Does environmental regulation promote common prosperity? Evidence from China

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Abstract

With the deepening of common prosperity development and aggravated urban pollution emissions in China, it is of great significance to clarify the impact of urban environmental regulation on common prosperity. Based on this, this paper empirically examines the panel data of 30 provinces in China from 2007 to 2021, and the results show that: First, there is a significant inverted "U" relationship between environmental regulation and common prosperity. The mechanism analysis shows that environmental regulation can promote or inhibit common prosperity through affecting industrial structure upgrading and technological innovation. Second, from the perspective of multidimensional indicators, environmental regulation can significantly promote overall prosperity, coordinated development and ecological welfare to a certain extent, but the impact on outcome sharing is not significant. Third, heterogeneity analysis shows that the inverted "U" relationship between environmental regulation and common prosperity is significant in eastern and western regions, but not significant in central regions. The above conclusions have implications for promoting optimal environmental governance and further development of common prosperity.

Keywords: Common prosperity; Environmental regulation; Inverted U

1 Introduction

Common prosperity is an essential requirement of socialism and an important hallmark of China's adherence to the socialist path with Chinese characteristics. China's understanding of the concept of common prosperity can be traced back to 1953 when the term was first mentioned in the People's Daily (Dunford 2022).Common prosperity is a differentiated concept on the basis of eliminating extreme poverty. China is still in the primary stage of socialism and there are still problems like imbalanced regional development and unreasonable income distribution. Achieving

common prosperity is still an arduous long-term task that requires perseverance. It needs to firmly put the interests of the people at the center of development, carefully examine the material and spiritual needs of the people, make efforts to resolve imbalanced and inadequate problems in current development, and meet the growing needs of the people for a better life.

To achieve common prosperity, on the one hand, it is necessary to achieve "prosperity". A good level of socioeconomic development forms the basis for "making the pie bigger". The essence of common prosperity is to meet the needs for a better life of the people across the country and regions, which requires providing abundant social wealth and a solid material foundation through the development of productive forces. Specifically, we should continue to advance industrialization and urbanization, develop advanced manufacturing, and promote technological innovation and application to improve labor productivity. At the same time, we need to optimize industrial structure, vigorously develop the service industry, and expand consumption space. Only when social wealth increases and economic strength grows can distribution regulation substantially improve the interests of different groups.On the other hand, common prosperity requires "commonness". A fair and equitable distribution system is key to "dividing the pie well". Common prosperity emphasizes both economic efficiency and social fairness. It requires making full use of taxation, transfer payments, social security and other regulatory means to establish reasonable systems for primary distribution, redistribution and tertiary distribution, so that the general public can share the dividends of development. Common prosperity is not egalitarian distribution, but allows for differences in the level of development across regions. However, we should accelerate narrowing the gap and promote coordinated development.(Kakwani, Wang et al. 2022).Currently, the imbalanced development between urban and rural areas and income distribution are still prominent issues in China. This not only affects the fairness of common prosperity, but also constrains the endogenous power of economic growth. We must establish a fair and equitable income and wealth distribution system, so that different groups can obtain development opportunities and share the fruits of development.

In exploring the realization of common prosperity, environmental regulation is an extremely important part. Common prosperity requires people to enjoy the dividends of sustainable economic development and meet the needs for a green and livable ecological environment. Waste pollution from corporate production activities is an important source of environmental pollution, so governing corporate production pollution has become a key effort in environmental regulation. China has always adhered to the ideology of ecological and environmental protection, and has promoted environmental

protection with a firm attitude. In 2012, the 18th CPC National Congress listed ecological civilization construction as part of the "five-pronged" development framework. In 2013, General Secretary Xi Jinping put forward that "lucid waters and lush mountains are invaluable assets". In 2015, China proposed a carbon peak plan at the Paris Climate Conference and made top-level strategic plans(Zhang, Liu et al. 2022).In 2022, the "14th Five-Year Plan" for Environmental Impact Assessment and Pollutant Discharge Permitting firmly implemented the pollutant discharge permitting system to prevent environmental pollution from the source and monitor ecological damage during the process. In addition, China adheres to a combination of control and governance, and takes practical measures to improve ecological environment issues. The Chinese government designs market-based regulatory tools according to the actual development status, such as strictly charging for environmental pollution, promoting emissions trading license systems, piloting carbon emissions trading mechanisms, etc., to advance low-carbon and sustainable development in regions(Zhang, Liu et al. 2022).And improves various laws and regulations on ecological and environmental protection, strengthens the supervision and administration system for environmental pollution, and institutionally constrains environmental issues.

The remainder of this paper is structured as follows:Part II provides a literature review on environmental regulation and common prosperity.Part III theoretically analyzes the relationship between environmental regulation and common prosperity and puts forward research hypotheses.Part IV introduces model settings and data sources.Part V analyzes baseline regressions, robustness tests, and mechanism analysis.Part VI further analyzes the impact of the digital economy on common prosperity from multiple dimensions and perspectives.

2 Review of Literature

2.1 Studies related to common prosperity

Common prosperity is a concept that combines productive forces and production relations, and contains two levels of connotation. It requires achieving prosperity through economic development, as well as enabling the entire population to share through a reasonable distribution mechanism. Currently, China still faces issues like the over-large wealth gap between regions and households, imbalanced development among eastern, central and western regions, urban-rural gaps, etc, which hinder the realization of the goal of common prosperity (Xin, Wang et al. 2022).We should actively and appropriately regulate the wealth accumulation speed of high-income groups, avoid excessive

concentration of wealth, increase opportunities for low-income groups to obtain wealth growth, and improve the coordination of wealth growth across different strata (Wan and Knight 2023).High-quality development and common prosperity are mutually reinforcing. High-quality development requires meeting people's needs in aspects like material life, employment, education, healthcare, social security, etc; the equalization emphasized by common prosperity can in turn promote improvement in the quality of economic and social development (Qian, Yuan et al. 2021).

As early as 2013, the World Bank proposed the development goals of eliminating extreme poverty and achieving common prosperity, defining common prosperity as enabling the bottom 40% of the population to have income growth, and proposing that economies should focus on promoting sustainable development of the ecological environment and socio-economy. This goal originates from the "quintile income" concept proposed by Basu (2000) , which holds that achieving common prosperity requires paying attention to the income conditions of the bottom 20% of the population. And realizing common prosperity often means that economies need to achieve economic growth, employment improvement, income increase, social fairness, etc (Rosenblatt and McGavock 2013).Common prosperity does not mean that every economic entity achieves absolute income growth, but rather that the relative income growth of low-income groups is realized along with overall economic growth, with economic development and social equity as the priorities of regional development (Narayan, Saavedra-Chanduvi et al. 2013).Therefore, in constructing evaluation indicators for common prosperity, it should be recognized that the core lies in sustainable economic growth and the relative income increase of low-income groups, rather than pure high-speed economic growth or mechanical equalization of incomes across different strata.

Relevant research on common prosperity has proposed many possible influencing factors. The level of economic growth is a fundamental element for achieving common prosperity by providing the material conditions (Dunford 2022).Employment conditions directly affect residents' income levels, while the development of the labor market also affects income disparities between different groups(Kakwani, Wang et al. 2022).Income distribution systems can influence the income levels of low-income groups through means like taxation and transfer payments, defusing unequal income distribution(Dwyer and Dunn 2022).Public services are closely related to people's sense of wellbeing and determine whether their needs for a better life can be met (Zhou, Chen et al. 2021).The level of coordinated regional development is also related to regional economic development and residents' living standards, thereby affecting the realization of common prosperity across regions(Qian, Yuan et

al. 2021).However, there is relatively little research from the perspective of environmental regulation, so this study has considerable theoretical significance. Implementing environmental regulation is an inevitable path under the trend of sustainable environmental development, and will also affect common prosperity through technological innovation, industrial upgrading, etc. Studying the relationship between environmental regulation and common prosperity is of great importance for promoting economic growth and social equity.

2.2 Relevant research on how environmental regulation affects economic growth

Environmental regulation may achieve "baking a bigger pie" through economic growth. The relationship between environmental regulation and economic growth is a topic under close scrutiny in academia. Some scholars believe that environmental regulation will have a linear positive or negative impact on economic growth, while others argue that the impact of environmental regulation on economic growth is nonlinear. No universally accepted conclusion has been reached regarding the relationship between environmental regulation and economic growth.

On one hand, some studies believe that environmental regulation can promote economic growth. First, environmental regulation stimulates corporate innovation activities, compensating for the additional costs brought by regulation and thus promoting economic growth. The "Porter hypothesis" first systematically expounded the relationship between environmental regulation and corporate competitiveness. Porter and Linde (1995) argued that although appropriate environmental regulation policies may increase corporate costs in the short term, they can effectively promote corporate technological innovation in the long run. The "innovation compensation theory" proposes that environmental regulation can guide corporate technological innovation while improving regional environmental pollution, so as to compensate for corporations' additional environmental pollution costs and improve industrial production capacity utilization(Yu and Shen 2020).The effect of environmental regulation on innovation economy also differs in regions with different levels of economic development(Du, Cheng et al. 2021).Second, environmental regulation affects regional environmental protection, enabling harmonious coexistence of environmental protection and economic growth(Murshed, Rahman et al. 2021).This creates a greener and more livable ecological environment for local residents and enhances their sense of wellbeing. It also intervenes in corporate resource exploitation and environmental protection, advancing sustainable economic development (Song, Tao et al. 2022).Analysis of OECD country panel data shows that implementing environmental regulation can significantly reduce carbon emissions, with an even greater effect than green

technology(Hashmi and Alam 2019).In the traditional "pollute first, control later" path, implementing strict and effective environmental regulation can help regions stay below the ECK turning point of environmental deterioration at relatively low levels, achieving a win-win for environmental protection and economic growth.

On the other hand, some studies believe that environmental regulation may inhibit economic development. First, environmental regulation may impose additional pollution abatement costs on corporations, stifling innovation and hampering regional economic growth. The "compliance cost theory" argues that implementing environmental regulation internalizes corporations' negative externality costs. Corporations will devote more investment towards environmental protection, increasing pollution abatement and compliance costs, crowding out innovation investment(Shuai and Fan 2020).Environmental regulation can also inhibit innovation through a "crowding out effect" (Ouyang, Li et al. 2020).The resulting increase in costs from innovation may even exacerbate pollution(Zhang, Liu et al. 2019).When environmental regulation becomes stringent enough, the "compliance cost effect" will gradually outweigh the "innovation crowding out effect", hampering corporate development(Wang, Sun et al. 2019).Second, environmental regulation may constrain economic development through the transfer and aggregation of polluting firms. The "pollution haven hypothesis" argues that due to differences in the stringency of environmental regulation across regions, pollution-intensive firms may relocate and cluster to reduce additional abatement costs, hindering sustainable economic development(Peng, Shen et al. 2021).The impact is greatest among cities with the same level of economic development (Zhang, Xu et al. 2021).Diverse environmental regulation across regions accelerates corporate transfer, affects regional industrial structure, and may create differences in economic performance.

In addition, some scholars believe that the relationship between environmental regulation and economic growth is not purely linear.Cao, Wan et al. (2020) , through analysis of Chinese provincial panel data, found an inverted U-shaped relationship between environmental regulation and economic growth. This is because regulation intensity was low initially, stimulating corporate innovation and improving production efficiency; later the intensity increased, innovation dividends became insufficient to offset regulation costs, corporations reduced input to maintain operations, and economic growth was hindered (Song, Wei et al. 2021).Zhang, Liu et al. (2022) further found through analysis that China's environmental regulation and economic growth have nonlinear and spatial effects, exhibiting an "N" effect. Meanwhile, some scholars also studied the nonlinear turning point

values. Pang, Zheng et al. (2019) believe that environmental regulation has a significant "threshold" effect on economic development, and regulation can fully play its role in regional economic growth only when the level exceeds a certain threshold, since regions often prioritize environmental development over the economy-environment contradiction when reaching relatively high economic development levels. Wang (2023) , through panel threshold regression models, found that corporate innovation has two thresholds - when the impact level of environmental regulation is between the two thresholds, it has a positive effect on economic growth.

2.3 Relevant research on how environmental regulation affects reasonable distribution

Environmental regulation may affect regional income disparities by influencing people's income levels, ultimately achieving the goal of “dividing the pie well”. Academia holds two main views on the poverty alleviation effects of environmental regulation. One believes that it can narrow income gaps through channels like raising low-income groups’ income and creating new employment. The other argues that it may widen income disparities by exacerbating the contradiction between environmental protection and economic development.

On one hand, some scholars believe environmental regulation can narrow income gaps. First, it may influence regional income disparities by affecting low-income groups' income and welfare. Environmental protection itself is a form of human capital investment. Environmental pollution not only affects the health of the regional labor force, but also impacts the innovativeness of human resources(Jiang, Fu et al. 2020).Analysis of the impact of environmental regulation on employment in Chinese cities shows that under regulation, pollution-intensive firms tend to relocate to small cities or underdeveloped areas, improving local employment and income levels of low-income groups to some extent(Sun, Yang et al. 2019).Second, environmental regulation may provide more job opportunities for the region, increasing income and reducing extreme income gaps. Corporations need more R&D staff for innovative production, improving regional employment (Sun, Yang et al. 2019).The "compliance cost effect" increases high-skilled labor employment while decreasing low-skilled employment, while the "innovation offset effect" promotes employment for both. Thus, as regulation strengthens, high-skilled employment rises, low-skilled employment first drops then rises, ultimately improving regional employment (Zhong, Xiong et al. 2021).Additionally, regulation promotes environmental projects and creates more new jobs, absorbing low-income groups into

ecological projects like desertification control and afforestation, raising wage income for the poor.

On the other hand, some scholars believe environmental regulation widens income disparities. There is an inherent contradiction between corporate economic activities and environmental protection - corporations are profit-driven, while the externality of environmental protection required for social sustainable development inevitably damages corporate interests (Lv, Shao et al. 2021).Under strict regulation, corporations are forced to cut inputs or relocate to avoid rising environmental costs, which hinders innovation, efficiency improvements, and regional sustainable development. Some regions may even relax regulation for short-term growth gains(Liu, Zhu et al. 2020).China's traditional regulatory approaches generally emphasize control and commands, which, while increasing corporate externality costs, also leads to declining environmental governance efficiency(Li, Zhu et al. 2019).Additionally, underdeveloped regions with ecologically fragile environments often rely on resource exploitation for development. Corporate relocation under regulation further aggravates ecological damage, negatively impacting local economic growth and poverty alleviation, widening income disparities.

In summary, existing research mainly defines common prosperity from the two aspects of economic growth and social distribution, linking environmental regulation to economic development from corporate behavior and environmental protection perspectives. There is relatively little research on the relationship between environmental regulation and common prosperity, which has important theoretical and practical significance. The main contributions of this study compared to existing research are:First, incorporating environmental regulation and common prosperity into the same analytical framework, and discussing the impact mechanism of regulation on realizing common prosperity based on a full understanding of its connotations.Second, constructing comprehensive analytical indicators with common prosperity as an integral whole, expanding research ideas and methods on the relationship between regulation and common prosperity.Third, using Chinese provincial panel data as research samples to examine the working mechanism of regulation combined with China's social development status, and conducting in-depth analysis on the relationship between regulation and common prosperity, which is of great practical significance.Fourth, incorporating the "appropriate range" of environmental regulation's impact on common prosperity, to more comprehensively and scientifically analyze how regulation plays a role in achieving common prosperity.

3 Mechanism analysis and research hypothesis

The connotation of common prosperity mainly includes two aspects - economic growth and reasonable distribution. It requires achieving high-quality economic development and reasonable social distribution. Environmental regulation affects regional common prosperity by influencing factors like the ecological environment, corporate activities, and people's income, ultimately impacting regional economic growth and income disparities. Environmental regulation directly affects environmental quality, which in turn increases health and effective working time for low-income groups, raising their income levels and living standards. Stringent regulation increases costs for corporations, forcing them to innovate technology or cut costs, leading to a transfer of labor in regulated industries to other sectors, creating new employment and impacting income and economic development (Hafstead and Williams III 2018).Therefore, as a long-term development strategy adhered to by China, environmental regulation plays an important role in achieving the goal of common prosperity.

Environmental regulation in China mainly influences corporate innovation and industrial restructuring. On one hand, regulation promotes corporate technological innovation through its mandatory nature, driving economic growth. China is moving towards high-quality economic development, and the impact of regulation on corporate green innovation is significant. Green innovation will further stimulate economic growth (Guo, Wang et al. 2023).With increasing regulatory standards, corporations need to bear extra environmental pollution costs and are forced to increase R&D investment, developing pollution control and cleaner production technologies, and actively innovating in areas like products, management mechanisms, production methods, etc. (Shao, Hu et al. 2020).The resulting benefits can increase productivity and corporate competitiveness, offsetting the additional costs of regulation, thus promoting economic development. This will facilitate regional technological progress and economic growth in the long run, achieving a win-win for the ecological environment and economic returns (Zhang, Liu et al. 2022).Ecological innovation also prompts corporations to improve environmental performance, which in turn indirectly impacts economic performance(Cai and Li 2018)，significantly enhancing resource utilization efficiency, reducing raw material and energy consumption, and directly lowering production costs. Meanwhile, through green and clean product design and production processes, corporations can directly improve product quality and value-add. Therefore, regulation-induced technological innovation can directly

influence aspects like total factor productivity, profitability, and market competitiveness, providing strong support for corporations to achieve higher wage income distribution in the future. Employees' productivity and sense of gain will also be improved(Ai, Hu et al. 2020).Additionally, new technology application can greatly improve the work environment and reduce occupational hazard risks, lowering labor costs. Besides boosting overall corporate economic returns, regulation-driven innovation will directly increase employee income levels, optimize income distribution structure, and ultimately promote common prosperity.

On the other hand, environmental regulation promotes comprehensive industrial upgrading, driving optimization of employment skills structure and income growth. Under increasing environmental pressure, China's regulatory intensity continues to strengthen. Highly-polluting and energy-intensive backward industries will be forced out while strategic emerging industries like new energy, new materials, high-end equipment manufacturing, and information technology will see rapid growth. This will comprehensively upgrade China's industrial structure and significantly expand the proportion of high-tech industries in the national economy. Meanwhile, advanced manufacturing requires higher professional skills and technical competence, which will directly create many high-skilled and high value-added jobs. Compared to traditional industries, high-tech can provide higher wage income, and industrial upgrading will also create job opportunities for medium and low-skilled labor, helping narrow income disparities between regions and groups. Different types of regulation also influence the impact mechanism on common prosperity. China's command-control and market-based regulations have nonlinear effects on environmental and economic performance(Li and Ramanathan 2018).Market-based regulation is more effective than command-control in jointly driving technological innovation and industrial progress, effectively promoting industrial upgrading (Wang, Wang et al. 2022).In light of actual development, China's eastern, central and western regions have differences. Under regulation, the east may accelerate optimization and high-quality development, while the central and west's polluting firms may hit "growth limits" and improve technology(Yu and Wang 2021).Regional governments tailor environmental decentralization based on development needs, interacting with regulation to jointly influence regional green total factor productivity and industrial restructuring, ultimately impacting economic growth(Wu, Hao et al. 2020).Therefore, robust environmental regulation can promote industrial upgrading, significantly improve labor skills structure, create more high-paying jobs across all levels, fundamentally driving income growth and promoting common prosperity. In summary, by mandating corporate

technological innovation and industrial upgrading, environmental regulation can raise employee income, expand the middle-income group, and advance common prosperity. Based on the above analysis, this paper puts forward the following hypotheses:

H1： Environmental regulation facilitates common prosperity mainly by improving the level of technological innovation and promoting industrial upgrading.

Environmental regulation has a facilitating effect on common prosperity within an appropriate range. When regulatory intensity is relatively weak, strengthening regulation can stimulate corporate innovation, improve production efficiency, drive industrial upgrading, and achieve win-wins for the environment and economy, thus promoting common prosperity (Peng, Sheng et al. 2020).However, when regulation becomes excessively stringent, corporations need to bear huge pollution control costs. The benefits from new technologies can hardly offset regulation costs, and overstrict regulation may hinder economic growth and income increase. Therefore, this study believes that the impact mechanism of regulation on common prosperity is not constant, but has a specific threshold (Song, Yang et al. 2020).Specifically, at the initial stage when regulation is weak, properly enhancing it can drive corporate technological innovation and green production. This is conducive not only to reducing pollution but also improving corporate efficiency, returns and competitiveness, along with employee wage income. However, excessive regulation makes it difficult for corporations to bear huge pollution control pressures. Declining production input will hamper economic growth, income increase, and may even reduce employment(Li, Dong et al. 2022).Given China's realities, environmental regulation levels vary greatly across regions. Spatial spillover and hysteresis effects indicate that regulation is more effective in eastern regions but weakened in western regions(Li, Liu et al. 2019).Appropriately strengthening regulation in the central and west can play a positive role. But excessive regulation in the already strict east may have negative impacts. Therefore, moderate regulation can reduce pollution and promote economic growth and common prosperity, while excessive regulation will inevitably have adverse impacts. In summary, environmental regulation has a facilitating effect on common prosperity within an appropriate range. Moderate regulation achieves environment-economy win-wins, while excessive regulation hampers growth. China should tailor regulation intensity accordingly. Based on the above analysis, this paper puts forward the following hypothesis:

H2： The facilitating effect of environmental regulation on common prosperity demonstrates an inverted U-shaped relationship.

4 model setting and Variable selection

4.1 Model setting

To examine whether the facilitating effect of environmental regulation on the level of common prosperity development demonstrates an inverted U-shaped relationship, this paper establishes the following model. First, based on theoretical analysis in the literature, environmental regulation is set as the independent variable, and the level of common prosperity development as the dependent variable. Then, considering that environmental regulation may have a nonlinear impact on the level of common prosperity development, the squared term of environmental regulation is introduced to explore whether there is an inverted U-shaped relationship between environmental regulation and common prosperity development. Combining the previous theoretical analysis, the model setting is as follows：

$$Compro_{it} = \alpha_0 + \alpha_1 Env_{it} + \alpha_3 Env_{it}^2 + \alpha Controls_{it} + \mu_i + \nu_t + \varepsilon_{it} \quad (1)$$

Where，$Compro_{it}$ represents the common prosperity level in province i in year t；Env_{it} represents the environmental regulation intensity in province i in year t； $Controls_{it}$ represents a series of control variables, specifically including population density (Pop), market size (Market), infrastructure level (Infrastructure), government intervention (Government), foreign trade level (Trade);μ_i represents provincial fixed effects； ν_i represents year fixed effects； ε_{it} is the random error term.

4.2 Variable selection

4.2.1 Interpreted variable: Connotation and measurement of common prosperity indicators

（1）General Secretary Xi Jinping emphasizes that common prosperity is the prosperity of all the people, not just a few. In terms of content, common prosperity contains both material and spiritual aspects; in terms of scope, it is not just a few people becoming prosperous, but universal prosperity for all the people; in terms of degree, common prosperity is not egalitarianism, but prosperity on the basis of reasonable gaps; in terms of time, common prosperity is not achieved simultaneously, but gradually in stages. Therefore, common prosperity is a multi-dimensional, comprehensive concept that cannot be simply judged by a single indicator. A three-dimensional indicator system is needed for evaluation instead of over-relying on any single indicator.Based on the summarization of General Secretary Xi and other important meetings and outline contents regarding the connotation of common prosperity, as well as existing literature, this paper divides common prosperity indicators into four

dimensions of overall prosperity, coordinated development, shared outcomes, and ecological welfare as secondary indicators, and constructs an evaluation indicator system for common prosperity based on this（Table 1）.

Table 1 Construction of common prosperity index

First-level indicators	Second-level indicators	Basic indicators	Units	indicator attribute
Common prosperity	Overall prosperity	Per capita GDP	Yuan/person	+
		Per capita disposable income	Yuan/person	+
		Per capita consumption expenditure	Yuan/person	+
		Urban residents' Engel coefficient	%	-
		Rural residents' Engel coefficient	%	-
	Coordinated development	Resident income gap	Index	-
		Regional development gap	Index	-
		Urban-rural development gap	Index	-
	Shared achievements	Urban park and green space area	Hectares	+
		Secondary school teacher-student ratio	Teachers per student	+
		Primary school teacher-student ratio	Teachers per student	+
		Local fiscal education expenditure	100 million yuan	+
		Hospital beds per 10,000 people	Beds	+
		Public transport vehicles per 10,000 people	Vehicles	+
		Per capita road area	Square meters	+
	Ecological well-	Air quality	μg/cubic meter	-

being			
	Energy consumption per unit GDP	Tons of SCE/10,000 yuan	-
	Harmless treatment rate of municipal waste	%	+

Firstly, overall prosperity. The concept of common prosperity in the new era does not mean equal prosperity. It should not promote egalitarianism or lead to common poverty. It must be built on a certain level of overall prosperity. Only by enlarging the overall "cake" can there be enough to share. Therefore, overall prosperity is a prerequisite for common prosperity and is inevitably included in the evaluation index system of common prosperity. This article selects five basic indicators, namely per capita GDP, per capita disposable income, per capita consumption expenditure, urban residents' Engel coefficient, and rural residents' Engel coefficient, to comprehensively measure the level of overall prosperity in a region.

Secondly, coordinated development. The coordination and balance of development are necessary conditions for achieving common prosperity. Only by continuously promoting regional coordinated development and improving the income levels and quality of life of people in various regions and industries can common prosperity be gradually realized. Therefore, coordinated development is not only an inherent requirement of common prosperity but also an important approach to achieving it. This article selects three basic indicators, namely income gap among residents, regional development gap, and urban-rural development gap, to measure the level of coordinated development. The smaller these three gaps are, the higher the degree of coordinated development in the region. Among them, the income gap among residents is measured using the Gini coefficient of income, with reference to the method proposed by (Sundrum 1992)；The regional development gap is measured using the Dagum Gini coefficient (Dagum 1998) calculated based on nighttime light data of counties in each province；The urban-rural development gap is measured using the Theil index of disposable income of urban and rural residents (Zhang, Tang et al. 2008).

Thirdly, shared achievements. The important purpose of promoting common prosperity is to enhance people's well-being and allow them to share in the fruits of development, continuously meeting the aspirations of the people for a better life. Therefore, it is necessary to adhere to the concept of sharing development achievements with the people and take the path of co-construction, co-governance, and sharing. This involves providing higher-quality public services and improved

social welfare for all people, and meeting the growing spiritual and cultural needs of the people. This article selects seven indicators, namely urban park green space area, student-teacher ratio in junior high schools, student-teacher ratio in primary schools, local government's education expenditure, number of hospital beds per 10,000 people, number of shared transportation per 10,000 people, and per capita road area, to comprehensively evaluate the level of shared development in a region.

Fourthly, ecological well-being. General Secretary Xi Jinping's scientific statement that "a good ecological environment is the fairest public product and the most inclusive well-being of the people" reveals the important relationship between the ecological environment and people's well-being. It signifies that meeting the increasing demand for a beautiful ecological environment is also an important aspect of promoting common prosperity. The connotation of common prosperity is not limited to material and spiritual wealth but also includes rich ecological civilization. Economic welfare, social welfare, and ecological welfare together constitute the welfare system of common prosperity. This article selects three basic indicators, namely air quality, energy consumption per unit of GDP, and harmless treatment rate of household waste, to comprehensively evaluate the level of ecological well-being in a region.

（2）Measurement of the level of common prosperity. This article refers to relevant research and uses the entropy method to calculate the level of common prosperity in China. Firstly, the various basic indicators are used to generate composite indices for the four sub-dimensions of overall prosperity, coordinated development, shared achievements, and ecological well-being. Then, the composite indices for the sub-dimensions are further combined using the same method to generate the composite index for common prosperity.

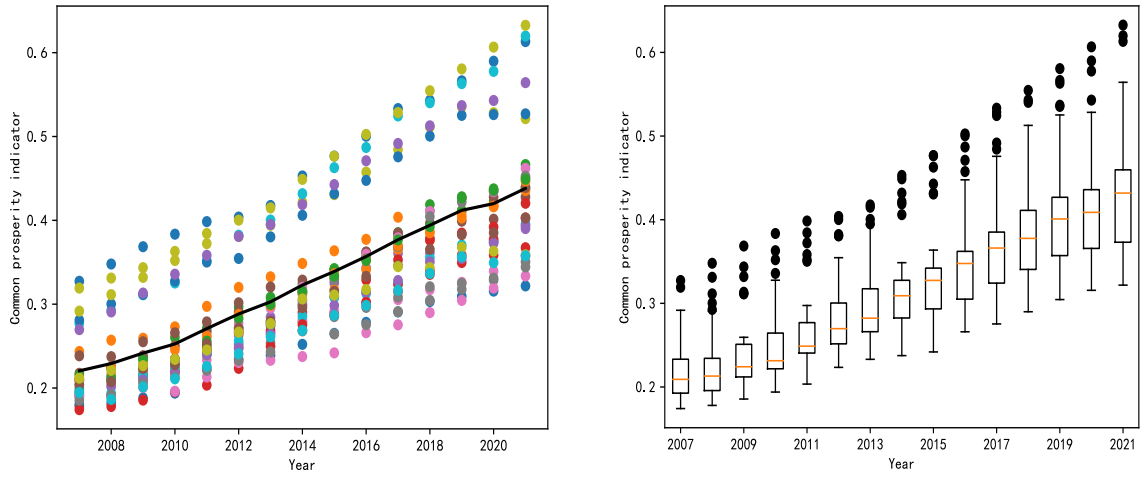

Figure 1 Distribution and box plot of common prosperity indicators in each province from 2007 to 2021

Using the entropy method, the level of common prosperity in each province of China from 2007 to 2021 was calculated. To further reflect the development level of common prosperity in China, a distribution map and box plot of the common prosperity development indicators for each province and autonomous region in China were created（Figure 1）.Firstly, looking at the mean and median values, the average values of the common prosperity development indicators have been continuously increasing from 2007 to 2019.Secondly, examining the distribution of the common prosperity development indicators among provinces, although more than half of the provinces were below the mean value in each year, some provinces have successfully surpassed the mean value during the ten-year period.Lastly, there is a significant disparity in the level of common prosperity development among provinces and autonomous regions in China. Moreover, as time goes on, the range of common prosperity level in the country is continuously widening.

4.2.2 Core explanatory variable

The main indicator of China's environmental assessment system is the reduction of emissions. Although the improvement of environmental quality and comfort is the ultimate goal of environmental regulation, the factors influencing this goal are complex. Therefore, using emission reduction as an assessment target is clearer. The government also needs to closely monitor pollutant emissions in environmental governance. Therefore, using emissions as a measure of environmental regulation is more accurate(Hoen, Tan et al. 2014).Based on this, this article refers to the research by (Zhang, Zhang et al. 2019) on measuring environmental regulation based on pollutant emissions per unit of GDP and constructs the following indicators:：

$$PX_{ij} = \frac{P_{ij}}{\frac{1}{n}\sum_{s=1}^{n} P_{is}}, i = 1,2,3 \tag{2}$$

$$PX_j = \frac{1}{3}(PX_{1j} + PX_{2j} + PX_{3j}) \tag{3}$$

$$ER_j = \frac{1}{PX_j} \tag{4}$$

Where *Pij* represents the emissions of the *i* pollutant per unit of industrial GDP in the *j* province，$\frac{1}{n}\sum_{s=1}^{n} P_{is}$ is the average value of the emissions of the *i* pollutant per unit of industrial GDP for all provinces in the country，PX_j represents the dimensionless sum average of pollutant emissions per unit of industrial GDP in the *j* province. Industrial wastewater emissions, industrial sulfur dioxide emissions, and industrial smoke (dust) emissions are used to measure pollutant emissions. ER_j represents the reciprocal of PX_j， The larger the value of ER_j, the greater the environmental regulation

intensity in city *j*. The core explanatory variables in this article are logarithmically transformed.

4.2.3 Mediating variable

We believe that environmental regulation policies can further impact the level of common prosperity by influencing the level of technological innovation and the upgrading of industrial structure in a region. Therefore, in this study, we introduce technological innovation level (Tech) and industrial structure upgrading (Ind) as mediating variables into the model. Specifically, the technological innovation level is represented by the natural logarithm of the number of granted patent applications within a province, which reflects the technological innovation capability of the province. The industrial structure is represented by the natural logarithm of the output value of the tertiary industry, which reflects the degree of industrial structure upgrading and the effect of industrial transfer.

4.2.4 Control variable

Population density (Pop) is represented by the number of people per square kilometer in each province; market size (Market) is represented by the ratio of the number of legal entities with sales above a certain threshold to the total sales, indicating a higher degree of marketization with a larger ratio; infrastructure level (Infrastructure) is represented by the ratio of road mileage to land area in each province; government intervention level (Government) is represented by the ratio of total fiscal expenditure to local GDP in each province; and trade level (Trade) is represented by the ratio of total import and export trade to local GDP in each province.

4.2.5 Data source

This article is based on panel data from 30 provinces in mainland China (excluding Tibet) from 2007 to 2021. The primary sources of the original data include the "China Statistical Yearbook," statistical yearbooks of various provinces, the "China Environmental Statistical Yearbook," and the official website of the National Bureau of Statistics. Detailed descriptive statistics of the various indicators for the 30 provinces over the 15-year period can be found in Table 2.

Table 2 Descriptive statistics

VarName	Obs	Mean	SD	Min	Max
compro	450	0.324	0.095	0.174	0.633
env	450	3.441	0.260	2.887	4.184
tech	450	7.798	1.618	3.135	11.541
ind	450	8.838	1.023	5.643	11.144
pop	450	0.058	0.069	0.004	0.393
Infrastructure	450	1.597	1.689	0.211	10.097
market	450	0.374	0.083	0.035	0.800
Government	450	0.250	0.111	0.097	0.758
trade	450	0.291	0.337	0.008	1.662

5 Empirical analysis

5.1 Benchmark regression

After considering the control variables, The regression results in Table 3 columns (1) and (2) show that in column (1), where only the dependent variable (Compro) and the core explanatory variable (Env) are included, the coefficient of the linear term for environmental regulation intensity is significantly positive, while the coefficient of the quadratic term is significantly negative. In column (2), after including other control variables, the estimated coefficient of the core explanatory variable, environmental regulation intensity, remains significantly positive, and the coefficient of the quadratic term remains significantly negative. This is consistent with the theoretical expectations, indicating that the impact of environmental regulation intensity on the level of common prosperity follows an inverted "U" shape pattern. Hypothesis 1 is supported. The scatter plot can be seen in Figure 2 This indicates that an appropriate level of environmental regulation intensity promotes the development of common prosperity, while excessive environmental regulation intensity inhibits the development of common prosperity.

Further,the authenticity of the inverted "U" relationship is tested, and the results support the existence of the inverted "U" relationship. Taking the regression results from column (2) with the inclusion of control variables as an example, the results indicate that the threshold value for environmental regulation intensity is 3.48, with a 95% confidence interval of [3.40, 3.54]. Both upper and lower bounds are within the range of the observed values of environmental regulation (ranging from 2.887 to 4.184). The slope of the "environmental regulation-shared prosperity" curve is significantly positive at the minimum observed value and significantly negative at the maximum observed value, indicating that both segments of the inverted "U" curve are sufficiently steep. The test results reject the null hypothesis of a monotonic or "U" shaped relationship between environmental regulation and the level of shared prosperity at a significance level of 1%, confirming the presence of an inverted "U" relationship between the two variables.

Table 3 Benchmark regression results

	(1) compro	(2) compro
env	0.3372***	0.3233***
	(4.27)	(4.72)
sqrenv	-0.0486***	-0.0465***
	(-4.26)	(-4.71)
pop		0.1371*
		(1.68)

Infrastructure		0.0019
		(1.02)
market		0.0074
		(0.58)
Government		-0.2069***
		(-6.92)
trade		-0.0676***
		(-7.84)
_cons	-0.3610***	-0.2902**
	(-2.65)	(-2.45)
province	YES	YES
year	YES	YES
Threshold of scale	3.47	3.48
Size threshold 95% confidence intervals	[3.40，3.54]	[3.40，3.54]
Sample interval of environmental regulation	[2.89，4.18]	[2.89，4.18]
N	450	450
R^2	0.943	0.958

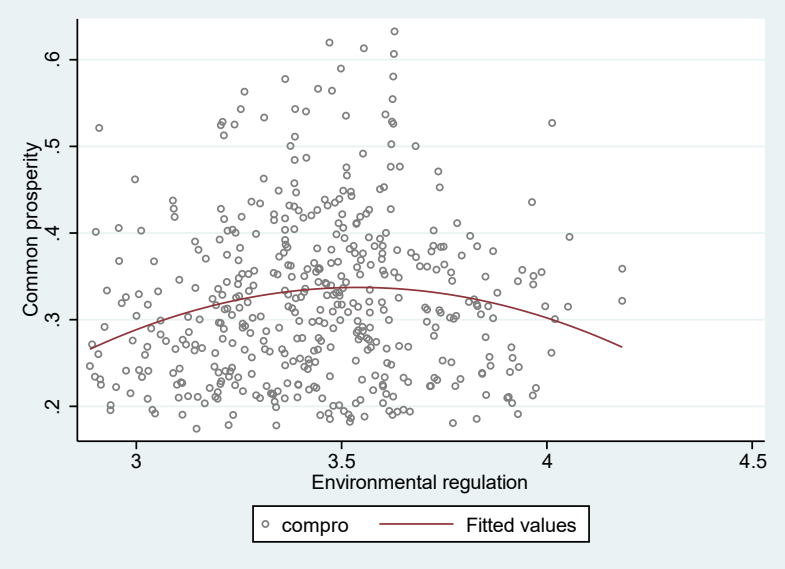

Figure 2 Environmental regulation and common prosperity

5.2 Robustness test

5.2.1 Replace explanatory variables

Regarding the environmental regulation indicator, environmental regulation intensity can also be measured using input-based indicators. For example, the ratio of environmental pollution control investment to gross domestic product (GDP) can be used as a proxy variable for measuring environmental regulation(Ren, Li et al. 2018).Therefore, we replace the core variable with the ratio of environmental pollution control investment to provincial GDP as a substitute variable to test whether the core conclusions of this study still hold after replacing the core explanatory variable. Table 4 column (1) presents the regression results after replacing the core explanatory variable, which

are consistent with the baseline regression results, indicating that the core findings of this study are robust.

5.2.2Bilateral truncation

To mitigate the influence of outliers, this study applies a 1% bilateral truncation to the sample data and then conducts regression analysis based on the truncated data. In Table 4 column (2), the estimated coefficient of the core explanatory variable retains the same sign and significance level, indicating that the core findings of this study remain valid.

5.2.3Remove samples

Compared to other provinces, municipalities directly under the central government have a certain degree of special autonomy in policy-making areas such as legislation, governance, and environment. In order to make the study more generalizable, this article excludes the four municipalities directly under the central government. From Table 4 column (3), it can be observed that after excluding the four municipalities, there is a significant inverted "U" relationship between environmental regulation and shared prosperity, once again confirming the robustness of the research findings.

5.2.4Generalized method of moments estimation

Due to the potential presence of omitted variables in the economic system, such as unquantifiable social factors and endogeneity issues caused by reverse causality, this study has two options to address endogeneity estimation bias: panel instrumental variable (IV) estimation and panel generalized method of moments (GMM) estimation. Since the former requires finding instrumental variables that are relatively exogenous, which is not feasible in this study, the generalized method of moments (GMM) estimation method is chosen for regression analysis. This method has two notable advantages: first, it can provide valid estimates even without additional reliable instrumental variables by utilizing all possible higher-order lagged variables as instruments; second, it allows for the inclusion of lagged dependent variables as explanatory variables, which better captures the inertia and path dependence characteristics of the economic system through dynamic panel regression. In this study, the lagged values of environmental regulation and the squared lagged values of environmental regulation are used as instrumental variables in the GMM model regression, as shown in Table 4 column (4). Based on the regression results, the main conclusions remain robust.

Table 4 Robustness test

	(1) compro	(2) compro	(3) compro	(4) compro
L.compro				0.9983***
				(52.40)

env_1	0.0165***			
	(3.57)			
sqrenv_1	-0.0040***			
	(-3.45)			
env		0.2775***	0.3295***	0.1097***
		(3.99)	(4.80)	(2.73)
sqrenv		-0.0399***	-0.0475***	-0.0160***
		(-3.96)	(-4.79)	(-2.76)
pop	0.2015**	0.1337*	0.5116***	-0.0502***
	(2.37)	(1.68)	(4.96)	(-3.68)
Infrastructure	0.0022	0.0030	-0.0031	0.0007
	(1.09)	(1.55)	(-1.52)	(1.44)
market	0.0149	-0.0005	0.0030	-0.0021
	(1.14)	(-0.04)	(0.23)	(-0.33)
Government	-0.1932***	-0.2277***	-0.2257***	-0.0181***
	(-6.26)	(-7.61)	(-7.62)	(-2.83)
trade	-0.0666***	-0.0626***	-0.1340***	0.0091**
	(-7.64)	(-7.39)	(-10.28)	(2.15)
_cons	0.2465***	-0.2081*	-0.3007**	-0.1719**
	(21.13)	(-1.73)	(-2.53)	(-2.55)
AR(1)				0.000
AR(2)				0.209
Sargan_p				0.282
province	YES	YES	YES	YES
year	YES	YES	YES	YES
N	450	450	390	390
R^2	0.957	0.960	0.962	0.96

6 Further Analysis

6.1 Analysis of mechanism

To further validate hypothesis H1, this study selects industrial structure upgrading and technological innovation as mediating variables to explore the mechanism of the impact of environmental regulations on the level of shared prosperity. As shown in the Table 5, there is a significant inverted "U" relationship between environmental regulation and industrial upgrading and technological innovation. Reasonable environmental regulation intensity promotes industrial upgrading and enhances technological innovation capabilities, thereby improving the level of shared prosperity. However, excessive environmental regulation intensity hinders industrial upgrading and technological innovation, which is detrimental to the development of shared prosperity.

Possible reasons for this relationship are as follows: Moderate environmental regulation, through setting emission standards and emission trading systems, can encourage companies to optimize production technologies, develop green products, and adopt cleaner production techniques, thereby promoting industrial structural upgrading and technological innovation. It also facilitates the transformation of industries towards technology-intensive and capital-intensive sectors, thereby driving technological innovation. On the other hand, excessive environmental regulation increases

pollution control and production costs for companies, disrupts the development order of industries, and hampers industrial expansion and technological accumulation. It may also lead to the outflow and transfer of high-pollution, high-energy-consuming industries, which is detrimental to the accumulation of technological capabilities in related fields. Additionally, the diminishing marginal returns of environmental regulation determine the non-linear relationship between environmental regulation and industrial technological innovation. The increasing marginal governance costs gradually weaken the innovation motivation of companies.

Table 5 Analysis of mechanism

	(1) ind	(2) compro	(3) tech	(4) compro
env	0.7355*	0.2907***	2.1319**	0.2791***
	(1.74)	(4.39)	(2.06)	(4.27)
sqrenv	-0.1065*	-0.0418***	-0.2946**	-0.0404***
	(-1.74)	(-4.38)	(-1.97)	(-4.28)
ind		0.0443***		
		(5.68)		
tech				0.0207***
				(6.59)
pop	-2.1652***	0.2330***	-1.8717	0.1759**
	(-4.30)	(2.90)	(-1.52)	(2.26)
Infrastructure	0.0425***	0.0001	0.0483*	0.0009
	(3.59)	(0.03)	(1.67)	(0.52)
market	0.7709***	-0.0267*	0.1866	0.0035
	(9.75)	(-1.95)	(0.96)	(0.29)
Government	-0.2056	-0.1978***	-1.3917***	-0.1780***
	(-1.11)	(-6.86)	(-3.08)	(-6.19)
trade	0.0306	-0.0690***	0.3565***	-0.0750***
	(0.57)	(-8.31)	(2.74)	(-9.07)
_cons	6.4157***	-0.5746***	2.4155	-0.3403***
	(8.78)	(-4.61)	(1.35)	(-3.02)
province	YES	YES	YES	YES
year	YES	YES	YES	YES
Threshold of scale	3.45	3.48	3.62	3.45
Size threshold 95% confidence intervals	[3.28，3.63]	[3.41，3.55]	[3.39，3.84]	[3.38，3.53]
Sample interval of environmental regulation	[2.89，4.18]	[2.89，4.18]	[2.89，4.18]	[2.89，4.18]
N	450	450	450	450
R^2	0.972	0.961	0.938	0.962

6.2 Re-examination of the influence in different regions and dimensions

6.2.1 Sub-dimension analysis

To further explore the impact of environmental regulations on the development of multidimensional shared prosperity, this article examines the effects of fiscal decentralization from four dimensions: overall prosperity, coordinated development, shared achievements, and ecological well-being. The regression results, as shown in Table 6, indicate that environmental regulations can influence the development of shared prosperity by affecting overall prosperity, coordinated

development, and ecological well-being, which is consistent with theoretical analysis. However, environmental regulations do not have a significant impact on shared achievements. In fact, their effect is opposite to the overall shared prosperity indicator, showing a positive "U" shape. The possible reason for this is that shared achievements may be influenced by factors such as regional development level, fiscal transfer payments, and the proportion of the population living in poverty. Looking solely at environmental regulations, their effect may be limited. The primary goal of environmental regulations is to protect the ecological environment, not to narrow income disparities. They achieve environmental objectives by limiting pollution, conserving resources, and other means. However, this may indirectly lead to industrial restructuring, which can affect income distribution. When the initial level of environmental regulations is not significant, environmental constraints have a relatively small impact on high-income groups but a larger impact on middle- and low-income groups, potentially widening income disparities. As the strength of regulations increases, polluting and high-emission backward industries are phased out, and high-tech industries develop, which benefits the employment opportunities and income levels of low-income groups. At the same time, strengthened environmental regulations increase the cost of environmental governance for businesses, constraining the income growth of high-income individuals and positively contributing to narrowing the income gap. In summary, the impact mechanism of environmental regulations on income distribution varies at different stages. Initially, they may widen the gap, but in the later stages, they help to narrow it, forming a positive "U" relationship. As for the other three dimensions, the effects of environmental regulations are more consistent and direct, showing an inverted "U" relationship.

Table 6 Sub-dimensional regression results

	(1)	(2)	(3)	(4)
	Affluence	development	Sharing	welfare
env	0.2483**	1.1137*	-0.2068	0.3162**
	(2.57)	(1.69)	(-1.51)	(2.06)
sqrenv	-0.0349**	-0.1655*	0.0299	-0.0446**
	(-2.50)	(-1.74)	(1.51)	(-2.01)
pop	0.4986***	-0.2446	0.7535***	0.3808**
	(4.33)	(-0.31)	(4.61)	(2.08)
Infrastructure	-0.0075***	-0.0287	-0.0187***	-0.0100**
	(-2.77)	(-1.55)	(-4.87)	(-2.32)
market	0.0130	0.1284	-0.0219	-0.1038***
	(0.72)	(1.04)	(-0.85)	(-3.61)
Government	-0.2819***	0.2334	0.0802	0.2738***
	(-6.68)	(0.81)	(1.34)	(4.08)
trade	-0.1995***	-0.0909	-0.1771***	0.1996***
	(-16.39)	(-1.10)	(-10.25)	(10.32)
_cons	-0.2216	-1.3171	1.0567***	0.0746
	(-1.33)	(-1.16)	(4.45)	(0.28)
province	YES	YES	YES	YES

year	YES	YES	YES	YES
Threshold of scale	3.56	3.37		3.55
Size threshold 95% confidence intervals	[3.41，3.70]	[3.16，3.57]		[3.37，3.72]
Sample interval of environmental regulation	[2.89，4.18]	[2.89，4.18]		[2.89，4.18]
N	450	450	450	450
R^2	0.967	0.044	0.818	0.568

6.2.2 Analysis by region

The regression results demonstrate the impact of environmental regulations on the level of shared prosperity from a regional perspective (Table 7). For the eastern and western regions, there is a significant inverted "U-shaped" relationship between environmental regulations and shared prosperity. This means that environmental regulations have a more pronounced effect on both restricting and promoting the development of shared prosperity in the western region. As for the central region, although the regression coefficient also indicates an inverted "U-shaped" relationship between environmental regulations and shared prosperity, it is not statistically significant. This suggests that the impact of environmental regulations on the development of shared prosperity in the central and eastern regions is not as significant as in the eastern and western regions.

One possible reason for this is that the industrial structure in the eastern and western regions is primarily focused on the secondary sector. Environmental regulations can directly influence the adjustment of the industrial structure and promote industrial upgrading. The western region relies more on resource industries, and environmental regulations can drive the optimization of its industrial structure and the development of green industries. The eastern region can restrict pollution from traditional manufacturing industries and develop export-oriented industries.

On the other hand, the central region has fewer large-scale heavy chemical industries, and its secondary sector is not as developed as in the eastern region. However, being located inland, the central region has developed strong service industries such as transportation, trade, and logistics due to its advantageous geographical position. Therefore, the central region has a higher proportion of service industries, and the impact of environmental regulations on its industrial structure adjustment is relatively weak, resulting in a less significant effect on shared prosperity.

Table 7 Analysis of heterogeneity

	(1) east	(2) middle	(3) west
env	0.3146**	0.1215	0.3516***
	(2.08)	(1.40)	(4.76)
sqrenv	-0.0459**	-0.0186	-0.0506***
	(-2.10)	(-1.49)	(-4.75)
pop	0.1410	6.4863***	-0.4392*
	(1.20)	(3.64)	(-1.77)
Infrastructure	0.0023	0.0771***	0.0086***

	(0.28)	(5.03)	(2.99)
market	0.0382	-0.0088	0.0119
	(1.15)	(-0.51)	(0.92)
Government	-0.1656	-0.1889**	-0.1058***
	(-1.63)	(-2.35)	(-4.26)
trade	-0.0590***	0.2600***	0.0653***
	(-4.16)	(4.42)	(3.34)
_cons	-0.2415	-0.2595	-0.3957***
	(-0.93)	(-1.65)	(-3.09)
province	YES	YES	YES
year	YES	YES	YES
Threshold of scale	3.43	3.27	3.47
Size threshold 95% confidence intervals	[3.26，3.59]	[2.91，3.62]	[3.41，3.53]
Sample interval of environmental regulation	[2.89，4.18]	[2.89，4.05]	[2.90，4.18]
N	165	120	165
R^2	0.958	0.983	0.982

7 Summary and policy recommendations

According to the theory of common prosperity in the new development stage, this article constructs an evaluation index system for common prosperity from four dimensions: overall prosperity, coordinated development, shared achievements, and ecological welfare, and conducts calculations based on it. At the same time, using panel data from Chinese provinces from 2007 to 2021, the article explores the impact of environmental regulation on common prosperity and draws the following main conclusions:First, there is a significant inverted "U" relationship between environmental regulation and common prosperity, with a turning point value of 3.48. This indicates that both excessively high or low levels of environmental regulation will weaken its promotion of common prosperity. Therefore, only by maintaining environmental regulation within a "moderate range" can the level of common prosperity in a region be significantly improved.Second, through mechanism testing analysis, it is found that environmental regulation can have a promoting or inhibiting effect on the level of common prosperity through its impact on industrial structure upgrading and technological innovation.Third, when looking at different dimensions, environmental regulation can significantly promote overall prosperity, coordinated development, and ecological welfare within a certain range, but its impact on shared achievements is not significant.When looking at different regions, the inverted "U" relationship between environmental regulation and common prosperity is significant in the eastern and western regions, but not significant in the central region.

Based on the above analysis, this article proposes the following policy recommendations:

(1) Promote moderate environmental regulation. Excessive environmental regulation can inhibit economic vitality, while insufficient regulation cannot achieve environmental benefits. Therefore, it

is necessary to strike a balance. First, the government needs to clearly define key environmental indicators. Priority should be given to indicators directly related to public health and ecological environment, such as air quality index and water quality. Second, scientific environmental indicator thresholds should be determined. Cross-departmental experts should be organized to study and determine the environmental carrying capacity red lines for different regions. Quantitative thresholds should be established based on international standards and experience. Third, a real-time monitoring and early warning system should be established. Environmental monitoring departments should use sensors, satellite remote sensing, and other methods to monitor environmental indicators in real-time and compare them with the thresholds. Early warnings should be triggered when the thresholds are approached.

(2) Implement tailored environmental regulation assessments to address regional differences in environmental regulation needs in the eastern, central, and western regions. Differential regulations should be formulated taking into account differences in resource and environmental carrying capacity, industrial structure, and technological equipment levels. In the eastern region, pollution emission standards can be raised, and efforts should be made to accelerate the elimination of outdated production capacity and promote industrial upgrading. In the western region, pilot projects and trials can be expanded, and emerging green industries should be encouraged. In the central and western regions, longer transition periods can be set when implementing high standards, and phased implementation should be carried out, with certain financial subsidies provided. More flexible standards can be applied to the central and western regions in terms of environmental facility allocation and issuance of pollution discharge permits to reduce implementation costs. A coordination mechanism for environmental regulation among regions should be established, data sharing should be strengthened, and the occurrence of "pollution havens" should be prevented.

(3) Optimize the policy combination of environmental regulation. Adopt various means such as economic, technological, and managerial measures to form a coordinated and synergistic regulatory system. Firstly, economic measures should be taken. Differentiated emission taxation and fees should be reasonably determined for different industries based on pollutant types and emission levels, with increased taxation and fees for key industries. Secondly, technological measures should be taken. Increase financial support for environmental governance technology research and development, with a focus on supporting energy-saving and emission reduction technology innovation in the equipment manufacturing industry. Establish a reward mechanism for environmental technology patents to

encourage enterprises to adopt new technologies for transformation. Thirdly, managerial measures should be taken. Higher permit standards should be implemented for heavily polluting industries, and a total pollutant control method should be adopted to limit the number of permits issued. Strict on-site inspection systems should be implemented to ensure that enterprises strictly comply with permit requirements.

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