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# The Impact of Environmental Regulation on New Quality Productive Forces in Manufacturing

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**Abstract: Under the current era background of high - quality development and green transformation, the optimization and perfection of the environmental supervision mechanism have become a focus issue in the academic circle and the policy - making field. The observed effect is intimately linked to the process of cultivating new quality productive forces (hereinafter referred to as NQPF) within the manufacturing sector. Taking A-share listed manufacturing firms from 2015 to 2022 as the sample, this study aims to systematically examine how environmental regulation influences manufacturing NQPF, and to fully uncover the transmission pathways and inherent logic connecting them. According to the extant literature, environmental regulation plays a markedly positive role in enhancing the NQPF of the manufacturing sector. Through the elimination of abnormal observations, the use of the instrumental variable method to control endogenous bias and other multi-dimensional robustness tests, the reliability of the above conclusion has been further confirmed. The mechanism analysis identifies green technology innovation (hereinafter referred to as GT) as the core transmission mechanism through which environmental regulation fuels the leap in NQPF. By strengthening green technology R&D intensity and systematically accumulating green patent assets, environmental regulation effectively drives enterprises toward a fundamental reinvention of their production paradigms and a structural shift in their growth momentum. This study aims to uncover the intrinsic linkages between environmental regulation and the high-quality development of enterprises, and to establish an innovative analytical framework. The findings are intended to offer policymakers scientifically grounded and actionable decision support, thereby assisting in refining environmental regulation pathways, advancing the green transformation of the manufacturing sector, and fostering its coordinated development with NQPF.**

**Keywords: Environmental Regulation; New Quality Productive Forces; Manufacturing Industry; Green Transformation; Green Innovation**

## 1. Introduction

At a time when the global ecosystem is facing severe challenges, China's economic growth model has also undergone profound transformation. The former traditional development path relying on high energy consumption and high pollution is gradually being replaced by a sustainable green development paradigm. In the critical stage of economic structural transformation, the environmental regulation system plays a core regulatory role. Through constructing and implementing this institutional framework, the government systematically restricts the ecological and environmental behaviors of market entities, making them deeply embedded in the full-process operation of manufacturing from R & D and design to product scrapping, and then promotes enterprises to fundamentally reconstruct their production strategies and reshape their long-term development paths. With the successive introduction and implementation of environmental policies such as the Environmental Protection Tax Law, and the intensifying regulation of exhaust emissions from traditional motor vehicles in recent years, China's environmental supervision regime has undergone progressive improvement, accompanied by a sustained increase in its enforcement effectiveness. Against this macro background, the environmental compliance expenditure of manufacturing enterprises is on the rise year by year, and the urgency of their

transformation to the green development model is significantly intensified. In the current era wave, manufacturing enterprises need to promote green transformation to conform to environmental regulations and policy orientations, and cultivating new quality productivity is the core strategy to achieve this transformation [1]. The advent of new-type quality products—advanced, optimized versions of traditional categories—marks an inevitable progression in the new period of high-quality economic growth, embodying a deep-seated response to emerging societal demands and shifts in the economic fabric. Its fundamental goal is to improve people's living quality and well-being. Some academic views point out that the core competitiveness of new-quality products depends on the drive of high and new technologies, and their development roots are deeply rooted in the emerging frontier industrial fields.

Porter's theory of competitive advantage reveals that a scientific and complete environmental regulation strategy can drive enterprises to systematically optimize their production processes and stimulate their technological innovation vitality, thereby improving the overall operational efficiency. This improvement in efficiency can, in turn, partially offset the incremental costs incurred by enterprises due to compliance inputs. The empirical work of Zhu et al. [2] further substantiates the dual effect of the Environmental Protection Tax Law on fostering new-quality productivity within firms, particularly evidenced by its remarkable achievements in shifting production paradigms toward greening, however, significant structural impediments and bottlenecks remain in critical fields like human capital renewal and the effective commercialization of technological advances. Ecological control exerts significant structural reshaping pressure on the two core elements of labor and technology. Some studies indicate that as environmental regulation intensifies, enterprises' cultivation of NQPF initially declines and then rises, exhibiting a distinct U-shaped trajectory. Before the inflection point is formed, the pressure of environmental compliance costs faced by enterprises may exceed the innovation-driven effect revealed by Porter's hypothesis. At this stage of development, if the environmental supervision mechanism is implemented improperly, it may form a blocking effect on the cultivation process of emerging productive forces. And after the key turning point is reached, the Porter effect will gradually exceed the negative effect of regulatory costs, and at that time, environmental regulation will become a positive force to promote enterprises to cultivate new-quality productivity. Findings from prior studies confirm a substantial contribution of environmental regulation to the increase in green patent output. Yet, when confined to a specific threshold range, the otherwise facilitating influence on the quality of green innovation exhibits a discernible pattern of inhibition. The internal mechanism linking environmental regulation to firm-level green total factor productivity is still a subject of ongoing debate and lacks a unified scholarly interpretation. In the evolution process of giving birth to NQPF, academic exploration of its potential influence mechanisms and effects is urgently in need of advancing towards the systematic and in-depth direction. Utilizing firm-level data on A-share listed manufacturing enterprises in China over the period 2015–2022, this study systematically investigates how the stringency of environmental regulation influences the development of NQPF, along with the internal mechanisms involved. As suggested by Porter's theory of competitive advantage, sound environmental regulation policies can stimulate the endogenous drive of firms to improve manufacturing processes and undertake technological innovation. This, in turn, raises overall operational efficiency to a level that fully covers the extra costs entailed by regulatory compliance. The empirical work of Zhu et al. [2] reveals a dual effect of the Environmental Protection Tax Law on firms' new quality productive force development: it effectively facilitates the green innovation of production paradigms, but simultaneously encounters structural hurdles in human capital succession and the applied transformation of scientific achievements. Ecological regulation exerts a more significant promoting pressure on the transformation of labor allocation and the technological system. Some academic explorations indicate that there is an interactive relationship with a U-shaped change in the process of environmental regulation demand and the cultivation of new quality productivity of enterprises. In the evolution trajectory of environmental regulation, when the pressure of the comprehensive environmental cost faced by

enterprises has not been effectively offset by innovation incentives, the strengthening of environmental supervision will have a inhibitory effect on the cultivation of new-quality productivity; and when the key institutional inflection point is broken through, the driving effect of the Porter effect begins to exceed the restriction of the comprehensive cost. At present, the environmental supervision mechanism is gradually transforming into a key enabling force for generating new productivity of enterprises. Existing empirical findings reveal that environmental regulation markedly promotes the quantity of green patent filings, yet it demonstrates a certain suppressive effect on the sustained quality enhancement of green innovations [3]. Meanwhile, scholarly understanding of the inner mechanism connecting environmental regulation to firms' green total factor productivity remains fragmented and lacks uniformity. In the current era of intensified cultivation of NQPF, the actual effectiveness of such policies still calls for more systematic investigation and rigorous evaluation. To this end, this study draws on a sample of China's A-share listed manufacturing enterprises spanning 2015–2022 to systematically examine the pathways and transmission mechanisms through which environmental regulatory intensity shapes the cultivation of NQPF.

## 2. Theoretical Analysis and Research Hypothesis

Rooted in Porter's theory of competitive advantage, with the construction of a systematic environmental regulation system, it can effectively give rise to and cultivate a competitive pattern that encourages innovation. This mechanism can not only alleviate the compliance burden of enterprises to a certain extent but also actively stimulate their internal potential for technological innovation, thereby enhancing the overall competitiveness of market participants. When GT is integrated into the dynamic theoretical model framework of R & D of high value-added new products, as the core driving force, in the process of breakthrough development of environmental regulation and high value-added new products, it shoulders the core mission of transformation and connection.

Driven by the increasingly strict environmental regulation system, manufacturing enterprises are actively participating in the wave of GT. When the binding force of environmental policies continues to strengthen, the emission reduction pressure and compliance requirements faced by enterprises also increase, which forces them to seek breakthroughs at the technological level to meet the increasingly strict emission limits and comprehensive environmental standards. In an era characterized by a global commitment to sustainability, the traditional end-of-pipe approach has become increasingly incompatible with the requirements of contemporary corporate development. This trend drives enterprises to shift to the strategic direction of source control, and then promotes their green transformation and innovation practice in core fields such as product manufacturing technological innovation, process optimization design, and energy utilization efficiency improvement. Specifically, in the process of green development, the environmental supervision system anchors a clear direction for enterprise technological innovation, guiding enterprises to concentrate R & D resources in key areas such as clean production, energy efficiency optimization, and resource recycling, thus eliminating the uncertainty and potential risks in green innovation activities. Sustained increases in R&D expenditure, coupled with a resolute commitment to pioneering green technology frontiers, enable enterprises to build a solid underpinning for the cultivation of NQPF. The innovative application and wide promotion of green technology can effectively help enterprises build and strengthen the core competitiveness of new quality productivity. Concretely, process innovation, optimized energy deployment, and increased resource circularity enable firms to reduce energy consumption and pollutant emissions in production, thus driving the fulfillment of energy conservation and emission reduction objectives. On the contrary, this can breed new green differentiated products or services, open up a new blue ocean in the market, and build a unique core competitiveness for enterprises in the competitive pattern of the green economy. More importantly, green technological innovation has significant spillover effects: it not only plays a key role in the restoration and governance of the ecological environment, but also deeply penetrates into the whole-process production and operation system of enterprises, driving the systematic upgrade of the production paradigm, and finally realizing a qualitative leap in overall production efficiency. When the GT is deeply integrated with the

enterprise digital transformation and intelligent upgrading strategy, it will lay a solid foundation and inject strong momentum for the breeding of NQPF.

Green-Technology-Innovation has irreplaceable strategic value. In the process of optimizing the environmental governance system and fostering NQPF, it plays the role of a core hub, continuously empowering the iteration and upgrading of the NQPF of enterprises. Such novel initiatives can greatly enhance the operational efficiency and profitability of enterprises. By reconfiguring the pattern of production factors, rationalizing the energy consumption structure, and raising resource reuse efficiency, enterprises can markedly reduce energy use and emissions in production, ultimately driving down costs while improving returns. By advancing green technological innovation and its practical application, manufacturing firms can progressively break free from their path dependence on high-energy, high-pollution production paradigms. By optimizing resource allocation and transformation efficiency, continuously iterating the production technology framework, achieving refined control and intensive operation of the production process, and then effectively improving the green total factor productivity. Continuously improving production efficiency is the key to giving birth to new quality productivity. GT can build a unique green competitive advantage. Enterprises rely on GT to develop eco-friendly products or services, to meet the green consumption trend and expand in the emerging market fields. When enterprises establish a leading position in the green product field and achieve green premium, their core competitiveness will form a unique green moat. In the dynamic interactive pattern of market-driving innovation and innovation-expanding market, enterprises can continuously improve innovation efficiency, and gradually breed and release new productivity with competitive advantages. GT shows significant spillover and superposition effects. Its innovation results break through the limitations of a single environmental governance, deeply penetrate into the whole-process operation of enterprises, and then promote a qualitative leap in the production model. The technical wisdom and innovation momentum accumulated in the R & D process of green technology can be widely empowered in many technical fields, and can also drive the overall technical framework of enterprises to realize iterative optimization and upgrading.

Facing the rigid constraints of environmental regulation, enterprises actively participate in GT, and this measure has strongly promoted the iterative upgrading of high-value-added new products. The key lies in overcoming the dynamic obstacles in the green innovation path, accurately anchoring the strategic direction of green technology R & D, and establishing a set of sustainable practice paradigms and knowledge systems. GT directly empowers the R & D process of enterprises' high-quality new products by improving production efficiency, constructing a differentiated competition pattern, and giving birth to knowledge spillovers. In the manufacturing industry, this kind of causal relationship is particularly prominent. This is because the manufacturing industry is not only the key focus area of environmental regulation policies, but also the core position of Green-Technology-Innovation practice, and at the same time it is also the key engine for creating high-quality products.

Combined with the theoretical explanations in the previous text, this study has constructed a set of hypothetical theoretical frameworks.

The optimized environmental management and supervision system has a significant promoting effect on accelerating the cultivation process of NQPF in manufacturing enterprises.

## 3. Research Design

### 3.1 Sample Selection and Data Sources

This study takes A-share listed manufacturing enterprises in China from 2015 to 2022 as the initial sample. In the data cleaning process, we excluded companies under special treatment (ST or *ST) and dropped observations with missing key variables, and winsorized all variables at the 1% level in both tails. The main data sources are the Wind and CSMAR databases.

### 3.2 Variable Definition

(1)This study focuses primarily on the level of new-quality productive forces. By referring to the existing research paradigms of scholars such as Zhang et al.[4] and Song et al.[5], and combining with the availability of data, the evaluation dimensions and indicators are systematically integrated and optimized. Finally, an evaluation index system of NQPF at the enterprise level is constructed, and the specific

content is shown in Table 1. Next, the entropy method will be used to carry out quantitative evaluation on the core concept of "NQPF".

**Table 1. Evaluation Index System for Enterprise New Quality Productive Forces**

| | | | |
|---|---|---|---|
| New Quality Labor Force | Employee quality | R&D personnel ratio | (Number of R&D personnel / Total number of employees) × 100 |
| | | HighEdu_Ratio | (Number of personnel with master's degree or above / Total number of employees) × 100 |
| | Management quality | Executives' green cognition | In(Frequency of green development keywords in annual reports+1) |
| | | Mgmt_Overseas | Takes the value 1 if any executive has an overseas background, and 0 otherwise. |
| new quality objects of labor | Ecological environment | EnvGov_Score | The E indicator of the Huazheng ESG rating, with 9 levels assigned values from 1 to 9 respectively. |
| | Future development | FixedAssets_Ratio | (Fixed assets / Total assets)x100 |
| | | CapAccum_Rate | (Increase in owners' equity for the year / Owners' equity at the beginning of the year)x100 |
| New Quality Means of Labor | Technological means of labor | Innov_Level | In(Number of granted patents+1) |
| | Digital means of labor | Dig_Degree | In(Frequency of digitalization keywords in annual reports+1) |
| | | Intangible_Ratio | (Intangible assets / Total assets)x100 |
| | Green means of labor | GreenTech_Level | In(Number of granted green patents+1) |
| | | GreenPatent_Ratio | (Number of granted green patents / Number of granted patents)x100 |

(2) In the theoretical framework of this research, the core explanatory variable is environmental regulation. The intensity of environmental information disclosure is employed as the key metric to gauge how enterprises behaviorally react to the pressure of external environmental regulation. Facing the increasingly strict external regulatory environment, enterprises usually shift their strategic focus to green transformation and GT to enhance their adaptability to complex external requirements. According to Article 19 of the "Measures for the Administration of Legally Disclosed Enterprise Environmental Information" promulgated by the Ministry of Ecology and Environment, the content of enterprise environmental information disclosure needs to be evaluated from two dimensions: non-monetary quality indicators and monetary quantity indicators. The quality indicators mainly focus on the textual expressions of enterprises' subjective intentions in green development or environmental protection plans, while the quantity indicators focus on quantifying the specific scale of enterprises' emission reduction and carbon reduction actions or the actual economic benefits generated by green practices and environmental measures. This study draws on the analytical framework of Zhang et al. [6] to construct a multi-dimensional evaluation system. The framework encompasses seven core dimensions—including environmental management, supervision and certification, and performance governance—and gauges enterprises' overall performance via 27 specific indicators. The final comprehensive evaluation score is obtained by the arithmetic average of the scores of each indicator. For the specific evaluation process, please refer to Table 2.

**Table 2. Variable Definitions**

| | | | |
|---|---|---|---|
| explained variable | New quality productive forces | NewPro | The comprehensive index calculated using the entropy method based on the evaluation index system in Table 1. |
| Independent variable | Environmental regulation intensity | ER | A dummy variable that takes the value of 1 if the listed company discloses environmental information in its annual report, corporate social responsibility report, or a separate environmental report for the current year, and 0 otherwise. |
| Mediating variable | Green technology innovation | GT | =Ln(Number of independently filed green invention patents in the current year + Number of independently filed green utility model patents in the current year+1) |
| Control variables | Firm size | Size | Natural logarithm of the firm's total assets at the end of the year. |
| | Firm age | Age | Firm age, measured as the natural logarithm of (observation year – year of establishment + 1). |
| | Leverage ratio | Lev | Total liabilities divided by total assets at the end of the year. |
| | Return on assets | ROA | Net profit divided by total assets at the end of the year. |

| | | | |
|---|---|---|---|
| | Shareholding ratio of the largest shareholder | LargestHolderRate | The ratio of the number of shares held by the largest shareholder to total share capital. |
| | Duality separation rate | Separation Rate | The difference between the control rights and ownership rights of the ultimate controller in the listed company. |

(3) This study incorporates a set of control variables comprising firm size (Size), operating years (Age), financial leverage (Lev), profitability (ROA), the largest shareholder's ownership stake (LargestHolderRate), and the separation between ownership and control (SeparationRate), all of which are defined in Table 2.

(4) In the theoretical framework of this study, green technology innovation (GT) is defined as the core mediating variable. As revealed by the previous academic exploration of Qi et al. [7], the maturity of GT can be measured quantitatively by the number of green patents obtained by manufacturing enterprises. The specific detection process is shown in Table 2.

### 3.3 Variable Definition

In view of the previous theoretical deduction and preset framework, this study has established the following benchmark regression model.

$$NewPro_{it}=\partial_0+\beta_1 ER_{it}+\Sigma\beta_k Controls_{it}+\mu_i+\lambda_t+\varepsilon_{it} \quad (1)$$

In the above model, $NewPro_{it}$ represents the level of NQPF of firm $i$ in year $t$, $ER_{it}$ represents the intensity of environmental regulation in the region where firm $i$ is located in year $t$; $Controls_{it}$ represents a set of control variables; $\mu_i$ denotes firm-specific fixed effects, used to control for time-invariant inherent characteristics of firms; $\lambda_t$ denotes time fixed effects, used to control for time trends such as macroeconomic environment; and $\varepsilon_{it}$ is the random error term.

## 4. Empirical Results Analysis

### 4.1 Descriptive Statistics

According to the statistical data in Table 3, the new quality productivity (NewPro) of manufacturing enterprises shows the following characteristics: The average value is 0.133 (SD = 0.072), with the distribution spanning 0.013 to 0.380. This distribution characteristic reveals that there are significant differences in the level of new quality productivity among sample enterprises, and the data has a relatively high degree of dispersion, providing a necessary empirical basis for the subsequent test of the impact effect of environmental regulation on enterprises' new quality productivity. The mean of environmental regulation intensity (ER) is 0.322, the distribution has a standard deviation of 0.292, a minimum of 0.037, and a maximum of 1. This study reveals that the implementation intensity of environmental regulation shows significant regional heterogeneity. The regulation intensity in some regions has exceeded the overall average level, which provides an analysis dimension for in-depth exploration of the differentiated influence mechanism under different regulation intensity situations. The arithmetic mean of the shareholding ratio of major shareholders of listed manufacturing enterprises in China is 31.53%, and the standard deviation is 13.70%. This statistical result reveals that the equity allocation shows a relatively concentrated characteristic. The average separation efficiency reaches 30.795%, and the highest efficiency can climb to 86.850%. This phenomenon reveals that some enterprises have the characteristic of significant separation of control right and ownership. The arithmetic mean of the scale of sample enterprises is 22, and the standard deviation is 1.182. This statistical characteristic shows that the scale distribution of sample enterprises has a certain degree of dispersion and difference. In conclusion, the mean, standard deviation, minimum value and maximum value of each variable are all in a reasonable interval, and no significant outliers are presented, indicating that the sample data has good distribution characteristics and can lay a solid foundation for the subsequent empirical research.

**Table 3. Descriptive Statistics**

| | | Age | LargestHolderRate | SeparationRate | Size | Lev | Roa | ER | NewPro |
|---|---|---|---|---|---|---|---|---|---|
| Observations | Valid | 9302 | 9302 | 9302 | 9302 | 9302 | 9302 | 9302 | 9302 |
| Mean | | 11.733 | 31.525 | 30.795 | 22.355 | 0.401 | 0.039 | 0.322 | 0.133 |
| Median | | 10.000 | 29.750 | 29.080 | 22.221 | 0.395 | 0.064 | 0.222 | 0.127 |
| Standard Deviation | | 6.963 | 13.698 | 15.488 | 1.182 | 0.186 | 0.539 | 0.292 | 0.072 |
| Variance | | 48.481 | 187.631 | 239.872 | 1.398 | 0.035 | 0.290 | 0.085 | 0.005 |
| Min | | 0.000 | 1.840 | 0.001 | 17.879 | 0.010 | -27.648 | 0.037 | 0.013 |
| Max | | 30.000 | 89.090 | 86.850 | 27.621 | 1.800 | 4.248 | 1.519 | 0.380 |

### 4.2 Regression Analysis

This study aims to explore the internal role paths and mechanisms through which environmental regulations affect the quality of new products in the manufacturing industry. The benchmark regression analysis is carried out through model (1), and the relevant results are presented in Table 4. Specifically, the fixed effects of the enterprise and time dimensions are included in the model in column (1), while column (2) further introduces the control variables at the enterprise level on this basis. The statistical analysis results show that in the first column of the model, the estimated coefficient of the environmental regulation intensity (ER) is 0.149, and its statistical significance level reaches the threshold of 5%. In the second regression specification, the estimated coefficient of environmental regulation (ER) rises to 0.151 and is statistically significant at the 5% level. The findings indicate that stricter environmental regulation is significantly and positively correlated with the level of new-quality productive forces in manufacturing enterprises. This result offers robust empirical support for Hypothesis H. Within the controlled regression framework presented in column (2), the coefficient on firm size is statistically significant and exhibits a positive influence. Enterprises with scale advantages often have inherent advantages in resource allocation, technological innovation, and green transformation processes, which have a positive promoting effect on optimizing organizational culture construction and improving the quality of new products.

**Table 4. Baseline Regression**

| | (1) | (2) |
|---|---|---|
| | NPRO | NPRO |
| ER | 0.149** | 0.151** |
| | (2.245) | (2.299) |
| ROA | | 0.161 |
| | | (0.190) |
| LEV | | -0.907 |
| | | (-1.493) |
| Size | | 0.4*** |
| | | (3.236) |
| SeparationRate | | 0.853 |
| | | (0.755) |
| LargestHolderRate | | 0.935 |
| | | (0.355) |
| Age | | 0.807 |
| | | (1.551) |
| cons | 0.171*** | 0.256*** |
| | (3.483) | (4.557) |

### 4.3 Robustness Tests

(1) Exclusion of abnormal years

During the observation period of this study, the sudden spread of the global COVID-19 pandemic in 2020 had a profound and multi-dimensional impact on the daily operations and long-term development paths of enterprises. As a key robustness check, the original data were systematically screened to exclude firm-year observations from 2020 to 2022, thereby eliminating the possible distortionary influence of this extraordinary year on the conclusions and ensuring the validity of the empirical analysis. Then, the regression analysis model was reconstructed and tested using the remaining effective data to ensure that the accuracy of the research conclusion was not affected by the data fluctuations in the abnormal period. The regression coefficient obtained from the regression analysis was 0.126, and under the test of the significance level $\alpha = 0.05$, this result reached statistical significance. This empirical result strongly supports the rationality of the original hypothesis H.

(2) Endogeneity test

In this study, referring to the methodology of Wang, Liu [8], this study confronts potential endogeneity by introducing an instrumental variable strategy. Specifically, the lagged measure of the explanatory variable—the intensity of environmental regulation in the prior period—is taken as the instrument, and the model is estimated using two-stage least squares (2SLS). In statistical testing, the selected instrumental variable shows a significant correlation with the explanatory variable to be estimated, and its significance level reaches the statistical significance threshold of 1%. The computed F-statistic, as confirmed by further testing, is well above the critical value of 10. This empirical evidence successfully avoids the estimation bias problem caused by the potential weak instrumental variable. In the second-stage estimation, the coefficient estimate for new product quality stands at 0.019 and achieves significance at the 1% level, thereby meeting the threshold for statistical reliability. Having effectively excluded internal interfering variables, the data reveal that an increase in environmental regulation stringency drives significant improvements in both new product

quality and enterprise productivity, and this result has passed formal robustness verification.

### 4.4 Mechanism Tests

Empirical evidence drawn from the regulatory effect model reveals that the environmental regulation system significantly drives—indeed "compels"—enterprises to cultivate new quality productivity. In order to deeply explore the internal transmission mechanism of environmental regulation affecting new quality productivity, this study will use models (1), (2), and (3) to focus on examining two core transmission paths: one dimension is the intensity of green R&D input, and the other is the effectiveness of transforming green innovation achievements into tangible results. In light of the initial benchmark regression analysis, this study intends to use the mediating effect test model to construct a set of economic analysis frameworks, and then systematically conduct empirical verification on the rationality of the core hypotheses.

$$M_{it}=a_0+a_1ER_{it}+\Sigma a_kControls_{it}+\mu_i+\lambda_t+\varepsilon_{it} \quad (2)$$

$$NewPro_{it}=\beta_0+\beta_1ER_{it}+\beta_2M_{it}+\sum\beta_kControls_{it}+\mu_i (3)$$

Using the chosen variables, regression specifications, and reference data as the foundation, this study quantifies enterprise green technology capability by computing the natural logarithm of (1 + annual green patent application counts).

Based on the empirical results in Table5, after controlling for the individual effects of enterprises, the time trend effects, and the enterprise heterogeneity characteristic variables, the coefficient on green technology development level is 0.568 and proves significant at the 1% level. Empirical evidence demonstrates that GT functions as a significant positive conduit through which environmental regulation fosters NQPF. This finding is consistent with the Porter hypothesis, which posits that environmental regulations can spur firms to pursue GT innovation, and subsequently, through channels like the optimization of production and operational processes, improving resource allocation efficiency, and enhancing green total factor productivity, it helps to breed and expand new outputs. The analysis reveals that ER carries a coefficient of 0.134 (significant at 1%), directly and positively affecting new-quality productivity. This reaffirms the benchmark model's conclusion regarding the direct effect of environmental regulation.

**Table 5. Baseline Regression**

| | (1) |
|---|---|
| | NPRO |
| GT | 0.568*** |
| | (1,161) |
| ER | 0,134*** |
| Controls<br>Individuals&Year | (6,929)<br>keep<br>keep |

### 4.5 Heterogeneity Analysis

The size of an enterprise demonstrates the effectiveness of resource integration, and is also related to the adaptability to environmental constraints and the courage of innovation investment. Generally speaking, larger enterprises have significant advantages in terms of capital reserves, structure optimization and risk resistance, which enables them to steadily promote the process of GT under strict environmental governance requirements. Small and medium-sized enterprises are generally trapped in a single financing channel and lack of resource accumulation, in the process of green economic transformation, the industrial structure is facing fundamental reshaping and challenges. In line with the approaches of Wang et al. [9] and Lyu et al. [10], the study segments the observations into large and small-to-medium-sized groups based on the median of total assets, and then carries out subgroup regression analyses. Within the large-enterprise group, as shown in Table 6, environmental regulation (ER) yields a coefficient of 0.331, which attains significance at the 1% statistical threshold. The coefficient value of environmental regulation (ER) for medium-sized and small-sized enterprises is 0.153, and this coefficient also passes the verification under the 1% statistical significance level, but its impact intensity is more limited than that of large enterprises. Large enterprises, with abundant capital reserves and excellent talent echelons, can accelerate the adaptive evolution of the production system, the financial support for green technology R & D should be significantly enhanced. With the transmission mechanism of economies of scale, promote the rapid and efficient transformation of green innovation achievements into commercial achievements with market value. In contrast, although small and med-sized enterprises show the characteristic of "passive response" under the pressure of environmental regulation, their inherent bottlenecks in financing channels, technical accumulation and talent reserve not

only restrict the in-depth expansion and wide extension of green transformation, but also weaken the positive enabling effect of environmental regulation on the cultivation of NQPF.

**Table 6. Heterogeneity Analysis**

| | (1) | (2) |
|---|---|---|
| | **Small firm size** | **Large firm size** |
| ER | 0.153*** | 0.331*** |
| | (0.422) | (0.374) |
| **Duality separation rate** | -0.2554** | -0.218* |
| | (0.802) | (0.095) |
| **LargestHolderRate** | 0.521 | 0.166 |
| | (0.971) | (0.104) |
| Age | -0.132*** | -0.138*** |
| | (0.172) | (0.188) |
| Lev | 0.918 | 0.061*** |
| | (0.619) | (0.008) |
| Roa | 0.208 | 0.021* |
| | (0.175) | (0.009) |
| cons | 0.110*** | 0.121*** |
| | (0.009) | (0.012) |

## 5. Research Conclusions

This research seeks to investigate the mechanism through which environmental regulation influences new product development in manufacturing firms. Select manufacturing listed enterprises that were listed and traded on the A-share market in the mainland of the China from 2015 to 2022 as the research samples, and carry out comprehensive and systematic empirical analysis and inspection work. The core research conclusions are as follows: Through systematic exploration and empirical analysis, the following key conclusions are drawn in this study: 1. [Specific finding one] 2. [Specific finding two] 3. [Specific finding three] these conclusions reveal the [core theme] and the [key law/mechanism] in the [related situation/field], and provide important basis for [practical application/ theoretical development].

The environmental governance policy system helps manufacturing enterprises to give birth to new types of productivity. The main regression estimates indicate that stricter environmental regulation is positively associated with the development of new-quality productivity at the firm level, and this conclusion remains stable after performing multiple robustness tests—such as excluding anomalous observations and employing instrumental variables to mitigate endogeneity bias. The empirical evidence confirms that the Porter Hypothesis holds well in the green transformation of the manufacturing sector. It also establishes a reliable basis for deploying environmental regulation as the key policy lever to nurture NQPF.

Under this context, green technological innovation represents the primary conduit for environmental regulation to fuel the leap in NQPF. Econometric research shows that environmental regulation promotes enterprises to increase the allocation of green R & D resources and optimize the strategy of obtaining green patents through the "force - back" mechanism, and then realizes the systematic transformation of the production paradigm and the revolutionary evolution of the quality state of productive forces. GT not only provides firms with clear innovation directions during the research and development phase but also enhances production efficiency and builds differentiated competitive advantages during the outcome transformation stage, thereby forming a virtuous cycle of "innovation–transformation–upgrading."

In the evolving process of fostering characteristic NQPF, the efficacy of environmental regulation demonstrates significant variation along the enterprise-size dimension. Large-scale groups, relying on their internal advantages in dimensions such as capital accumulation, gathering of top talents, and organizational operation efficiency, are usually better at transforming the external constraints imposed by environmental regulations into the driving force for internal green innovation, thereby exerting a more pivotal steering function in the leapfrog advancement of NQPF through distinct competitive advantages. Small and medium-sized enterprises also show an active adjustment trend when facing environmental regulations. However, their transformation results are not satisfactory, and they generally face restrictive bottlenecks in resource allocation in the process of moving towards green development.

In conclusion, based on the exploratory achievements and key findings in the early stage of this study, this paper specifically puts forward targeted policy guidelines and action initiatives.

Under the environmental governance framework driven by pressure, "mandatory technological leap" constitutes its core operation mechanism.

Taking the stimulation of innovation effectiveness as the engine, we can build a solid core driving force for the cultivation of NQPF. The internal logical system of this governance paradigm is: the external pressure exerted by environmental regulation will be directly transformed into the endogenous demand of enterprises for carrying out Green-Technology-Innovation, thus promoting the NQPF of the manufacturing industry to achieve a qualitative leap from the systemic level. To this end, administrative departments need to continuously improve the institutional framework for environmental governance, ensure that policy tools have stronger sustainability and predictability, under the clear policy guidance, it promotes enterprises to take the initiative to strengthen green technological innovation and optimize the efficiency of human resource allocation.

Second, it is necessary to unblock the key chains for the transformation of GT into NQPF, and build a closed-loop development ecology of "R & D - application - iteration". Empirical research shows that GT is the key link for environmental governance to empower the cultivation of NQPF. However, in the whole process of promoting GT from R & D investment to achievement transformation, it faces many practical bottlenecks such as high risk, long R & D cycle, and blockage of financing channels. In view of this, the government needs to strengthen financial support for GT, improve the fast examination and rights protection mechanism for green patents, and promote the demonstration application and large-scale promotion of green technology achievements in the manufacturing industry.

At the same time, it is urgent to fully activate the policy regulation efficiency in the diversified environmental governance system so as to guide small and medium-sized enterprises to realize green transformation. Academic research shows that under the policy framework of strengthening environmental governance, larger enterprises often demonstrate more remarkable achievements in green transformation. Nevertheless, impeded by their inherent resource constraints, SMEs often experience considerable difficulty in building the productive momentum required for new product innovation. Therefore, when formulating policies, full consideration should be given to the actual situations of different types of enterprises, and efforts should be made to avoid implementing a "one-size-fits-all" standardized governance model.

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