Research on the driving factors for the high-quality development of China's forestry economy under the carbon peaking and carbon neutrality goals

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Abstract: Under the development path of green circular economy with the goal of "double carbon", the high-quality development of forestry economy is an important driving force for tapping the new momentum of green transformation of industrial structure. Based on panel data of 31 provinces in China from 2009 to 2018, this paper constructs a two-way fixed-effects model to explore the drivers of high-quality development of the forestry economy, using forestry economic output value as the explanatory variable. The study found that forestry protection efforts, average forestry salary levels, forestry employees, annual afforestation area, technology level and regional industrial structure significantly contributed to forestry economic development. Therefore, China should formulate targeted forestry development policies based on the drivers of the forestry economy, so as to support and ensure the quality development of the forestry economy.

Keywords: Forestry economy, carbon peaking, carbon neutrality, high-quality development.

1. Introduction

With the gradual progress of ecological civilization construction and governance, the urgency and importance of high-quality development of forestry economy has become more and more prominent[1-3]. Forests contain the majority of the carbon stored in terrestrial ecosystems[4], and play a crucial role in mitigating global climate change[5-7]. In the context of China's "carbon peak" and "carbon neutral" goals, the forestry economy is a key medium for implementing the spirit of the Paris Agreement and building a green, low-carbon and circular development system. In 2021, the output value of China's economic forestry will exceed RMB 2.2 trillion, enriching the endogenous power of economic development. Besides, based on the positioning and functions of the forestry industry, the forestry economy relies on the growth of forest trees, forest management and the processing and manufacturing of forest products to achieve the absorption, fixation and consumption of carbon dioxide, which is a stable ballast for the "double carbon" strategic goal. Therefore, in the context of practising the concept of green and low-carbon development, exploring the driving factors for the high-quality development of the forestry economy is an important step towards achieving a balanced development of ecological environmental protection and forestry economy, and tapping into the new momentum of green transformation of the industrial structure.

In the "carbon peak" and "carbon neutral" target management, forestry economic development has received extensive attention from academics. Ke et al., (2019) find that capital investment demonstrates the largest impact on the forestry output value, followed by property system, afforestation area, labor input and technologies progress. Zhang et al., (2006) figure out that per capita GDP has a far greater impact on the changes in forest areas than any other factor. In this study, on the basis of the environmental Kuznets curve (EKC) hypothesis, Hao et al., (2019) examined the relationship between forest resources and economic growth using panel data from 30 provinces in China, indicating that positive effects of China's pursuit of a more balanced growth path where forest resources would be less consumed and more actively protected. However, the macroscopic research on forestry economic development is not sufficiently focused, and the driving factors leading to the high-quality development of China's forestry economy need to be further clarified. Therefore, this paper takes the forestry economy as an entry point and combines provincial panel data and fixed-effects models in China to explore in depth the drivers of high-quality forestry economic development, so as to suggest ways to create a new growth pole for forestry economic development and to achieve the synergistic development of the dual carbon goal and the forestry economy.

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2. Study design

2.1 Indicator construction and data sources

The forestry economy is a key development area that responds to the concept of "carbon neutrality" and "carbon peaking" and contributes to the transformation of China's green economy. It is important to clarify the drivers of forestry economic development in order to promote high-quality forestry economic development and strengthen the country's green economic orientation. According to the Cobb-Douglas production function of input-output relations, labour, capital and technology are the main factors that determine the level of output. Combining the industry characteristics of the forestry economy, this paper is based on panel data of 31 provinces in China from 2009 to 2018, with forestry economic output value (y) as the explanatory variable, fixed asset investment (x1), forestry protection efforts (x2), average forestry salary level (x3), forestry employees (x4), annual afforestation area (x5), technology level (x6) and regional industry structure (x7) as explanatory variables to explore the drivers of high-quality forestry economic development.

The explanatory variables and explanatory variables were obtained from the China Statistical Yearbook and the China Forestry and Grassland Statistical Yearbook. In the data processing, some of the missing and incomplete variables were excluded, and to avoid the influence of extreme values on the regression results, the continuous data were Winsorized, resulting in a total of 3111 panel data for the regression analysis. In the data processing, some of the missing and incomplete variables were excluded. In order to avoid the influence of extreme values on the regression results, and to eliminate heteroskedasticity and reduce the influence of data fluctuations, the data of all variables are logarithmised in this paper, and a total of 310 panel data are finally involved in the analysis.

Table 1 Variables descriptive

Variable	Obs	Mean	Std. Dev.	Min	Max
y	310	15.91427	1.522213	11.22398	18.24822
x1	310	12.45288	1.772174	6.654153	16.20072
x2	310	9.758498	1.019107	6.923629	12.33122
x3	310	10.70818	0.5239589	9.464362	12.13306
x4	310	9.885813	1.177959	6.498282	12.68242
x5	310	11.70065	1.309801	6.566672	13.59879
x6	310	13.10423	2.820206	0	17.71906
x7	310	44.76664	9.490284	28.6	80.98

2.2 Model construction

In order to explore the drivers of high-quality development of China's forestry economy, and considering the heterogeneous influence of different regions in different evolutionary periods and the specificity of traditional perceptions on forestry economic development, this paper constructs a two-way fixed effects model controlling for time and individuals (see equation 1), in order to accurately analyse the impact of different variables on the forestry economy.

$$y = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + \alpha_3 x_3 + \alpha_4 x_4 + \alpha_5 x_5 + \alpha_6 x_6 + \alpha_7 x_7 + \lambda_i + \gamma_t + \varepsilon_{it} \quad (1)$$

Where y is the explanatory variable, xi is the explanatory variable, α_i and ε_{it} are the regression coefficients and error terms, respectively. When the regression coefficient is significantly positive, it indicates that the variable can promote the development of forestry economy with high quality; on the contrary, when the regression coefficient is significantly negative, it inhibits the development of forestry economy.

3. Empirical analysis

3.1 Correlation analysis

In order to avoid the empirical error caused by the multicollinearity between different variables of the panel data, this paper combined with the variance inflation factor VIF to carry out the test of collinearity, and found that the variance inflation factor of the variables are less than 10, indicating that there is no multicollinearity. In the correlation analysis, it can be found that the average salary level of forestry, forestry employees and technology level are significantly and positively correlated with the forestry economy, but the correlation between other variables and the forestry economy is not significant and still needs further analysis.

Table 2 Results of correlation analysis

	y	x1	x2	x3	x4	x5	x6	x7
y	1.0000							
x1	-0.0415	1.0000						
x2	0.2346***	0.0210	1.0000					
x3	-0.0348	-0.3224***	0.0698	1.0000				
x4	0.5288***	0.1060*	0.1970**	0.5078***	1.0000			
x5	0.3368***	-0.0861	0.4502***	-0.2991***	0.6516***	1.0000		
x6	0.4304***	-0.0411	-0.0105	0.2249**	0.1369	-0.0306	1.0000	
x7	-0.2267**	-0.1420	0.0599	0.6921***	-.4436***	-0.5112***	0.1826**	1.0000

3.2 Analysis of fixed effects

This paper use the panel data of 31 provinces across China from 2009-2018 to analyse the drivers of high-quality development of forestry economy by Stata 16.0 software. Firstly, based on the F-test results, it is found that the F-value is 0 and the original hypothesis of using mixed utility is rejected, then through the Hausman test results, it is found that the P-value is 0.0001 and the original hypothesis of using random effect is rejected, so this paper chooses the fixed effect model to test the relationship between the forestry economy and the explanatory variables. Based on the results of the stepwise regression of fixed effects, it can be found that the variables of forestry protection, average salary level of forestry, forestry employees, annual afforestation area, technology level and regional industrial structure are significantly and positively related to the forestry economy, i.e. they promote the high-quality development of the forestry economy; while the variables of fixed asset investment are not significantly related to the high-quality development of the forestry economy. In particular, forest rangers in the

forestry industry reduce the probability of forestry disasters and economic losses by strengthening the daily management of forest areas, thus ensuring the healthy development of the forestry economy; average forestry salary is a capital investment in the forestry economy, which is conducive to fully mobilising the work motivation of forestry personnel and increasing the sense of responsibility for forestry protection and development; The forestry employees is the labour input and the output driver for the quality development of the forestry economy, which strongly guarantees the value transformation, recycling and value-adding process of the forestry economy. The annual afforestation area is an effective measure to increase the carrying capacity of the environment and an important driving force for the sustainable development of the forestry economy; technology is the first productive force, and the forestry economy is no exception. The industrial structure reflects the development orientation of the forestry economy, indicating that the forestry economy and the transformation and upgrading of the regional industrial structure have achieved effective integration and complementarity.

Table 3 Fixed effects regression results

VARIABLES	y	y	y	y	y	y	y
x1	-0.010	-0.013	-0.015	-0.009	-0.014	-0.014	-0.020**
	(-0.99)	(-1.27)	(-1.58)	(-0.99)	(-1.48)	(-1.44)	(-2.21)
x2		0.091**	0.104***	0.105***	0.107***	0.110***	0.118***
		(2.56)	(3.02)	(3.16)	(3.17)	(3.34)	(3.58)
x3			0.580***	0.735***	0.760***	0.722***	0.661***
			(3.15)	(4.54)	(4.77)	(4.63)	(4.45)
x4				0.399***	0.426***	0.420***	0.423***
				(2.83)	(2.96)	(3.10)	(3.47)
x5					0.108***	0.103***	0.087***
					(3.07)	(2.90)	(2.67)
x6						0.061**	0.029*
						(2.57)	(1.16)
x7							-0.025***
							(-3.79)
Constant	13.762***	12.809***	6.431***	0.878	-0.688	-1.180	2.028
	(69.03)	(29.57)	(3.04)	(0.35)	(-0.26)	(-0.47)	(0.97)
province	yes	yes	yes	yes	yes	yes	yes
year	yes	yes	yes	yes	yes	yes	yes
Observations	310	310	310	310	310	310	310
R-squared	0.980	0.981	0.983	0.984	0.984	0.985	0.986
r2_a	0.977	0.978	0.980	0.981	0.982	0.982	0.983
F	1094	931.2	800.8	718.8	755.8	731.1	553.3

In order to test the robustness of the empirical findings, this paper combines the variable substitution method, using the total amount of various economic forestry products to characterize the forestry economy, keeping other explanatory variables unchanged, and again using a two-way fixed effects model to conduct stepwise regression analysis. It can be found that after replacing the explanatory variables, the main variables such as forestry protection efforts, average forestry salary level, forestry employees, technology level and regional industrial structure are still significantly and positively related to the high-quality development of forestry economy. The annual afforestation area is not significantly related to the forestry economy, which may be due to the uncertainty of the growth cycle of forest areas and the lag between afforestation behaviour and forest product output. Overall, the robustness tests show that the regression results are robust and objective.

Table 4 Robustness test results

VARIABLES	y	y	y	y	y	y	y
x1	0.015	0.009	0.008	0.014	0.014	0.015	0.015
	(1.01)	(0.72)	(0.61)	(1.13)	(1.15)	(1.17)	(1.16)
x2		0.188***	0.199***	0.200***	0.200***	0.202***	0.201***
		(3.92)	(4.23)	(4.35)	(4.35)	(4.38)	(4.36)
x3			0.489**	0.655***	0.652***	0.635***	0.639***
			(2.18)	(2.97)	(2.92)	(2.79)	(2.70)
x4				0.424**	0.422**	0.419**	0.419**
				(2.35)	(2.30)	(2.31)	(2.30)
x5					-0.012	-0.014	-0.013
					(-0.34)	(-0.40)	(-0.36)
x6						0.028*	0.030*
						(1.00)	(1.07)
x7							0.002*
							(0.21)
Constant	13.135***	11.166***	5.783**	-0.126	0.031	-0.192	-0.404
	(51.70)	(18.44)	(2.22)	(-0.04)	(0.01)	(-0.05)	(-0.10)
province	yes	yes	yes	yes	yes	yes	yes
year	yes	yes	yes	yes	yes	yes	yes
Observations	310	310	310	310	309	309	309
R-squared	0.977	0.979	0.980	0.981	0.981	0.981	0.981
r2_a	0.973	0.975	0.977	0.978	0.978	0.978	0.978
F	368.0	443.9	407.5	396.2	388.3	392.8	379.1

4. Conclusions and recommendations

With the "double carbon" target management, the development of forestry economy has entered a new stage. In order to promote the high-quality development of the forestry economy, this paper explored the drivers of the forestry economy using the explanatory variables of the forestry economy and a two-way fixed-effects model. we found that the strength of forestry protection, the average salary level of the forestry industry, the number of forestry employees, the annual afforestation area, the level of technology, and the regional industrial structure significantly contributed to the development of the forestry economy. Therefore, China should formulate targeted forestry development policies based on the drivers of the forestry economy in order to support and ensure the quality development of the forestry economy.
Province in China should take into account the current situation and characteristics of forestry development in different regions, and actively promote the construction of a supporting forestry industry, from increasing the number of forest rangers, raising the minimum salary

level of the industry and expanding the number of forestry workers, in order to enhance the level of labour and capital investment in the forestry economy, so as to fully mobilise the enthusiasm and sense of responsibility of forestry workers and attract the public to participate in forestry development work. At the same time, in order to promote the sustainable development of the forestry economy, local governments should, on the one hand, actively increase the annual afforestation area, improve the regional vegetation cover and thus ensure that the environmental carrying capacity is within the normal range; on the other hand, they should increase investment in forestry economy technology development, promote the transformation of innovation results, and improve the effectiveness and efficiency of the high-quality development of the forestry economy. In addition, the forestry economy should actively match the development path of industrial transformation and upgrading, shift to high value-added forestry tourism and leisure services and other tertiary industries, promote the modernisation process of forestry economic development, and effectively improve the quality of forestry economic development.

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