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The Research on Financial Development, Environmental Regulation, and Economic Growth in Anhui Province

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Abstract

Based on panel data from 16 prefecture-level cities in Anhui Province from 2009 to 2019, this paper constructs a threshold effect model to explore in-depth the internal relationship and mechanism between financial development, environmental regulation, and economic growth at different stages of financial development in Anhui Province. The empirical findings reveal significant regional disparities in economic growth across Anhui Province. In addition to financial development and environmental regulation, human capital and technological output are also key factors. The impact of environmental regulation and financial development on economic growth presents a nonlinear relationship, showing either a "J-shaped" or positive "U-shaped" curve under different levels of financial development. Based on these findings, it is recommended that Anhui Province place greater emphasis on ecosystem protection, optimize the financial development system, and promote the coordinated advancement of environmental regulation and financial development to foster high-quality and sustainable economic growth. These insights can help guide Anhui Province's future economic development strategies, improve related policy formulation, and enhance the effectiveness of policy implementation.

Keywords

Anhui Province; Financial Development; Environmental Regulation; Economic Growth; Threshold Effect.

1. Introduction

In recent years, China's economy has been growing at a breakneck pace, earning the country the nickname "The Eastern Express." However, with the gradual slowdown of economic growth, China has entered a "new normal," characterized by a trend of structural adjustment. Against this backdrop, it is particularly crucial for Anhui Province to adapt to the times by adjusting and optimizing its economic structure to achieve high-quality and sustainable development.

On the one hand, financial development contributes to economic growth by creating scale effects through industry expansion. In the process of economic system transformation, Anhui Province has adopted cutting-edge regulatory strategies and reform measures from within the country. The continuous expansion of the financial sector and the gradual improvement of the financial system have effectively reduced financing costs for local enterprises, optimized corporate cash flow management, enhanced regional economic liquidity and dynamism, and promoted the transition and upgrading of the economy toward a virtuous cycle of development.

On the other hand, environmental regulation has standardized corporate economic behavior, effectively curbing environmental pollution and fostering high-quality, sustainable economic growth. Although structural adjustments have alleviated the negative consequences of overexploitation, issues such as environmental pollution and resource shortages remain persistent. Against the backdrop of a sharp decline in the national environmental carrying

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capacity, Anhui Province, adhering to the principles of sustainable development, has implemented a series of environmental governance and ecological economic policies, mitigating the adverse impact of economic growth on the environment.

Therefore, in the context of the "new normal" of the economy, and in the face of increasingly severe ecological and environmental challenges, the formulation of effective economic optimization strategies becomes crucial. This study aims to explore the impact of financial development and environmental regulation on sustainable economic growth and the enhancement of its quality. By analyzing the regional disparities in Anhui's economic growth, the research scientifically reveals the heterogeneity of provincial-level economic phenomena. Furthermore, it establishes an empirical model to examine the relationship between financial development, environmental regulation, and economic growth, providing theoretical support and empirical evidence for promoting quality improvement and sustainable development in Anhui Province.

2. Literature Review

2.1. Research on Financial Development and Economic Growth

Financial development refers to the structural changes and improvements in financial markets, encompassing both short-term and long-term transformations. According to Goldsmith in his work Financial Structure and Development, financial development reflects the integration and evolution of financial instruments and institutional attributes. Mckinnon [1] views financial development as a gradual improvement process of financial markets in developing countries, while Levine [2] emphasizes the growth of the financial sector and institutional enhancement. According to the Chinese Financial Dictionary, financial development can be defined as the relative expansion of financial asset scale within financial markets.

In terms of the relationship between financial development and economic growth, there has been extensive and in-depth international research. Goldsmith [3], by constructing financial ratio indicators, revealed a positive correlation between financial development and economic growth. Levine and Beck's [4] cross-country analysis further emphasized that financial development can partially promote economic growth. However, Cole et al. [5] focused on the risks present in financial market development, particularly how capital misallocation affects market efficiency, potentially harming economic growth and even leading to recession.

In the domestic research field, although the start was later, unique insights and results have been shown in certain aspects. Sun Wuqin [6], from the perspective of financial structure, compared bank intermediary markets with financial markets, highlighting the critical role of financial markets in promoting technological innovation and economic growth. Yin Jianfeng [7] further detailed the relationship between financial markets and technological innovation, pointing out that different financial structures have differential impacts on the paths to promoting technological innovation. Zhang Xiaobo and Fu Qiang [8], using endogenous growth theory, analyzed the impact of financial openness on economic growth and found that under fully open financial policies, financial development and economic growth can achieve positive synchronized growth. Additionally, several scholars such as Emmanuel K, Ganda Fortune, et al. [9-16] also argue that financial development and economic growth are connected to varying degrees.

2.2. Domestic and International Literature Review on Environmental Regulation and Economic Growth

Environmental regulation is implemented by the government to regulate behaviors that result in negative externalities, such as pollution. Pan Jiahua [17] described environmental regulation as the government's use of non-market means to regulate the utilization of environmental

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resources. Zhao Yumin [18] argues that environmental regulation combines tangible systems and intangible awareness to constrain behavioral agents. Based on this, we define environmental regulation as a series of eco-economic policies formulated by the government in governing environmental pollution and protecting ecosystems, which effectively constrain corporate behavior, eliminate negative externalities, and promote sustainable coordination between the economy and the environment.

When discussing the interaction between environmental regulation and economic growth, the international academic community has adopted various theoretical frameworks, but the conclusions are not uniform. For example, Pashigian [19] pointed out that environmental regulation might inhibit economic growth by increasing investment and production costs for firms. In contrast, Porter's [20] "Porter Hypothesis" suggests that environmental regulation can positively promote economic growth, corporate performance, and technological innovation. Meanwhile, Urpelainen [21] used a game-theoretic model to demonstrate that under uncertainty, the relationship between environmental regulation and economic growth is also uncertain.

Domestically, the findings on this topic can be broadly categorized into three main viewpoints. Xie Zhongchou [22] constructed a provincial panel model incorporating the quadratic term of environmental regulation and found that environmental regulation has a significant negative impact on economic growth. Ma Hailiang [23] used productivity data from China's three major economic regions to build a distributed lag model and concluded that environmental regulation has a positive impact on economic growth by affecting productivity, but the significance level varies by period. Xiong Yan's [24] research found a positive "U-shaped" nonlinear relationship between environmental regulation and economic growth. Additionally, scholars such as Nieuwhof Annet, Yu Cao, et al. [25-32] have also emphasized the complex interaction between environmental regulation and economic growth.

Overall, both domestic and international studies have explored the interaction between environmental regulation and economic growth. The main differences in research lie in the indicators and perspectives chosen, the examination of the "Compliance Cost Theory" versus the "Porter Hypothesis," and the insufficient exploration of nonlinear relationships. It is noteworthy that despite empirical results varying due to regional, cultural, policy, and economic factors, researchers have reached a high consensus on policy recommendations: advocating for stronger environmental regulations and proactive financial development policies to promote stable economic growth.

3. Facts and Mechanisms

3.1. Key Facts

From 2010 to 2020, Anhui Province's financial sector expanded continuously with stable overall growth, gradually becoming an important driving force behind economic development. Despite the severe impact of the COVID-19 pandemic, which led to a sharp economic decline and a sluggish capital market, the growth momentum of the stock market, bond market, and banking sector remained remarkably strong. Specifically, the number of listed companies doubled in 2020 compared to a decade earlier, and the issuance of stocks and bonds saw significant increases. Both the insurance and banking industries showed favorable development trends, and the social financing environment improved markedly.

Regarding environmental regulation, despite Anhui Province's rapid economic growth since the beginning of the reform and opening-up period, its technological level has been relatively backward, and there has been a lack of sustainable development concepts. This has resulted in increasingly severe ecological and environmental pollution problems. Although a series of pollution prevention and control measures have been implemented, the environmental issues

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have not been fundamentally resolved. For example, from 2009 to 2019, the environmental treatment fees levied on enterprises increased annually, reflecting the orderly execution of pollution prevention policies. However, the fluctuating number of cities meeting air quality standards and the changing trends in environmental pollution control investment indicate that the governance outcomes are less than ideal.

In terms of economic structural transformation, Anhui Province has actively promoted the optimization of its industrial structure in recent years, increasing efforts in innovative technology research to align economic structure with development scale, aiming for steady economic growth. From 2000 to 2019, the economy showed a generally coordinated growth trend, with a rapid acceleration between 2005 and 2012. However, the growth rate slowed from 2013 to 2016 due to policies aimed at adjusting the industrial structure. The primary reason was the overemphasis on developing the secondary industry, which caused serious environmental pollution, leading to chain reactions that resulted in localized economic fluctuations.

Moreover, significant regional disparities exist between financial development, environmental regulation, and economic growth in Anhui Province. For instance, the differences in financial development across regions, the varying intensity of environmental regulation from north to south and from east to west, and the regional disparities in economic growth all highlight the internal heterogeneity within the province.

3.2. Mechanisms

The mechanism by which financial development promotes economic growth can be realized through two main pathways:

Efficiency-based Pathway: Financial development facilitates the efficient allocation of resources through both the "visible hand" and the "invisible hand," optimizing capital operations and reducing inefficient investments. This improvement in capital allocation efficiency supports economic growth.

Cost-based Pathway: Financial development reduces transaction costs, production costs, and financing costs, stimulating market demand and encouraging the continuous expansion of enterprise production scales, thereby generating economies of scale and promoting economic growth.

The impact of environmental regulation on economic growth can be analyzed from two perspectives:

Cost Transmission Mechanism: Based on the "Compliance Cost Hypothesis" or "Porter Hypothesis," this perspective emphasizes how the costs and innovation compensation associated with environmental regulation influence economic growth.

Pollution Haven Hypothesis: This viewpoint suggests that the regional characteristics of different environmental regulation strategies lead to varying effects on local economic growth.

Given the above analysis, this study proposes the following hypotheses:

Hypothesis 1: Financial development and environmental regulation in Anhui Province have a certain impact on economic growth.

Hypothesis 2: The impact of financial development and environmental regulation on economic growth varies across regions in Anhui Province.

Hypothesis 3: There is a significant threshold effect between financial development, environmental regulation, and economic growth in Anhui Province.

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4. Model and Data

4.1. Variable Selection

4.1.1. Dependent Variable

Economic growth (EG) is measured using the logarithm of real per capita GDP. The year 2009 is chosen as the base year, and real per capita GDP is logarithmically transformed to eliminate the effects of price levels, inflation, and units of measurement. This indicator accurately reflects the growth rate and development level of regional economies [33] .

4.1.2. Independent Variables

Financial Development (FD): Financial development is measured using the financial correlation ratio, which is the proportion of the sum of year-end deposit and loan balances of financial institutions to the region's GDP. This indicator reflects the extent to which the financial sector supports economic activity and its efficiency in resource allocation [34] .

Environmental Regulation (ER): Environmental regulation is measured by the proportion of environmental protection expenditures to total fiscal expenditures, which reveals the intensity of government investment in environmental protection and pollution control, and its potential impact on economic activity [35] .

4.1.3. Control Variables

Human Capital (HC): As a substitute for labor, human capital is measured by the weighted average number of years of education of local residents, reflecting the human capital conditions of various social strata [36] .

Technological Innovation (TI): As a substitute for technology, technological innovation is measured by the ratio of R&D expenditure to general fiscal expenditure, reflecting the region’s investment in technological innovation and R&D activities [37] .

Technological Output (TO): Another proxy for technology, technological output is measured by the logarithm of the number of patent grants in the region, reflecting the economic role of patents in social production [38] .

Government Expenditure Scale (GOV): As a substitute for capital, government expenditure scale is measured by the ratio of government fiscal expenditure to regional GDP, reflecting the degree of government intervention in economic activities [39] .

4.2. Model Specification

To analyze the impact of financial development and environmental regulation on economic growth in Anhui Province, a static balanced panel data model is constructed. The model considers key variables and their potential impacts on economic growth, incorporating individual effects as control terms. The model expression is as follows:

$$EG_{it} = \alpha_0 + \alpha ER_{it} + \beta FD_{it} + \gamma HC_{it} + \delta TI_{it} + \zeta TO_{it} + \xi GOV_{it} + \mu_i + \varepsilon_{it} \quad (1)$$

Where: α_0 is the intercept term; α , β , γ , δ , ζ and ξ are the estimated coefficients; i represents the prefecture-level city; t represents time; μ_i denotes individual effects for the prefecture-level cities; ε_{it} is the random error term.

4.3. Data Explanation

Research on economic growth traditionally focuses on national-level analysis, while studies at the provincial or city level are relatively scarce [40-41] . Existing literature often focuses on single linear relationships, rarely incorporating a comprehensive analysis of multiple factors and regional disparities [42-43] . Although some studies consider factors such as economic

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institutions, industrial structure, and technological innovation, discussions on environmental regulation have been largely limited to linear regression models, without delving into complex factors like regional differences [44-47] .

Given the significant regional disparities in economic growth within Anhui Province, simple regression analysis may lead to spurious results. Thus, this study selects data from 16 cities in Anhui Province for the period from 2009 to 2019. Additionally, factors such as resource endowments, local culture, and historical background are considered. The province is divided into three regions based on the Huai River and Yangtze River:

Northern Anhui: The cities north of the Huai River, including Suzhou, Huaibei, Fuyang, Bozhou, Bengbu, and Huainan.

Central Anhui: The cities between the Yangtze and Huai Rivers, including Hefei, Lu'an, Anqing, and Chuzhou.

Southern Anhui: The cities south of the Yangtze River, including Wuhu, Ma'anshan, Tongling, Xuancheng, Chizhou, and Huangshan.

The data were obtained from official statistics websites. Missing data for some prefecture-level cities were supplemented using linear interpolation and moving average methods. Cities like Chaohu, which has been dissolved as an administrative unit, and newly established county-level cities with insufficient data, were excluded from the study. Since the short panel data are approximately considered stationary series, they can be used directly for regression analysis. Descriptive statistics for the relevant variables are shown in Table 1.

Table 1. Descriptive Statistics for Variables

Variable	Sample Size	Mean	S. D.	Min	Max
EG	176	16.017 1	0.595 2	14.714 0	17.927 0
HC	176	8.132 6	0.683 0	6.805 3	10.135 0
FD	176	2.314 7	0.540 8	1.473 6	4.071 1
ER	176	0.033 4	0.020 8	0.009 0	0.122 9
TO	176	7.438 9	1.089 2	4.127 1	10.317 1
TI	176	0.088 2	0.075 3	0.005 5	0.317 2
GOV	176	0.192 6	0.060 9	0.069 6	0.328 1

5. Empirical Analysis

5.1. Model Diagnostic Tests

Table 2 summarizes the results of various diagnostic tests for the regression model:

Table 2. Regression Model Series Test Results

Test Method	F-statistic	P-value
F-test	62.37	0.000 0
Friedman's Test	44.46	0.000 1
Testparm Test	1847.23	0.000 0
Hausman Test	33.51	0.000 0
Modified Wald Test	1081.25	0.000 0
Wooldridge Test	582.67	0.000 0

The results of the F-test, Friedman's test, Testparm test, and Hausman test are all significant, indicating the presence of cross-sectional dependence, and confirming that a fixed effects model is more appropriate than random effects or mixed effects models. Additionally, the

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Modified Wald and Wooldridge tests are significant, pointing to heteroscedasticity and serial correlation issues in the model. As a result, the study adopts the fixed effects model with Driscoll and Kraay standard errors to ensure robustness in the estimation results.

5.2. Baseline Regression

Table 3 shows the results of the baseline regressions for models (1), (2), and (3), which represent mixed effects, random effects, and fixed effects models, respectively:

Table 3. Overall Regression Results of the Models

Variable	(1)	(2)	(3)
HC	0.189***	0.204***	0.189***
	(6.11)	(6.98)	(6.11)
FD	0.192***	0.186***	0.192***
	(4.77)	(4.78)	(4.77)
ER	-0.565	-0.257	-0.565
	(-0.94)	(-0.45)	(-0.94)
TO	0.241***	0.230***	0.241***
	(13.92)	(14.08)	(13.92)
TI	0.759	0.861*	0.759
	(1.78)	(2.08)	(1.78)
GOV	0.213	0.391	0.213
	(0.64)	(1.26)	(0.64)
Regional Effects	Controlled	Controlled	Controlled
N	176	176	176

The results indicate the following: Financial Development (FD) shows a significant positive effect, indicating that the orderly development of financial markets provides substantial support for economic growth. Environmental Regulation (ER), although negative, is not significant, suggesting that while environmental regulation increases operational costs for businesses, its inhibitory effect on economic growth is not obvious. Human Capital (HC) has a significant positive impact, implying that improving education levels plays a crucial role in promoting technological innovation and industrial upgrading. Technological Output (TO) significantly promotes economic growth, while Technological Innovation (TI) is not significant, suggesting a time lag in the transformation of technological achievements. Government Expenditure Scale (GOV) is also not significant, implying that the direct influence of fiscal policy on economic growth is limited. These results confirm Hypothesis 1, indicating that financial development and environmental regulation contribute to economic growth to some extent. They also underscore the critical roles of human capital and technological output in driving economic growth in Anhui Province. Additionally, the consistency of the results across models (1), (2), and (3) demonstrates the robustness of the baseline regression.

5.3. Regional Regression

Table 4 presents the results of regional regressions, with models (1), (2), and (3) representing the fixed effects models for Northern Anhui, Central Anhui, and Southern Anhui, respectively:

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Table 4. Grouped Regression Results of the Models

Variable	(1)	(2)	(3)
HC	0.230**	0.191*	0.163**
	(4.18)	(3.90)	(4.14)
FD	0.249**	0.033	0.441**
	(5.02)	(0.75)	(4.58)
ER	-1.708**	2.783*	-0.895*
	(-4.30)	(3.81)	(-2.72)
TO	0.222**	0.207**	0.247***
	(6.78)	(8.15)	(8.86)
TI	0.062	1.482	0.860
	(0.11)	(1.91)	(1.83)
GOV	0.016	1.251**	-0.218
	(0.08)	(7.12)	(-0.48)
Regional Effects	Controlled	Controlled	Controlled
N	66	44	66

The regional results reveal significant spatial heterogeneity and regional differences in the key drivers of economic growth in Anhui Province: Financial Development (FD) shows a significant positive effect in Northern and Southern Anhui, while the effect is not significant in Central Anhui, suggesting regional disparities in the impact of financial development on economic growth. Environmental Regulation (ER) promotes economic growth in Central Anhui but has an inhibitory effect in Northern and Southern Anhui, implying that the effectiveness of environmental policies is closely related to regional characteristics. Human Capital (HC) significantly promotes economic growth in all regions, especially in Northern and Central Anhui, highlighting the core role of education and human resource quality in driving regional economic development. Technological Output (TO) and Technological Innovation (TI) contribute to economic growth in all regions, underscoring the critical role of technological achievement transformation in regional economic development. Government Expenditure Scale (GOV) has a significant positive effect in Central Anhui but a negative effect in Southern Anhui, reflecting differences in government spending scale and policy orientation across regions. These findings confirm Hypothesis 2, demonstrating that the key drivers of economic growth exhibit significant spatial heterogeneity and regional differences across Anhui Province. Considering these regional disparities when formulating and implementing economic growth strategies will lead to more effective and sustainable development.

6. Study on Threshold Effects

6.1. Construction of the Threshold Panel Model

Based on the panel threshold model proposed by Hansen, and drawing on the research methods of Lian Yujun et al., this study constructs a threshold regression model for economic growth in Anhui Province, using financial development as the threshold variable. While this model can address issues of heteroscedasticity and autocorrelation, it is not effective in dealing with multicollinearity problems. It is generally accepted that multicollinearity exists when the correlation coefficient exceeds 0.8. Based on the correlation test results, the variable Technological Output (TO) is excluded from the model. The specific threshold panel model is set as follows:

First, financial development (FD) is set as the threshold variable for environmental regulation (ER). The model expression is as follows:

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$$EG_{it} = \alpha_1 ER_{it} \cdot I(FD_{it} \le \lambda_1) + \alpha_2 ER_{it} \cdot I(\lambda_1 < FD_{it} \le \lambda_2) + \cdots + \alpha_n ER_{it} \cdot I(FD_{it} > \lambda_n) + \beta FD_{it} + \gamma HC_{it} + \delta TI_{it} + \xi GOV_{it} + \mu_i + \varepsilon_{it} \quad (2)$$

Next, to enhance the explanatory power of the model, interaction terms between financial development and environmental regulation are introduced:

$$EG_{it} = \alpha_1 ER_{it} FD_{it} \cdot I(FD_{it} \le \lambda_1) + \alpha_2 ER_{it} FD_{it} \cdot I(\lambda_1 < FD_{it} \le \lambda_2) + \cdots + \alpha_n ER_{it} FD_{it} \cdot I(FD_{it} > \lambda_n) + \beta FD_{it} + \gamma HC_{it} + \delta TI_{it} + \xi GOV_{it} + \mu_i + \varepsilon_{it} \quad (3)$$

Then, financial development is set as its own threshold variable:

$$EG_{it} = \alpha_1 FD_{it} \cdot I(FD_{it} \le \lambda_1) + \alpha_2 FD_{it} \cdot I(\lambda_1 < FD_{it} \le \lambda_2) + \cdots + \alpha_n FD \cdot I(FD_{it} > \lambda_n) + \beta ER_{it} + \gamma HC_{it} + \delta TI_{it} + \xi GOV_{it} + \mu_i + \varepsilon_{it} \quad (4)$$

Finally, the interaction terms between financial development and environmental regulation are introduced again to further enhance the model:

$$EG_{it} = \alpha_1 ER_{it} FD_{it} \cdot I(FD_{it} \le \lambda_1) + \alpha_2 ER_{it} FD_{it} \cdot I(\lambda_1 < FD_{it} \le \lambda_2) + \cdots + \alpha_n ER_{it} FD_{it} \cdot I(FD_{it} > \lambda_n) + \beta ER_{it} + \gamma HC_{it} + \delta TI_{it} + \xi GOV_{it} + \mu_i + \varepsilon_{it} \quad (5)$$

Where: $\alpha_1, \ldots, \alpha_n, \beta, \gamma, \delta$ and ξ are the coefficients; $I(\lambda_{n-1} < Q_{it} \le \lambda_n)$ is an indicator function, which takes the value of 1 if the condition inside the brackets is satisfied, and 0 otherwise; $\lambda_1, \lambda_2, \ldots, \lambda_n$ are the unknown threshold values, and n is a positive integer representing the number of thresholds.

6.2. "Threshold Effect" Study

6.2.1. Estimation of Threshold Values

To reveal the stage-specific characteristics of the impacts of financial development and environmental regulation on economic growth at different levels of financial development, the panel threshold regression model proposed by Hansen is applied to estimate the number of thresholds and the threshold parameters. Table 5 summarizes the estimation results.

Table 5. Estimation Results of Threshold Values

Model	Threshold Variable	Number of Thresholds	F-statistic	P-value	Threshold Estimate
(1)	FD	Single	24.66	0.006 7	1.693 2
		Double	14.87	0.083 3	2.065 2
		Triple	8.94	0.896 7	-
(2)	FD	Single	24.08	0.006 7	1.751 4
		Double	12.31	0.170 0	-
		Triple	9.74	0.853 3	-
(3)	FD	Single	21.37	0.023 3	1.751 4
		Double	19.77	0.006 7	2.065 2
		Triple	6.81	0.890 0	-
(4)	FD	Single	23.07	0.043 3	1.693 2
		Double	19.42	0.023 3	2.095 8
		Triple	9.40	0.803 3	-

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The findings indicate that the threshold effects vary across different models under different levels of financial development. Specifically: Model (1) exhibits a double threshold effect at the 10% significance level. Model (2) confirms the existence of a single threshold effect at the 1% significance level. Models (3) and (4) both display double threshold effects at the 5% significance level.

6.2.2. Threshold Value Analysis

To understand the impact of environmental regulation (ER), financial development (FD), and their interaction on economic growth, the threshold effect model is estimated. The regression results are presented in Table 6.

Table 6. Threshold Effect Results for Threshold Variables

Model	Observed Value	Threshold Classification	Coefficient	t-value	P-value
(1)	ER	FD≤1.693 2	-12.435 0	-3.99	0.000
		1.693 2<FD≤2.065 2	-0.985 0	-1.14	0.255
		FD>2.065 2	3.184 7	3.33	0.001
(2)	ER*FD	FD≤1.751 4	-1.970 7	-2.99	0.003
		FD>1.751 4	1.515 0	3.70	0.000
(3)	FD	FD≤1.751 4	0.058 9	0.74	0.462
		1.751 4<FD≤2.065 2	0.177 1	2.56	0.011
		FD>2.065 2	0.255 5	4.47	0.000
(4)	FD*ER	FD≤1.693 2	-5.485 4	-2.12	0.035
		1.693 2<FD≤2.095 8	3.526 8	2.03	0.044
		FD>2.095 8	5.755 8	4.11	0.000

Model (1) shows a positive "U-shaped" relationship between environmental regulation and economic growth across different stages of financial development. In the early stages of financial development, environmental regulation may suppress economic growth due to increased business costs. However, as financial markets mature, environmental regulation becomes a positive factor in promoting economic growth. Model (2) reveals a similar "U-shaped" relationship between the interaction of environmental regulation and financial development and economic growth. The threshold value is lower compared to the standalone effect of environmental regulation, indicating that financial development influences the economic growth effects of environmental regulation policies. Model (3) shows a "J-shaped" relationship between financial development and economic growth, implying that financial development initially contributes little to economic growth but becomes a significant factor as financial markets improve, suggesting that the advancement of the financial sector is key to fostering economic growth. Model (4) illustrates how environmental regulation affects the relationship between financial development and economic growth at different levels of financial development. When financial development is low, environmental regulation may exacerbate the burden on businesses, hindering the positive effects of financial development on economic growth. However, as financial markets develop, the synergy between environmental regulation and financial development promotes economic growth, especially when financial development reaches higher levels. These results confirm Hypothesis 3, demonstrating that the effects of financial development and environmental regulation on economic growth in Anhui Province are characterized by threshold effects. This finding underscores the need to consider the stages of financial market development when formulating environmental and financial policies.

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6.2.3. Threshold Crossing Analysis

Table 7 summarizes the threshold-crossing situation for financial development levels in different cities of Anhui Province, revealing the complex non-linear interactions between financial development, environmental regulation, and economic growth.

Table 7. Threshold Effect Crossing Situations for Threshold Variables

Model	Observed Value	Threshold Classification	Cities
(1)	ER	FD≤1.693 2	0
		1.693 2<FD≤2.065 2	Chuzhou, Ma'anshan
		FD>2.065 2	Hefei, Huaibei, Bozhou, Suzhou, Bengbu, Fuyang, Huainan, Lu'an, Wuhu, Xuancheng, Tongling, Chizhou, Anqing, Huangshan
(2)	ER*FD	FD≤1.751 4	0
		FD>1.751 4	Hefei, Huaibei, Ma'anshan, Wuhu, Xuancheng, Bozhou, Suzhou, Bengbu, Fuyang, Huainan, Chuzhou, Lu'an, Tongling, Chizhou, Anqing, Huangshan
(3)	FD	FD≤1.751 4	0
		1.751 4<FD≤2.065 2	Chuzhou, Ma'anshan
		FD>2.065 2	Hefei, Huaibei, Bozhou, Suzhou, Bengbu, Fuyang, Huainan, Lu'an, Wuhu, Xuancheng, Tongling, Chizhou, Anqing, Huangshan
(4)	FD*ER	FD≤1.693 2	0
		1.693 2<FD≤2.095 8	Chuzhou, Ma'anshan
		FD>2.095 8	Hefei, Huaibei, Bozhou, Suzhou, Bengbu, Fuyang, Huainan, Lu'an, Wuhu, Xuancheng, Tongling, Chizhou, Anqing, Huangshan

Model (1) shows that when financial development is at a moderate level (such as in Chuzhou and Ma'anshan), the economic growth effect of environmental regulation is relatively weak. However, in cities with higher financial development (such as Hefei, Huaibei, etc.), the positive impact of environmental regulation on economic growth becomes significantly stronger, exhibiting a positive "U-shaped" dynamic. This suggests that once financial development reaches a certain stage, the economic benefits of environmental regulation are optimized and become more apparent. Model (2) confirms that at higher levels of financial development, the interaction between environmental regulation and financial development significantly promotes economic growth. All cities have crossed the first threshold value, demonstrating the generally positive impact of environmental regulation under higher levels of financial development. Models (3) and (4) analyze the impact pathways of financial development itself on economic growth. Cities with lower levels of financial development have not crossed any thresholds, while cities with higher financial development, such as Hefei and Huaibei, have clearly crossed the second threshold. This illustrates the "J-shaped" or "U-shaped" effect of financial development, where financial development contributes little to economic growth in the initial stages, but as financial markets develop and mature, its positive impact on economic growth becomes increasingly evident and strong. In summary, most cities in Anhui Province have entered a high level of financial development, where the positive interaction between environmental regulation and financial development plays a key role in promoting economic growth. Particularly in cities with more advanced financial development, environmental regulation not only does not hinder economic growth, but, in fact, complements and enhances financial development, jointly driving healthy economic growth as financial markets mature and capital allocation efficiency improves.

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7. Conclusion and Recommendations

7.1. Research Conclusion

Anhui Province has been actively guiding its economic development model from extensive to intensive growth, but the transformation is still in its early stages, and exploring future economic development paths remains a crucial task. Based on data from 2009 to 2019, panel and threshold models were constructed to deeply analyze the drivers of economic growth and their regional differences. The study yields the following conclusions:

Multiple Factors Affect Economic Growth: Financial development, human capital, and technological output play important roles in driving economic growth in Anhui Province, whereas the direct impact of environmental regulation on economic growth is not significant.

Regional Differences in Growth Drivers: The influence of various factors on economic growth shows significant regional differences. In northern and southern Anhui, financial development has a notable positive impact on economic growth, while in central Anhui, environmental regulation is the key factor driving growth.

Threshold Effects: The impact of financial development and environmental regulation on economic growth exhibits significant threshold effects at different levels of financial development, following either a "J-shaped" or positive "U-shaped" non-linear relationship. Most cities in Anhui have reached a high level of financial development, at which point the synergy between environmental regulation and financial development effectively promotes economic growth.

7.2. Research Recommendations

Based on the comprehensive analysis of economic development in Anhui Province from 2009 to 2019, the following recommendations are proposed:

Deepen Environmental Regulation Reform and Focus on Ecological Protection: The current environmental regulation measures have a limited positive impact on economic growth and may lead to a crowding-out effect. It is recommended that Anhui further optimize its environmental protection measures to ensure the sustained health of the ecosystem while promoting the optimization and upgrading of the economic structure and the reform of the environmental governance system, achieving harmonious growth between the economy and the environment.

Upgrade the Financial Industry and Improve the Financial System: The improvement of financial development levels has a significant positive effect on economic growth. Anhui Province should accelerate the integration of financial markets and optimize resource allocation, promoting the financial industry toward deeper, more diversified structures that better serve the real economy, providing strong financial support for economic transformation.

Coordinate the Implementation of Environmental Regulation and Financial Development: The interaction between environmental regulation and financial development has a more pronounced positive impact on economic growth. It is recommended that Anhui Province simultaneously promote financial development while strengthening environmental regulation. By optimizing the interaction between the two, the province can foster industrialization and jointly promote the development of a green economy.

Accelerate Upgrades in Human Capital and Technological Innovation and Optimize Government Regulation: Human capital and technological innovation are key drivers of economic growth. Anhui should invest in education and research and development (R&D) to enhance the quality of human capital, encourage innovation and the application of technology, and create a favorable environment for the transformation of technological achievements and economic growth through effective government regulation.

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Implement Differentiated Policies and Respect Regional Differences: Economic growth demonstrates significant variation across regions. When formulating policies, Anhui should fully consider regional characteristics and implement differentiated strategies. In regions with advanced financial development, focus should be placed on environmental protection, while in regions with weaker financial development, efforts should be made to improve the efficiency of financial services and the effectiveness of environmental regulation.

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References

[1] Mckinnon. Money and Capital in Economic Development[J]. Washington DC: Brookings Institution, Inc, 1973.

[2] Levine R. Finance and growth: Theory and evidence[M]. Handbook of Economic Growth, Elsevier Science, 2005.

[3] Goldsmith R W. Financial Structure and Economic Growth in Advanced Countries: An Experiment in Comparative Financial Morphology[M]. National Bureau of Economic Research, Inc, 1955.

[4] Beck T, Levine R, Loayza N. Finance and the Sources of Growth[J]. Journal of financial economics, 2000, 58(1-2): 261-300.

[5] Cole H L, Greenwood J, Sanchez J M. Why doesn't technology flow from rich to poor countries? [J]. Econometrica, 2016, 84(4):1477-1521.

[6] Sun W Q. The Impact of Different Financial Structures on Technological Innovation [J]. Economic Geography, 2004, (3). (In Chinese).

[7] Yin J F. Financial Structure and Economic Growth [M]. Beijing: Beijing People's Publishing House, 2006. (In Chinese).

[8] Zhang X B, Fu Q. An Analysis and Evaluation of the Effect of Financial Liberalization on China's Economic Growth - An Empirical Analysis Based on China's 1979-2009 Data [J]. Economic Science, 2011, (3): 5-16. (In Chinese).

[9] Emmanuel K M, Wen X Z, Isaac O P, Samuel G, Albert H N. Financial development and economic growth nexus in Africa[J]. Business Strategy & Development, 2020, 3(4).

[10] Ganda F. Effect of foreign direct investment, financial development, and economic growth on environmental quality in OECD economies using panel quantile regressions[J]. Environmental Quality Management, 2020, 30(2).

[11] Mac J A, Eric A, John G G, Seyram K, David M. Financial development and economic growth nexus in SSA economies:The moderating role of telecommunication development[J]. Cogent Economics & Finance, 2021, 9(1).

[12] Wang J, Zhang S L, Zhang Q J. The relationship of renewable energy consumption to financial development and economic growth in China[J]. Renewable Energy, 2021, 170.

[13] Dai S G, Hu W T, Li H. Financial Development, Human Capital Accumulation, and Economic Growth [J]. Statistical Research, 2023, 40(10): 83-95. (In Chinese).

[14] Sun Y Q, Zhang X. Financial Agglomeration, Institutional Environment, and Industrial Structure Upgrading - A Double Test Based on Dynamic Panel and Threshold Regression [J]. Journal of Changchun University of Science and Technology (Social Science Edition), 2021, 34(02): 81-87. (In Chinese).

[15] Wang S N. The Contribution of Financial Development in Chang-Ji to Economic Growth in Jilin Province [J]. Journal of Changchun University of Science and Technology (Social Science Edition), 2013, 26(03): 108-109+129. (In Chinese).

ISSN: 2692-7608 DOI: 10.6981/FEM.202411_5(11).0017

[16] Xu Z X, Zhang L. Analysis of the "Non-linear" Migration Characteristics of the Impact Mechanism of Regional Financial Development on Economic Growth [J]. Inquiry into Economic Issues, 2023, (05): 113-125. (In Chinese).

[17] Pan J H. Economic Analysis of Sustainable Development Paths [M]. Beijing: China Renmin University Press, 1997. (In Chinese).

[18] Zhao Y M, Zhu F M, He L L. Research on the Definition, Classification, and Evolution of Environmental Regulation [J]. China Population, Resources and Environment, 2009, (6): 85-90. (In Chinese).

[19] Pashigian B P. The Effect of Environmental Regulation on Optimal Plant Size and Factor Shares[C]. Chicago - Center for Study of Economy and State, 1984, 10(2):1-28.

[20] Porter, Michael E. America's Green Strategy [J]. Scientific American, 1991, 5(4):1-5.

[21] Urpelainen J. Frontrunners and Laggards:The Strategy of Environmental Regulation under Uncertainty[J]. Environmental and Resource Economics, 2011, 50(3):325-346.

[22] Xie Z C, Zhang X F, Lu D. Natural Resource Endowment, Environmental Regulation, and Regional Economic Growth [J]. Jianghuai Forum, 2013, (6): 61-67. (In Chinese)

[23] Ma H L, Huang D C, Yao H Z. Can Environmental Regulation Stimulate Productivity Growth? - An Empirical Study from China's Three Major Economic Regions [J]. China Science and Technology Forum, 2011, (12): 105-110. (In Chinese).

[24] Xiong Y. The Relationship between Environmental Regulation and Economic Growth Based on Provincial Data [J]. China Population, Resources and Environment, 2011, (5): 126-131. (In Chinese).

[25] Nieuwhof A. Ezinge Revisited - The Ancient Roots of a Terp Settlement:Volume 1:Excavation; Environment and Economy; Catalogue of Plans and Finds[M]. Barkhuis: 2020-11-06.

[26] Cao Y, Wan N N, Zhang H Y, Zhang X L, Zhou Q. Linking environmental regulation and economic growth through technological innovation and resource consumption: Analysis of spatial interaction patterns of urban agglomerations[J]. Ecological Indicators, 2020, 112.

[27] Michellehavich. Hi-tech sewers can help safeguard public health, environment and economies[J]. The American City & County, 2021.

[28] Seol Y M, Lee S, Lee J Y, Han J G, Hong G. Excavation Method Determination of Earth-Retaining Wall for Sustainable Environment and Economy: Life Cycle Assessment Based on Construction Cases in Korea[J]. Sustainability, 2021, 13(5).

[29] Li G, Sun M Y. Analysis of the Coupled and Coordinated Development between Economic Growth and Environmental Quality in the Yangtze River Delta [J]. Journal of Changchun University of Science and Technology (Social Science Edition), 2023, 36(06): 93-99+107. (In Chinese).

[30] Hu M Y, Liu D Z. Spatial Driving Mechanism of High-Quality Economic Growth in the Yellow River Basin under the Low-Carbon Background [J]. Journal of Changchun University of Science and Technology (Social Science Edition), 2023, 36(02): 105-110+125. (In Chinese).

[31] Du K R, Ouyang X L, Zheng Y W. Does Environmental Regulation Promote Green Economic Growth in Chinese Cities? [J]. Statistical Research, 2023, 40(12): 39-49. (In Chinese).

[32] Wang R J, Xu B. Environmental Regulation, Industrial Structure Optimization, and Economic Growth - An Empirical Study Based on Prefecture-Level Cities in Northwest China [J]. China Business Review, 2023, (05): 143-148. (In Chinese).

[33] Deng C Y, Wan Y. Integration of Industry and City and Economic Growth from the Perspective of High-Quality Development - An Empirical Test Based on Panel Data of 254 Chinese Cities [J]. Enterprise Economy, 2024, (05): 87-98. (In Chinese).

[34] Li M. Analysis of the Impact Mechanism of Financial Development on Regional Economic Growth - A Case Study of Q City [J]. Modern Enterprise, 2024, (04): 123-125. (In Chinese).

[35] Li S F, Yang L, Feng H Y. Green Finance, Environmental Regulation, and High-Quality Economic Development - A Comparative Analysis Based on the Coordinated Development Strategy of Beijing-Tianjin-Hebei [J]. Journal of Central University of Finance and Economics, 2024, (03): 3-15. (In Chinese).

ISSN: 2692-7608 DOI: 10.6981/FEM.202411_5(11).0017

[36] Zhu L, Wu Z W, Wang Y. The "Engine" of High-Quality Economic Development — High-End Manufacturing Development, Human Capital Allocation, and Economic Growth [J]. Quantitative & Technical Economics, 2024, 41(04): 48-67. (In Chinese).

[37] Zhang Y, Sui D C, Meng W S. Technological Innovation, Technology Introduction, and Green Economic Growth Efficiency [J]. Statistics and Decision, 2024, 40(02): 133-138. (In Chinese).

[38] Yu Q H. Foreign Direct Investment, Financial Development, and Green Economic Growth [D]. Southwest University of Finance and Economics, 2019. (In Chinese).

[39] Xu Y X. The Stabilizing Growth Effect of China's Countercyclical Fiscal Expenditure [J]. Fiscal Research, 2023, (08): 44-57. (In Chinese).

[40] Jiang X T. The Impact of Manufacturing Servitization on the Quality of Economic Growth - An Empirical Analysis Based on WIOD Data of 42 Countries [J]. Economic Research Guide, 2024, (01): 31-34. (In Chinese).

[41] Wang Q, Liu X Y. The Endogenous Dynamics of Economic Scale and Economic Growth - Evidence from International Experience [J]. The Economist, 2024, (03): 45-55. (In Chinese).

[42] Du K R, Ouyang X L, Zheng Y W. Does Environmental Regulation Promote Green Economic Growth in Chinese Cities? [J]. Statistical Research, 2023, 40(12): 39-49. (In Chinese).

[43] Guo W. An Empirical Study on the Impact of E-Commerce on Economic Growth - A Case Study of Shaanxi Province [J]. Science & Technology and Industry, 2023, 23(11): 158-161. (In Chinese).

[44] Ren G Q, Lai H F, Zhao L F. Environmental Regulation, Digital Transformation, and Green Technological Innovation - Data Analysis from Chinese Industrial Enterprises [J]. Journal of Beijing Institute of Technology (Social Sciences Edition), 2024, 26(03): 28-42. (In Chinese).

[45] Zhou B, Li Y. The Coupling Coordination Effect of Green Finance and Technological Innovation on Low-Carbon Economic Development [J]. Research on Economics and Management, 2024, 45(03): 3-22. (In Chinese).

[46] Wu K, Song J Z, Chen Y W. The Impact Mechanism of Population Growth and Shrinkage on Urban Economic Resilience - Based on the Moderating Effect of Industrial Structure and Human Capital [J]. Resources Science, 2024, 46(02): 249-261. (In Chinese).

[47] Li S H, Qu X E. The Green Productivity Growth Effect of China's OFDI in "Belt and Road" Countries - An Empirical Test Based on Absorptive Capacity and Institutional Environment [J]. Inquiry into Economic Issues, 2024, (01): 121-137. (In Chinese).