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The Effect of Natural Resources, Natural Resources Tax, Natural Resources Related Tax, Environmental Pollution Control Investment on China's Economic Growth

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ABSTRACT

This study is grounded in the marginal productivity theory and Pigouvian tax theory. Utilizing panel data from China spanning 2003 to 2022 and employing the Cobb-Douglas production function as the analytical framework, this study examines the impact of natural resources, natural resources tax, natural resources related tax, and environmental pollution control investment on Gross Domestic Product (GDP). At the national level, the results indicate that natural resources and natural resource tax have a positive effect on economic growth. Conversely, natural resources related tax and environmental pollution control investment show a negative correlation with GDP growth. Regionally, these variables exhibit heterogeneous effects across China's eastern, central, western, and northeastern regions. Specifically, natural resources significantly promote economic growth only in the eastern region, while their impact in the central, western, and northeastern regions remains inconclusive. The natural resources tax positively influences economic growth in the western region, but its effect in the other regions is ambiguous. In contrast, natural resources related tax inhibits economic growth in the western region but contribute positively to growth in the central region; their influence in the eastern and northeastern regions is statistically insignificant. Finally, environmental pollution control investment negatively affects economic growth in the central and western regions, with uncertain impacts in the eastern and northeastern regions. These findings underscore the complex, region-specific dynamics between taxation, environmental investment, and economic performance in China.

1. INTRODUCTION

Understanding the impact of natural resources on economic growth is critically important. While economic growth fundamentally depends on the utilization of natural resources, excessive consumption can hinder long-term sustainable development [1]. Globally, many countries continue to pursue economic expansion at the expense of environmental health, intensifying the exploitation of natural resources and contributing to air, water, and land pollution [2]. For example, increased energy consumption has led to higher carbon dioxide emissions, resulting in environmental degradation, global warming, and climate change [3, 4]. To mitigate the adverse effects of these environmental challenges, the implementation of strategic policies and effective tax instruments is essential [5]. China has introduced a natural resources tax as part of its strategy to support sustainable economic development objectives [6]. This tax is intended to improve environmental quality, curb pollution and overexploitation, and promote the advancement of green technologies [7]. By enhancing environmental conditions, the natural resources tax also contributes to the long-term potential for economic growth [8]. Revenue generated from this tax is distributed across various sectors of the economy, thereby providing a significant boost to national economic development [9].

In addition to the natural resources tax, the environmental protection tax plays a vital role in both promoting economic growth and preserving the environment. It encourages enterprises to innovate in green technologies [10, 11], increases operational costs for high-polluting industries, and facilitates industrial restructuring [12]. Moreover, by raising the cost of carbon emissions, the tax helps to reduce greenhouse gas emissions and advance the transition to a green economy [13].

Similarly, the consumption tax serves as a tool to mitigate environmental pollution and support green economic growth by imposing levies on high-pollution products [14]. This tax structure incentivizes firms to adopt sustainable production methods and motivates consumers to choose environmentally friendly goods. Meanwhile, the natural resources tax contributes to the responsible use and conservation of natural assets [15].

This study classifies both the environmental protection tax and the consumption tax as natural resources related tax, as they are directly associated with the utilization of natural resources [16, 17]. In China, many products subject to the natural resources tax are also liable for environmental protection and consumption taxes. For instance, coal and fuel oil—key items under the natural resources tax—are major fossil fuel energy sources as well as significant contributors to pollution [18]. The combustion of these resources emits carbon dioxide and other air pollutants, thereby exacerbating environmental degradation [19]. Imposing a consumption tax on refined petroleum products such as gasoline and diesel yields multiple advantages, including conserving petroleum resources, reducing emissions, and improving air quality management [20]. Therefore, incorporating natural resources related taxes as an independent variable in the model is crucial for a comprehensive analysis.

Furthermore, both the natural resources tax and its related tax are categorized as Pigouvian taxes, designed to internalize environmental externalities [21, 22].

In addition, environmental pollution control investment has become an integral part of the economic system. Such investment not only supports the development of green and environmentally friendly enterprises but also stimulates the growth of non-environmental sectors through demand-side effects [23]. This, in turn, enhances overall production capacity and contributes to an increase in effective social supply [24, 25].

In addition to conducting analysis at the national level, this study also examines the relationships between natural resources, natural resource tax, natural resources related tax, and environmental pollution control investment from a regional perspective. Specifically, it explores how these factors influence economic growth across different regions of China. Table 1 presents the classification of all 31 mainland Chinese provinces into four major regions: eastern, central, western, and northeastern.

Table 1. Classification of provinces by regions in China

Region	Provinces
Eastern	Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Hainan
Central	Shanxi, Anhui, Jiangxi, Henan, Hubei, Hunan
Western	Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang
Northeastern	Liaoning, Jilin, Heilongjiang

Source: National Bureau of Statistics of China, 2021

Significant differences exist in the economic development of China's eastern, central, western, and northeastern regions, stemming from variations in geographic location, natural endowments, and industrial composition. The eastern coastal region benefits from its strategic location for international trade and has witnessed rapid growth across multiple sectors, including finance, commerce, shipping, garment manufacturing, and electronic information industries. In contrast, the central region plays a key role in agricultural production and supplies essential energy and raw materials. This region is characterized by traditional heavy industries and resource-based sectors, such as Shanxi's coal industry and Henan's nonferrous metal industry.

The western region, however, has a relatively underdeveloped industrial base, primarily focused on resource extraction industries such as oil and gas in Xinjiang and rare earth mining in Inner Mongolia. Natural resource tax rates vary across regions [26], leading to differing economic and environmental impacts, which justifies a regional-level analysis of the eastern, central, and western regions. Meanwhile, the northeastern region remains geographically distant from the country's economically advanced coastal areas. Its economic growth is largely driven by industries such as equipment manufacturing, steel, and chemicals.

According to the National Bureau of Statistics of China (NBS), the regional contributions to GDP in 2023 were as follows: the eastern region accounted for 52.14% of national GDP, followed by the central (21.57%): western (21.53%): and northeastern regions (4.76%). Notably, the GDP of the eastern region surpassed the combined output of the central, western, and northeastern regions.

In response to existing research gaps, this study sets out specific objectives by integrating natural resources, natural resources tax, natural resources related tax, and environmental pollution control investment as key factors influencing China's economic growth. Using 20 years of panel data from 2003 to 2022, the study follows the methodology of Xue et al. [26] and includes 29 mainland Chinese provinces (excluding Shanghai and Tibet). The analysis is conducted using Stata software and is structured across two levels: the national level and the regional level (eastern, central, western, and northeastern regions).

Guided by marginal productivity theory and Pigouvian tax theory, the study also incorporates several control variables: physical capital, human capital, research and development (R&D), foreign direct investment (FDI), government expenditure, and all other taxes. "All other taxes" refer to total tax revenues excluding natural resources tax and natural resources related tax. The main independent variables are natural resources, natural resource tax, natural resources related tax, and environmental pollution control investment.

Ultimately, this research aims to provide valuable insights for policymakers and academics seeking to understand the economic implications of natural resource utilization, taxation, and environmental investment in China.

2. LITERATURE REVIEW

2.1 Natural resources and economic growth

Natural resources are a critical input in driving economic growth; however, their significance varies across regions and over time. Liu et al. [27] identified natural resources as a catalyst for overall economic growth in China. Nevertheless, regional differences are evident: while natural resources significantly stimulate economic growth in the western region, they mark a turning point with negative impacts on growth in the eastern, central, and northeastern regions.

Several studies affirm the positive role of natural resources in promoting economic growth. Hayat and Tahir [28], for example, found that natural resources have a statistically significant and positive impact on the economic growth of the United Arab Emirates (UAE) and Saudi Arabia, while Oman experiences only modest benefits. Haseeb et al. [29], using time series data from 1970 to 2018 and applying a novel quantile regression approach, demonstrated that natural resources positively influence economic growth in four of the top five Asian economies rich in natural resources—namely China, Malaysia, Indonesia, and Thailand—with India being the exception. Similarly, Hidayat et al. [30], using time series data from 2000 to 2021, found that natural resources exert a substantial positive influence on economic growth within the ASEAN region.

Conversely, other studies support the "resource curse" hypothesis, suggesting that natural resources may hinder economic growth. Rahim et al. [31] provided empirical evidence supporting this theory by showing that high levels of natural resource rents impede economic progress in the Next Eleven countries. Sun and Wang [32], analyzing panel data from 30 Chinese regions between 2000 and 2019, found that natural resources have a significant negative effect on economic growth. Meng and Zhang [33], through the construction of provincial green growth efficiency indices and panel data analysis, concluded that natural resources reduce regional green growth efficiency. Similarly, Khan et al. [34] identified a negative correlation between both aggregated and disaggregated measures of natural resources and economic development in G7 countries, thereby reinforcing the validity of the "resource curse" hypothesis at both macro and micro levels. Table 2 summarizes key findings about the effect of natural resources on economic growth.

Table 2. The effect of natural resources on economic growth

Ref. No.	Positive	Negative
[27]	China, western region	eastern, central, northeastern regions
[28]	UAE, Saudi Arabian, Oman	
[29]	China, Malaysia, Indonesia, Thailand.	India
[30]	ASEAN region	
[31]		Next Eleven nations
[32]		China
[33]		China
[34]		G7 nations

Based on the preceding discussion and grounded in the marginal productivity theory, the following hypotheses are proposed:

H1: *There is a positive relationship between natural resources and China's economic growth.*
H1a: *There is a positive relationship between natural resources and China's economic growth by the region.*

2.2 Natural resources tax and economic growth

The impact of the natural resources tax on economic growth has been extensively studied by scholars, yielding mixed findings. Some studies suggest that the natural resources tax promotes economic growth. For instance, Xue et al. [26], using data from 29 provincial-level administrative units in mainland China (excluding Shanghai and Tibet) from 2006 to 2015, found a positive correlation between the natural resources tax and economic growth—both at the national level and across the eastern, central, western, and northeastern regions. Similarly, Xu et al. [35], employing panel data from 1995 to 2017 and including control variables such as financial development, renewable energy, technological innovation, and provincial fiscal expenditures, reported that the natural resources tax positively influenced economic growth across all quantiles of China's provincial economies. In the context of Vietnam, Nguyen [36] found that indirect taxes—such as the natural resources tax and environmental protection tax—enhanced economic growth, whereas direct taxes had no statistically significant impact. However, the study could not conclude that indirect taxes had a more substantial effect than direct taxes. Additionally, Xue and Li [37] observed that the natural resources tax negatively affects economic growth in areas without resource dependency but positively contributes to growth in resource-cursed regions. The more severe the resource curse, the more the natural resources tax appears to stimulate economic development.

On the other hand, some research points to a negative relationship. Zeng et al. [38] argued that the natural resources tax has a more detrimental impact on macroeconomic output than the environmental protection tax in China. However, the combined implementation of both taxes was found to be more effective in reducing output and waste emissions than either policy in isolation. Hu et al. [39] indicated that the natural resources tax could enhance overall government tax revenues in China. However, it results in a decrease economic growth, as well as a fall in other tax revenues, enterprise profits, and household income.

Moreover, Qiao and Chu [40] emphasized the complex dynamics of Pigouvian taxation, noting that such taxes have an inverted U-shaped relationship with steady-state economic growth and social welfare. Among different tax types, the natural resources tax was found to have a greater initial impact on growth and welfare than the environmental protection tax. Although both taxes followed similar emission reduction curves, the turning point of the environmental protection tax occurred later in the economic development trajectory. The main findings regarding the effect of natural resources tax on economic growth are summarized in Table 3.

Table 3. The effect of natural resources tax on economic growth

Ref. No.	Positive	Negative	U-Shaped
[26]	China, eastern, central, western, northeastern regions		
[35]	China		
[36]	Vietnam		
[30]	ASEAN region		
[37]	resource curse areas (e.g. Heilongjiang)	non-resource curse places (e.g. Beijing)	
[38]		China	
[39]		China	
[40]			China

Hence, based on the above discussion, the following hypotheses are formulated to be tested:

H2: *There is a positive relationship between natural resources tax and China's economic growth.*
H2a: *There is a positive relationship between natural resources tax and China's economic growth by the region.*

2.3 Natural resources related tax and economic growth

Ndiaye and Korsu [17] investigated the effects of various tax types—including direct, indirect, trade, and total taxes (with and without natural resources related tax)—across all Economic Community of West African States (ECOWAS) members and five non-ECOWAS sub-Saharan African countries from 2000 to 2010. Their analysis of tax effort revealed that ECOWAS countries were operating below their tax capacity, regardless of the type of tax. Notably, nearly 75% of tax revenue in the West African Economic and Monetary Union and the West African Monetary Zone was derived from natural resource taxes in countries like Guinea-Bissau and

Nigeria. When these taxes were excluded, tax effort dropped drastically to 25% and 7%, respectively. This sharp decline in tax revenue highlights the heavy dependence of these nations on natural resource-based taxation.

In addition, several studies have examined the economic implications of environmental protection tax and consumption tax—both categorized as natural resource related taxes—suggesting that they may support economic growth. For instance, using fixed effects and the Arellano-Bond dynamic panel estimation methods, one study found that factors such as recycled materials, urban waste, recycled materials trade, labor productivity, environmental taxes, and resource productivity positively influenced the economic growth of European Union (EU) import economies [41]. De Pascale et al. [42] emphasized the long-term stabilizing role of environmental taxes in the EU, highlighting their potential to achieve "double dividends" by reducing income volatility while supporting environmental goals. Similarly, Nguyen et al. [43] demonstrated that both consumption and income taxes positively impact local economic growth in Vietnam. Guan and Meng [44] found that the environmental protection tax in China not only stimulates local economic development but also generates spatial spillover effects that benefit neighboring regions. In Latin America, Canavire-Bacarreza et al. [45] indicated that higher reliance on consumption taxes tends to enhance economic growth in Latin America, although some countries may experience modest adverse effects.

Table 4. The effect of natural resources related tax on economic growth

Ref. No.	Positive	Negative	Insignificant
[17]	West African Economic and Monetary Union and West African Monetary Zone		
[41]	EU		
[42]	EU		
[43]	Vietnam		
[44]	China		
[45]	Latin American		
[22]		31 OECD countries	
[46]		China	
[47]		China	
[48]		China	
[49]			EU

Conversely, other research suggests that environmental protection and consumption taxes may hinder economic growth. Hassan et al. [22], using panel data from 31 OECD countries between 1994 and 2013, found that revenues from environmentally related taxes negatively affect economic growth in both the short and long term, particularly when interacted with initial levels of real GDP per capita. Chen [46], through a dynamic stochastic general equilibrium (DSGE) model that incorporates pollution, environmental taxes, and labor market frictions, argued that environmental taxation negatively affects both labor markets and macroeconomic stability in China. Li [47] critiqued the effectiveness of the consumption tax, arguing that its weak regulatory role in industry, its potential to cause inflation through tax reforms, and its limited effect on income distribution reduce its contribution to economic growth. Similarly, Yao et al. [48] reported that a 1% increase in China's consumption tax leads to a 0.16% decline in economic growth. Table 4 summarizes the significant outcomes regarding the effect of natural resources related tax on economic growth.

Furthermore, an analysis of annual panel data from 2000 to 2022 across EU member states found that consumption tax does not have a statistically significant impact on economic growth [49].

Hence, based on the above discussion, the following hypotheses are formulated to be tested:

H3: *There is a positive relationship between natural resources related tax and China's economic growth*.

H3a: *There is a positive relationship between natural resources related tax and China's economic growth by the region.*

2.4 Environmental pollution control investment and economic growth

The existing literature on the impact of environmental pollution control investment on economic growth presents mixed and, at times, contradictory findings. Chen et al. [50] examined data from 10 provinces in China—namely Jiangsu, Shandong, Henan, Hebei, Beijing, Tianjin, Hunan, Anhui, Jiangxi, and Jilin—from 2003 to 2012. Their results indicate that, in the long term, moderate increases in pollution control investment (i.e., less than double) negatively affect economic growth. However, when the growth in investment exceeds a twofold increase, it contributes positively to economic growth. Despite this positive impact, the efficiency of economic growth declines as investment levels continue to rise. In a related study, Chen et al. [51] argued that environmental pollution control investment can hinder short-term economic performance, especially under more stringent pollution control targets. Nevertheless, long-term gains may be realized through reduced GDP losses when air pollution is effectively managed.

In contrast, other studies support the view that environmental pollution control investment contributes positively to economic development. Zhang [24], using a panel regression model, found that such investments promote green economic growth in China's eastern region. Zhang and Gui [52] also reported that investment in environmental governance positively influences China's overall economic growth. Similarly, Wan and Sheng [53] concluded that pollution control investment enhances both clean energy consumption and economic growth. Wu et al. [54] further supported these findings by demonstrating that environmental pollution control investment has a favorable impact on China's GDP. Table 5 summarizes key findings about the effect of environmental pollution control investment on economic growth.

Table 5. The effect of environmental pollution control investment on economic growth

Ref. No.	Positive	Negative
[50]	10 provinces in China (investment exceeds double)	10 provinces in China (investment less than double)
[51]	China (short-term)	China (long-term)
[24]	China	
[52]	China	
[53]	China	
[54]	China	

Hence, based on the above discussion, the following hypotheses are formulated to be tested:

H4: *There is a positive relationship between Environmental pollution control investment and China's economic growth.*

H4a: *There is a positive relationship between Environmental pollution control investment and China's economic growth by the region.*

3. THEORETICAL FRAMEWORK

Marginal Productivity Theory was first introduced in the late 18th century to explain how different factors of production are compensated based on their contribution to the output. According to the theory, when all other inputs are held constant, the change in the value of output resulting from the addition (or removal) of a single unit of a production factor equals that factor's marginal product—effectively its compensation or opportunity cost. In neoclassical economics, this relationship is typically expressed through a production function, which captures the technical association between inputs and outputs. The derivative of this function represents the marginal product of each input [55].

In the early 20th century, mathematician Charles Cobb and economist Paul Douglas applied marginal productivity theory to estimate the marginal contributions of labor and capital. They developed the Cobb-Douglas production function, one of the most widely used models in global economic analysis to examine the input-output relationship. Given its flexibility and empirical reliability, the Cobb-Douglas production function is adopted in this study to assess the impact of natural resources and related taxes on regional economic growth in China [26].

Meanwhile, Pigouvian Tax Theory has emerged as a foundational concept in modern taxation literature, particularly in addressing negative externalities arising from resource use and environmental degradation [56]. This theory posits that taxes should be levied on activities that generate external costs not captured by market prices. A Pigouvian tax serves to internalize these externalities by aligning private costs with social costs [57]. Examples include taxes on tobacco, alcohol, luxury goods, environmental pollutants, and natural resources. In this context, Pigouvian tax theory provides an appropriate framework for exploring the effects of natural resource taxes and related environmental levies on economic growth [22].

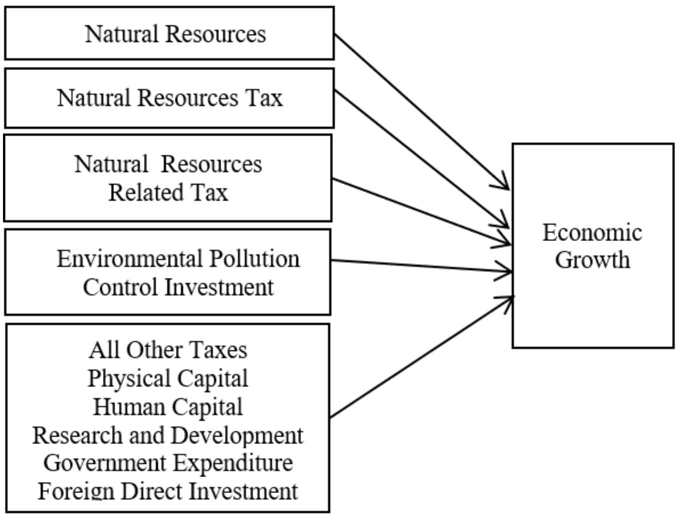

Figure 1. The conceptual model of the study

By integrating Marginal Productivity Theory and Pigouvian Tax Theory, this study provides a comprehensive framework to investigate how natural resources, natural resources tax, natural resources related tax, and environmental pollution control investment influence China's economic growth. Control variables in the model include physical capital, human capital, research and development (R&D): foreign direct investment (FDI): government expenditure, and all other taxes (excluding the specific natural resources tax and natural resources related tax). These controls help isolate the net effects of the main variables of interest.

Figure 1 presents the conceptual model that underpins this study.

4. RESEARCH METHODOLOGY

4.1 Design and population

This study aims to investigate the relationship between natural resources, natural resources tax, natural resources related tax, environmental pollution control investment and economic growth in China by employing a quantitative research methodology grounded in both causal and descriptive research designs. The analysis is based on panel data covering the period from 2003 to 2022. Consistent with the approach adopted by Xue et al. [26], the research scope encompasses 29 provinces in mainland China, excluding Shanghai and Tibet. The analysis is conducted across two dimensions: (1) the national level, which examines the aggregate effects across the country, and (2) the regional level, which disaggregates the provinces into eastern, central, western, and northeastern regions to capture spatial economic differences. The statistical software Stata is utilized for all data analyses. This includes the generation of descriptive statistics, as well as the preparation and screening of data for multivariate analysis, particularly through the testing of multiple regression hypotheses.

4.2 Econometric model

This article analyzes the effect of natural resources, natural resources tax, natural resources related tax, environmental pollution control investment on economic growth through the construction of a panel model.

American mathematician Cobb and economist Douglas established the Cobb-Douglas production function in the early half of the 20th century.

$$Y = AK^{\alpha}L^{\beta} \tag{1}$$

In the Cobb-Douglas production function, *Y* represents total industrial output, *A* denotes the level of technology, *K* refers to physical capital, and *L* signifies labor input. The coefficients α and β represent the output elasticities of labor and capital, respectively. These parameters capture the percentage change in output resulting from a percentage change in the corresponding input. Subsequent studies, such as those by Xue et al. [10], Kwakwa et al. [58], and Oryani et al. [59], have adapted and extended the Cobb-Douglas framework to evaluate economic growth in various contexts. Building on this foundation, the present study employs the Ordinary Least Squares (OLS) estimation technique to avoid the complexities associated with nonlinear regression and to more clearly interpret the relationship between each input variable and economic growth. This approach is informed by the methodologies of Hong [60] and Wang et al. [61], who developed a generalized Cobb-Douglas production function. After applying a logarithmic transformation, the model is expressed as a multivariate linear regression, allowing for straightforward estimation and interpretation.

$$\begin{aligned}\text{InGDP}_{\text{it}} &= \alpha_0 + \alpha_1\text{NR}_{\text{it}} + \alpha_2\text{InNRT}_{\text{it}} + \alpha_3\text{InNRRT}_{\text{it}} \\ &+\alpha_4\text{InEPCI}_{\text{it}}+\alpha_5\text{InAOT}_{\text{it}} + \alpha_6\text{InPC}_{\text{it}} + \alpha_7\text{InHC}_{\text{it}} \\ &+\alpha_8\text{InR\&D}_{\text{it}} + \alpha_9\text{InGE}_{\text{it}} + \alpha_{10}\text{InFDI}_{\text{it}} + \varepsilon_{\text{it}}\end{aligned} \quad (2)$$

where, *i* denotes the region, *t* signifies time; α_0 represents the intercept term; α_i (where i = 1, 2,…, 10) indicates the regression coefficients; and ε_{it} refers to the random disturbance component. The GDP serves as the dependent variable for assessing economic growth [26], while natural resources (NR): natural resources tax (NRT): natural resources related tax (NRRT): and environmental pollution control investment (EPCI) are incorporated as independent variables. Additionally, physical capital (PC): human capital (HC): research and development (R&D): government expenditure (GE): foreign direct investment (FDI): all other taxes (AOT) are designated as control variables.

4.3 Variables and data

At the initial stage of analysis, and in accordance with standard econometric practices, the panel data underwent a structured cleaning and preprocessing process to ensure reliability and consistency. No missing values, duplicate records, or outliers were identified. All numerical variables were found to lie within the acceptable statistical range (±3 standard deviations): and thus, no data were truncated or removed. Financial figures denominated in Chinese Yuan were standardized to units of 10,000 Yuan before applying a natural logarithmic transformation.

In this study, natural resources refer primarily to non-renewable energy and metal resources. The natural resources-related mining sector includes the extraction and processing of coal, oil, natural gas, metal, and non-metallic minerals. Common indicators for measuring natural resources include fixed asset investment in mining, resource rents, and extraction volumes. However, reliable data on natural resource rents in China are unavailable, and extraction volumes are difficult to aggregate due to differing units and classifications. Since resource development requires specialized infrastructure such as mines and refineries, the share of mining industry fixed asset investment is adopted as a proxy for natural resource reliance. A higher share indicates greater dependence on resource development and indirectly reflects resource endowment. This approach also facilitates cross-regional and cross-national comparisons, as used in Liu et al. [27] and Meng and Zhang [33]. Therefore, natural resources are measured as the percentage of mining industry fixed asset investment in total fixed asset investment.

According to China's "fee-to-tax" reform and associated legislation, the Environmental Protection Tax (EPT) officially replaced pollution discharge fees starting 1 January 2018 (Environmental Protection Tax Law, Article 27). The Implementing Regulations were enacted concurrently, and the Regulations on the Collection and Use of Pollution Fees—the previous legal basis—were simultaneously repealed [62]. Consequently, for the years prior to 2018, comparable pollution fee data are used as a proxy for environmental protection tax [63]. In this study, natural resources related tax is calculated as the sum of the environmental protection tax (or pollution discharge fees) and the consumption tax.

To measure human capital, the study adopts the Jorgenson-Fraumeni (J-F) lifetime income approach [64], which has been widely used in both developed and developing countries [65]. The J-F method captures a broad array of human capital components, including formal education, on-the-job training, health, innate ability, and unmeasured school quality [66]. Human capital is measured as the stock attributable to the non-retired labor force aged 16 and above, excluding the school-age population [67].

Table 6. Details of variables and data

Variables	Notation	Operationalisation	Data Source
Economic growth	GDP	The natural logarithms of gross domestic product of regional	NBS
Natural resources	NR	The percentage of mining industry fixed asset investment in total fixed asset investment	NBS
Natural resources tax	NRT	The natural logarithms of natural resources tax	China Taxation Yearbook Series
Natural resources related tax	NRRT	The natural logarithms of the sum of environmental protection tax (pollution discharge fees) and consumption tax	China Taxation Yearbook Series and Financial Engineering Database (Wind)
Environmental pollution control investment	EPCI	The natural logarithms of environmental pollution control investment	Hong Kong Asia Economic Database (CEIC)
All other taxes	AOT	The natural logarithms of total tax revenue less natural resources tax and natural resources related tax collected by Chinese tax authorities	China Taxation Yearbook Series
Physical capital	PC	The natural logarithms of capital stock with the perpetual inventory approach	NBS
Human capital	HC	The natural logarithms of labor force human capital	Human Capital in China 2024
Research and development	R&D	The natural logarithms of science and technology (three fiscal science expenditures scientific and undertaking expenditure before 2007)	Series of Finance Yearbook of China
Government expenditure	GE	The natural logarithms of local fiscal general budget expenditures	NBS
Foreign and direct investment	FDI	The natural logarithms of actual utilization of provincial foreign direct investment	Wind

For physical capital, the perpetual inventory method is used, as proposed by Shan [68]. Using 2000 as the base year and assuming a capital depreciation rate of 10.96%, fixed capital stock data were updated through 2022 using the formula: Current capital stock = Previous capital stock × (1 - 10.96%) + Current total fixed asset formation. Since 2018, the National Bureau of Statistics (NBS) ceased publishing fixed asset formation data at the provincial and regional levels. Following Zou and Chen [69], this study estimates post-2018 capital stock by applying provincial fixed asset investment growth rates to extend the data series.

Research and development (R&D) is measured using government expenditure on science and technology, including three categories of science fiscal expenditures (classified under "scientific and undertaking expenditure" prior to 2007) [70]. Government expenditure is captured through local general public budget expenditures [71], and foreign direct investment (FDI) is measured based on the actual utilization of FDI at the provincial level [72].

An overview of all variables, definitions, and data sources is provided in Table 6.

5. RESULTS AND DATA ANALYSIS

5.1 Analysis at the national level

5.1.1 Descriptive

Table 7 presents the descriptive statistics of all variables. The results indicate that there are 580 valid observational samples, data from 29 provinces for 20 years, with an average value of the dependent variable InGDP at 18.5746, a standard deviation of 1.1013, a minimum value of 15.1636, and a maximum value of 20.9819.

Table 7. Descriptive statistics of variables

Variable	Mean	Std. Dev.	Min	Max
InGDP	18.5746	1.1013	15.1636	20.9819
NR	0.0395	0.0428	0.0001	0.3971
InNRT	11.7427	1.4835	7.1709	15.8519
InNRRT	14.2003	1.2492	9.6069	16.6936
InEPCI	14.0243	1.0589	10.4913	16.4661
InAOT	16.6048	1.1647	12.9506	19.3446
InPC	19.2541	1.0626	16.1951	21.4189
InHC	20.9723	0.9926	17.6950	23.1571
InR&D	12.8797	1.3458	9.1864	16.2741
InGE	17.0144	1.0226	13.8681	19.0377
InFDI	14.2919	1.7436	7.6358	18.6224

5.1.2 Stationarity test

To avoid pseudo-regression, it is essential to assess the stability of the data panel. This study employs the Fisher-type unit-root test (Fisher-ADF) test to analyze the original sequence of variables. The Fisher-ADF test results indicate that the four statistics (Inverse chi-squared, Inverse normal, Inverse logit t, Modified inv.chi-squared) for all variables reject the null hypothesis of panel unit root, with corresponding p-values of 0.0000 for each. Consequently, the InGDP, NR, InNRT, InNRRT, InEPCI, InPC, InHC, InR&D, InGE, and InFDI series are deemed stable.

5.1.3 Fixed-effects regression

National level analysis utilizing data from 29 provinces in mainland China (excluding Shanghai and Tibet) spanning the years 2003 to 2022. A Hausman test was applied to the data, and the significant P value (Prob > chi^2 = 0.0000) was less than 5%. The random-effects model was rejected, and it was deemed more appropriate to utilize the fixed-effects model. The fixed-effects regression analysis is shown in Table 8.

Table 8. Fixed-effects regression

Variable	Coefficient	P>|t|	Variable	Cofficient	P>|t|
NR	0.5965	0.000	InPC	0.2825	0.000
InNRT	0.0187	0.003	InHC	0.1419	0.000
InNRRT	-0.0466	0.001	InR&D	0.1232	0.000
InEPCI	-0.0473	0.000	InGE	0.2852	0.000
InAOT	0.1158	0.000	InFDI	-0.0262	0.000
_cons	3.2543	0.000	**R**-squared: Within=0.9882, Between=0.9625, Overall= 0.9349		
Dependent Variable: InGDP, Number of obs = 580, F(10, 541)= 4542.38, Prob > F = 0.0000					

According to Table 8, a total of 580 samples were analyzed, and the model's F(10, 541)= 4542.38, Prob>F= 0.0000, showing that the model as a whole is extremely significant. The model's R-squared value indicates that the total proportion of variation explained is greater than 93%. Hence, less than 7% variability in InGDP is explained by other factors outside NR, InNRT, InNRRT, InEPCI, InAOT, InPC, InHC, InR&D, InGE, InFDI. Therefore, the model is statistically robust and the model's explanatory ability meets expectations.

H1: *There is a positive relationship between natural resources and China's economic growth.*

The P value of the variable NR is 0.000, which means that the coefficient is significant. It shows that natural resources have a significant positive effect on GDP.

H2: *There is a positive relationship between natural resources tax and China's economic growth.*

The coefficient of InNRT is significant. It shows that natural resources tax has a significant positive effect on GDP.

H3: *There is a positive relationship between natural resources related tax and China's economic growth.*

The P value of the variable InNRRT is 0.001, the coefficient is -0.0466, which means it significantly reject the null hypothesis. It shows that natural resources related tax has a significant negative effect on GDP.

H4: *There is a positive relationship between environmental pollution control investment and China's economic growth.*

The P value for the variable InEPCI is 0.000, indicating that the coefficient is highly significant at -0.0473, so decisively rejecting the null hypothesis. It indicates that environmental pollution control investment adversely impacts GDP.

Table 8 further reveals that physical capital (PC): human capital (HC): research and development (R&D): and government expenditure (GE) all exert positive effects on GDP. In contrast, foreign direct investment (FDI) exhibits a negative relationship with GDP. This finding aligns with the "pollution haven" hypothesis, which suggests that increased openness to international markets may encourage foreign-funded enterprises to relocate high-emission and high-energy-consuming industries to China, thereby exacerbating regional carbon emissions and environmental degradation. Conversely, the "pollution halo" hypothesis argues that FDI can also lead to environmental improvement by enabling the transfer of energy-efficient technologies and cleaner production practices through technological spillovers [73].

Empirical results also indicate that China's economic growth is positively influenced by natural resources and the natural resources tax, while it is negatively affected by natural resources related tax and environmental pollution control investment.

In summary, from a national perspective, both natural resources and the natural resources tax contribute positively to economic growth, consistent with the theoretical foundations of marginal productivity theory and Pigouvian tax theory. However, natural resources related tax and environmental pollution control investment appear to have a dampening effect on economic performance.

5.2 Analysis at the regional level

To analyze regional heterogeneity, this article also examines the potential positive impact of natural resources, natural resources tax, natural resources related tax, and environmental pollution control investment on China's regional economic growth by categorizing the country into eastern, central, western, and northeastern areas according to NBS. Table 9 shows the regression results that have been established:

According to Table 9, natural resources, natural resources tax, natural resources related tax, and environmental pollution control investment affect economic growth differently depending on the region. Here is the particular study:

H1a: *There is a positive relationship between natural resources and China's economic growth by the region.*

Natural resources have a significant positive effect on GDP in the eastern. Nonetheless, with the exception of the eastern region, the influence of natural resources on economic growth in the central, western, and northeastern regions is negligible.

H2a: *There is a positive relationship between natural resources tax and China's economic growth by the region.*

It shows that natural resources tax has a significant positive effect on GDP in the western. Nonetheless, with the exception of the western region, the influence of natural resources tax on economic growth in the eastern, central and northeastern regions is insignificant.

H3a: *There is a positive relationship between natural resources related tax and China's economic growth by the region.*

Natural resources related tax has a significant positive effect on economic growth in the central region. However, in the western region, the effect of natural resources related tax on economic growth is negative. Nonetheless, in the eastern and northeastern region, the effect of natural resources related tax remains ambiguous. The P value for the variable InNRRT is 0.407 and 0.503 in the eastern and northeastern region, indicating that the coefficient is not significant.

H4a: *There is a positive relationship between environmental pollution control investment and China's economic growth by the region.*

Environmental pollution control investment has a significantly negative effect on economic growth in the central and western regions. However, in the eastern and northeastern regions, the effect of environmental pollution control investment remains insignificant. The P value for the variable InEPCI are 0.185 and 0.187 in the eastern and northeastern region respectively, indicating that the coefficient is not significant.

Table 9. Panel data regression results for eastern, central, western, and northeastern

Variable	Eastern		Central		Western		Northeastern	
	Coefficient	P>|t|	Coefficient	P>|t|	Coefficient	P>|t|	Coefficient	P>|t|
NR	2.4135	0.000	0.3092	0.435	0.2387	0.150	0.7690	0.119
InNRT	0.0071	0.467	-0.0048	0.791	0.0443	0.010	-0.0004	0.986
InNRRT	-0.0203	0.407	0.1058	0.016	-0.0930	0.000	-0.0242	0.503
InEPCI	-0.0209	0.185	-0.0722	0.000	-0.0785	0.000	-0.0402	0.187
InAOT	0.1543	0.001	0.1602	0.004	0.0477	0.170	0.2918	0.000
InPC	0.5551	0.000	0.1942	0.001	0.3015	0.000	0.1939	0.000
InHC	0.1524	0.002	-0.1144	0.089	0.1187	0.009	0.0873	0.290
InR&D	0.1820	0.000	0.0809	0.000	0.1633	0.000	-0.0439	0.569
InGE	-0.0838	0.306	0.4377	0.000	0.3510	0.000	0.3407	0.002
InFDI	-0.0434	0.004	-0.0301	0.025	-0.0009	0.914	-0.0417	0.015
	Number of obs = 180		Number of obs = 120		Number of obs = 220		Number of obs = 60	
	Prob > F=0.0000		Prob > F=0.0000		Prob > F=0.0000		Prob > F=0.0000	
	R-squared = 0.9976		R-squared= 0.9958		R-squared = 0.9953		R-squared= 0.9936	

6. DISCUSSION

A multitude of significant findings emerged from this study. At the national level, fixed-effects regression analysis indicates that natural resources have a positive impact on China's economic growth, confirming previous literature [27, 29]. Similarly, the natural resources tax also exerts a beneficial influence on economic growth. This supports both the Marginal Productivity Theory and Pigouvian Tax Theory, and aligns with earlier findings [26, 35] that suggest a positive relationship between Pigouvian taxes and economic performance.

In contrast, natural resources related tax has a negative effect on economic growth, which appears inconsistent with the theoretical expectations of Pigouvian taxation. This discrepancy may stem from the design of the tax system itself. For example, China's environmental protection tax—part of the natural resources related tax—is governed by a regional tax quota system, which may incentivize high-tax enterprises to relocate to low-tax regions during periods of "tax depression." This can lead to regional dislocations, tax base erosion, and localized economic decline. Moreover, the compensation mechanism designed to stimulate innovation under the natural resources related tax framework remains imperfect. While it compels firms to conserve resources, it also increases their tax burden and operational costs. Given the risks and uncertainties associated with innovation—especially the transformation from investment to output—many firms reduce R&D spending under cost pressures, which weakens their innovation capacity and harms economic growth. These results highlight the need for the Chinese government to enhance the effectiveness and structure of the natural resources related tax system.

Additionally, environmental pollution control investment is found to have a negative impact on economic growth, contrary to both the Marginal Productivity Theory and prior research [24, 52-54]. Pollution control often requires substantial capital outlays to upgrade equipment or adopt cleaner technologies, which may strain enterprise cash flows, leading to reduced production or even closure. Furthermore, large-scale public investments in environmental projects—such as ecological restoration or wastewater treatment plants—can divert fiscal resources away from critical sectors like education, healthcare, infrastructure, and productive investment, resulting in short-term GDP losses. However, in the long term, such investments may conserve resources, promote innovation in production technologies, and boost the profitability of environmental protection industries.

At the regional level, the analysis reveals distinct patterns. Natural resources have a significant positive effect on economic growth only in the eastern region, with no significant effect observed in the central, western, or northeastern regions. This contradicts earlier findings by Liu et al. [27], who reported a positive effect in the western region and negative effects in the eastern, central, and northeastern regions. The divergence may be attributed to China's regional economic imbalance—where resource-poor eastern provinces have more developed economies, while resource-rich central, western, and northeastern provinces remain economically underdeveloped. These latter regions have historically relied on energy and mineral industries and have neglected technological innovation, limiting the productivity gains from natural resource exploitation.

The natural resources tax has a positive and significant impact on economic growth in the western region, which confirms prior findings [26]. This region is rich in natural resources, and tax revenues from resource extraction comprise a substantial share of local fiscal budgets. When managed effectively, this revenue can be used to support infrastructure and development, thereby enhancing regional economic performance. However, the effects of the natural resources tax in the eastern, central, and northeastern regions remain unclear, deviating from Xue et al. [26], who found a positive effect across all regions. These inconsistencies suggest that region-specific tax policies should be considered to better align with local economic contexts.

The natural resources related tax demonstrates regionally heterogeneous effects: it hinders economic growth in the western region but promotes growth in the central region, aligning with Pigouvian theory. Its effect in the eastern and northeastern regions, however, is not statistically significant. These results suggest that the government should consider reforming tax policies in the western, eastern, and northeastern regions to reduce inefficiencies and encourage environmentally sustainable growth.

Finally, environmental pollution control investment exerts a significant negative effect on economic growth in the central and western regions. These areas are dominated by traditional industries, such as chemicals and heavy manufacturing, where the costs of installing pollution control systems are high. As a result, environmental investments may reduce industrial output and divert public spending from other essential development areas, thereby constraining growth. Nevertheless, in the long run, environmental improvements can enhance regional attractiveness, drive technological advancement, and support sustainable growth. The lack of significant impact in the eastern and northeastern regions suggests a need for the government to reassess and strengthen pollution control strategies in those areas to ensure their long-term economic and environmental sustainability.

7. CONCLUSION

This article examines the relationship between natural resources, natural resources tax, natural resources related tax, and environmental pollution control investment in connection to regional economic growth, utilizing China's panel data from 2003 to 2022. This work develops a model to perform a comparative analysis of the unique conditions in China's eastern, central, western, and northeastern regions, taking into account regional disparities. Conclusions are derived from the empirical analysis results.

From a national viewpoint, this study provides evidence that natural resources and natural resources tax have significantly increased China's economic growth. This outcome validates both H1 and H2. China's existing natural resources and natural resources tax management systems appear effective. The government's collection of natural resources tax helps rectify market distortions, adjust investment structures, and incentivize enterprises to enhance technological capacity, thereby promoting regional economic growth. The imposition of the natural resources tax can drive firms to improve resource efficiency, reduce energy consumption and pollutant emissions, contribute to ecological preservation, and support sustainable economic development. However, natural resources related tax and environmental pollution control investment exert a significant negative effect on economic growth. These results reject H3 and H4. Despite the constructive intent behind implementing natural resources related tax and environmental pollution control investment, current policies require recalibration. Institutional enforcement needs to be strengthened to improve environmental awareness and to encourage firms to reduce emissions and optimize energy usage.

From a regional perspective, natural resources have a positive effect on economic growth only in the eastern region, while the influence in the central, western, and northeastern regions remains statistically insignificant. The natural resources tax has a significant positive impact on economic growth in the western region, yet its influence on the eastern, central, and northeastern regions is still insignificant. Natural resources related tax hinders economic growth in the western region, while it promotes economic growth in the central region, consistent with Pigouvian theory. The impact of natural resources related tax on the eastern and northeastern regions remains ambiguous. Environmental pollution control investment has a significant negative effect on economic growth in the central and western regions, while its influence in the eastern and northeastern regions is still not significant. These findings carry important policy implications for fostering regional and national economic growth. To achieve these objectives, the government must implement a diversified strategy. Policymakers should enhance resource tax policy design across different regions, particularly in the central, western, and northeastern areas, to maximize policy effectiveness. Simultaneously, efforts should be directed toward diversifying the natural resource sector and channeling tax revenues into productive economic sectors such as technology and manufacturing to support long-term sustainable growth. To ensure consistent tax revenues and the sustainable use of natural resources, practical and region-specific policy adjustments are essential. It is also necessary to refine the implementation of natural resources tax and environmental pollution control investment policies to better align them with the broader goals of economic development.

This study aims to explore the economic conditions of various Chinese provinces while accounting for broader macroeconomic issues and regional disparities. A limitation of this research is the exclusion of Shanghai and Tibet due to data unavailability and other constraints. Future studies could expand the scope to include these regions or conduct cross-national comparisons. In addition, future research may consider incorporating variables such as renewable energy usage, education expenditure, and digitalization to assess their effects on economic growth. The framework applied in this study may also be adaptable to other national contexts beyond the panel data structure employed here. Further, the scope of natural resources related tax could be expanded to enable a deeper examination of its economic implications. This study only employed grouped regression analyses to address regional heterogeneity, which is a methodological limitation. Future research could adopt more advanced econometric techniques to investigate regional disparities. Moreover, the use of local fiscal science expenditures as a proxy for R&D excludes private-sector R&D, thereby requiring caution in interpreting the results and limiting their generalizability.

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