's environmental governance has made great progress and development, to successfully achieve the goal of "carbon peaking and carbon neutrality", we are facing pressure in the practice of green technology innovation and the formulation and implementation of environmental regulation policies, especially in regions with backward economic development, with high environmental pressure and with more prominent contradictions between economic development and environmental protection. Economic responsibility audit not only provide forensic information on fiduciary responsibilities, but also facilitate government to play a better constructive role in maximizing public interests[5].

In low-carbon development, the authenticity and legality objectives of economic responsibility audit can effectively supervise the availability of low-carbon financial funds for allocation, reasonable distribution and accurate records; it can further regulate the formulation and implementation of low-carbon policies and the legal collection and use of low-carbon funds; it can also urge the units with the above problems to rectify and reform. And the effectiveness audit objective of economic responsibility will prompt government leaders to make correct regional economic development goals and rationalize low-carbon development plans, achieve low-carbon economic balance. In the process of helping to achieve the goal of "carbon peaking and carbon neutrality",

[3] Guiding Opinions on Promoting High Quality Development of Central Enterprises to Do a Good Job of Carbon Peaking and Carbon Neutral Work

[4] Science and Technology to Support Carbon Neutral Implementation Plan (2022-2030)

[5] Opinions on Auditing to Better Serve the Construction of an Innovative Country and a World Science and Technology Power

[6] Regulations on Economic Responsibility Auditing of Major Leading Party and Government Cadres and Leading Personnel of State-owned Enterprises

economic responsibility audit can promote the management awareness of leaders and the scientific choice of innovation behavior in terms of regional innovation capacity. It can also encourage leaders to exercise their authority, use funds and manage innovation activities in a rational manner, and pay great attention to the economy, efficiency and effectiveness of resource utilization; to enhance innovation capacity and increase economic value added by imitating, absorbing, improving technology and accelerating R&D; to minimize the cost of "trial and error" by means of expert verification[6].

In conclusion, the economic responsibility audit can control the unreal, illegal and ineffective phenomena caused by blind and misplaced investment etc.in innovation behavior in time, stimulate the innovation consciousness of government leaders, form a series of scientific innovation activities, cultivate emerging green industries, and promote the upgrading of low-carbon industries. The hypotheses are proposed:

H1: Economic responsibility audit significantly contribute to low-carbon development.

H2: Economic responsibility audit significantly contribute to regional innovation.

H3: Regional innovation capacity has a mediating role in economic responsibility audit for low-carbon development.

3.Research design and empirical analysis

3.1. Study design

In order to ensure the consistency of the time caliber of the relevant data and the completeness and comprehensiveness of the empirical research data, the study takes the relevant data of 30 Chinese provinces from 2009 to 2020 as the sample. Carbon emissions are obtained from China Carbon Accounting Database, data of economic responsibility audit authenticity and legality indicators are obtained from China Audit Yearbook, innovation capacity index is obtained from China Regional Innovation Capacity Evaluation Report, other data are obtained from CSMAR, data collation and empirical study using spss software and stata software, using regression analysis based on statistical principles of data can determine the correlation between dependent variables and mediating variables, independent variables, so as to establish a regression equation model with good correlation to prove the research hypothesis and predict future changes in the dependent variable.

Carbon emissions(t)measure low-carbon development, the economic responsibility audit authenticity objective is measured by the accounting inaccuracy rate (zs); the legality objective is measured by the violation rate (hf); the factor analysis method is used to construct effectiveness (xy) from tax revenue growth rate, per capita disposable income growth rate, gross product growth rate, budget revenue growth rate, budget expenditure growth rate, and consumption expenditure growth rate. The regional innovation index (cxnl) measures the regional innovation capacity, and the control variables are selected as the number of enterprises (qy), foreign trade (logjckzb) and education and culture(bkzb).Models(1) and (2) verify the impact of economic responsibility audits on low carbon development and regional innovation capacity, and model(3)verifies the mediating effect of regional innovation capacity in the relationship between economic responsibility audits and low carbon development:

$$t=\beta_0+\beta_1 zs+\beta_2 hf+\beta_3 xy+\beta_4 qy+\beta_5 logjckzb+\beta_6 bkzb+\varepsilon \quad (1)$$

$$cxnl=\beta_0+\beta_1 zs+\beta_2 hf+\beta_3 xy+\beta_4 qy+\beta_5 logjckzb+\beta_6 bkzb+\varepsilon \quad (2)$$

$$t=\beta_0+\beta_1 zs+\beta_2 hf+\beta_3 xy+\beta_4 cxnl+\beta_5 qy+\beta_6 logjckzb+\beta_7 bkzb+\varepsilon \quad (3)$$

3.2. Empirical Analysis

Descriptive analysis and correlation analysis are not presented for space reasons. Stepwise regression method is used to test the models from the perspective of authenticity, legitimacy, and effectiveness. The authenticity regression test chart is used as an example, while the legality and effectiveness regression test charts are not shown and textual descriptions are provided.

The multivariate regression of the economic responsibility audit authenticity objective (Table1), $r^2$is 0.039, and the model is significant overall. The test results show that when the rate of accounting inaccuracy (zs) increases, i.e., the audit of authenticity objective (zs) is weak, the carbon emission (t) in model 1 increases significantly at the 5% level with a regression coefficient of 0.025,the hypothesis H1 holds; the regional innovation capacity (cxnl) in model 2 decreases significantly at the 1% level with a coefficient of -0.001, the hypothesis H2 holds. The mediation test of model 3 regional innovation capacity (cxnl) between authenticity target (zs) and carbon emission (t) shows that the significance level of authenticity target (zs) decreases from 5% to 10%, and the regression coefficient decreases from 0.025 to 0.02. The significance level of regional innovation capacity (cxnl) is 10%, the regression coefficient is -4.912, which indicates that the direct effect of economic responsibility audit authenticity objective on low carbon development is reduced, innovation capacity has a partial mediating effect, the H3 holds.

Table 1. Authenticity objective, regional innovation capacity and low carbon development

Variable Type	**Variable Name**	**Carbon emissions (t)**	**Regional innovation capacity (cxnl)**	**Carbon emissions (mediating effect)**
		Model 1	**Model 2**	**Model 3**
Explanatory variables	Authenticity target (zs)	0.025**	-0.001***	0.020*
		(0.011)	(0.000)	(0.011)
Control variables	Number of enterprises (qy)	0.072	0.000	0.072
		(0.064)	(0.001)	(0.064)
	Education and Culture (bkzb)	-678.934	-0.672	-682.234
		(523.529)	(10.665)	(521.706)
	Foreign trade (logjckzb)	26.064	-0.937**	21.460
		(23.331)	(0.475)	(23.388)
Intermediate variables	Regional innovation capacity (cxnl)			-4.912*
				(2.709)
	r^2	0.030	0.076	0.039

The multiple regression of the economic responsibility audit legitimacy objective,$r^2$is 0.042, and the model is significant overall. The test results show that when the violation rate (hf) increases.The audit of legality target (hf) is weak, the carbon emission (t) in model 1 increases significantly at the 1% level, with a regression coefficient of 267.847, validating H1; the regional innovation capacity (cxnl) in model 2 decreases significantly at the 1% level, with a coefficient of -11.745, validating H2; model 3, the regional innovation capacity (cxnl) in the mediation test between legality target (hf) and carbon emission (t), the effect of legality target (hf) on carbon emission (t) decreases from 267.847 to 214.255, and the significance level decreases from 1% to 5%, and the regional innovation capacity (cxnl) shows a negative correlation at 10% level with a coefficient of -4.563, verifying H3.

The multiple regression of the economic responsibility audit effectiveness objective ,$r^2$is 0.049 and the model is significant overall. The test results show that: the higher the comprehensive efficiency index (xy), the higher the carbon emissions (t) in model 1 at the 5% level, with a regression coefficient of 135.798, which is at the stage of degradation of environmental quality with increasing income of the environmental Kuznets "inverted U" curve, and is not consistent with the absolute decoupling of carbon emissions with economic growth,H1 is not valid. In model 2, the regional innovation capacity (cxnl) is significantly positively correlated at the 1% level, with a coefficient of 5.397, the good overall efficiency of the local situation, which helps to improve the regional innovation level by putting forward new requirements for industrial upgrading, H2 is valid. In model3, the effect of comprehensive benefit index (xy) on carbon emissions (t) rose from 135.798 to 176.909, the significant degree remains 5%, regional innovation capacity (cxnl) is 1% level negative correlation with a coefficient of -7.617,the comprehensive benefit index (xy) requires high, although carbon emissions (t) appeared to rise, but the mediating effect of cxnl is also obvious,H3 holds.

3.3. Robustness tests

The vif command was used to find that the vif values of the explanatory variables, mediating variables and control variables did not exceed 10, indicating that there was no multicollinearity problem; considering the problem of two-way causal endogeneity, the mediating variables, control variables and explained variables were used to lag one-period data, and winsor2 was used to shrink the tail at the 1% level; considering the problem of endogeneity of omitted variables, the hausman test procedure was used to find that the p-value was 0.0000 to reject the original hypothesis, Fe was correlated at the 1% or 5% level, so the fixed-effects model (fe) was selected to develop the empirical evidence.

The robustness test is conducted by replacing carbon productivity (tc) with carbon emissions (t) , and it passes the test in general with consistent direction and better results. In the main test of authenticity objective (zs), carbon emissions (t), regional innovation capacity (cxnl) and mediating effect are significant at 5%, 1% and 10% levels, while in the robustness test, they are all at 1% level, regional innovation capacity (cxnl) changes from partial to full mediating effect; significance in the main test of legitimacy objective (hf) is significant at 1%, 1%, and 5% levels, while the robustness test is at 1% level, and regional innovation capacity (cxnl) still plays a partial mediating role; the main test of effectiveness objective (xy) is significant at 5%, 1%, and 5% levels, the robustness test is at 1% level, regional innovation capacity (cxnl) changes from partial to full mediating effect. The results of the robustness test prove that the empirical test of this paper is stable.

4.Conclusions and Recommendations

The empirical test results show that strengthening economic responsibility auditing significantly promotes low-carbon development with truthfulness and legality objectives, and legality objective is more effective, but effectiveness objective is in the opposite direction, indicating that China's economic development is positively correlated with carbon emissions and is in the rising stage of the environmental Kuznets "inverted U" curve. The strengthening of economic responsibility audit

significantly promotes regional innovation capacity, with legality being the most obvious, followed by effectiveness. Regional innovation capacity has a mediating effect between economic responsibility audit and low carbon development, with the best effectiveness and the second best legality.

Through the analysis, although the authenticity goal to promote low-carbon development is not as obvious as legality, the problem of economic business authenticity has been greatly reduced with China's continuous improvement of economic responsibility auditing, corruption punishment and full audit coverage, the authenticity goal of economic responsibility auditing has been basically achieved. The legitimacy objective is prominent in promoting low-carbon development, mainly because there are still irregularities in economic operation such as misappropriation of special funds. Strengthening the effectiveness goal must help regional innovation capacity and low-carbon economic development.

In order for economic responsibility audit to better contribute to the "carbon peaking and carbon neutrality" goal, we suggest that: on the one hand, auditors continue to pay attention to the economic responsibility audit authenticity goal, and moreover, they should increase the review of legality and effectiveness goals; on the other hand, government leaders should strive to balance the contradiction between economy and environmental protection, and reach the highest point of the environmental Kuznets "inverted U" curve as soon as possible, achieve absolute decoupling of economic growth and carbon emission reduction, enhance regional low-carbon technology research and development capacity to develop low-carbon transition paths on the basis of increased innovation awareness.

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