



# The Impact of Greening Transformation of Manufacturing Enterprises in Yangtze River Delta on the High-Quality Development of Regional Economy

Shiying Xu, Xueyue Miao\*

School of Chengdu University of Information Technology, Chengdu, China

xsy189@vip.163.com, \*miumxym@163.com

**Abstract.** Under the background of high-quality development, greening transformation is a necessary way for traditional manufacturing enterprises to achieve green development. This paper selects Shanghai and Shenzhen A-share listed manufacturing enterprises in the Yangtze River Delta Economic Zone from 2012 to 2022 as research samples. The results show that the green transformation of manufacturing enterprises in the Yangtze River Delta has a positive and significant impact on the high-quality development of the regional economy, and the positive impact is more obvious in state-owned manufacturing enterprises. The mechanism test shows that the green transformation of manufacturing enterprises in the Yangtze River Delta can promote the high-quality development of the regional economy through the optimization of resource allocation. The conclusions of this paper are useful for promoting the green transformation of manufacturing enterprises and promoting the high-quality development of the regional economy.

**Keywords:** green transformation, high-quality regional economic development, resource allocation.

## 1 Introduction

Since the 18th National Congress of the Communist Party of China (CPC), General Secretary Xi Jinping has attached great importance to the development of the manufacturing industry, stressing that the manufacturing industry is the foundation of the real economy. Under the constraints of the "double carbon" target, the high-quality development of manufacturing enterprises is related to the power transformation of the national economic growth mode.[1]

As Vinod Thoma (2001) points out, the quality of economic development can perfectly fill the possible deficiencies of the speed of economic development.[2] In order to more accurately measure the actual level of economic development, Mlachila et al. (2014) first constructed the QGI index to consider the degree of stability of China's economic growth.[3] Matsuhashi and Takase (2015) found that environmental regulations increased green process innovation in energy-intensive industries, leading to a

decline in carbon emissions.[4]Yuan Yijun and Chen Zhe (2019) empirically found that the transformation of manufacturing enterprises and green innovation present a U-shaped relationship, and that pollution-intensive manufacturing industries are able to realize the transformation to clean manufacturing development by upgrading the level of green technology innovation.[5]Wan Panbing et al. (2021) found that the green transformation of manufacturing enterprises can be realized through technological transformation, which improves the enterprise resource utilization rate and improves the enterprise energy structure.[6]

Based on the above literature, it is found that most of the studies on the impact and mechanism of greening transformation and lack the relationship between the two at the micro enterprise level. Therefore, this paper explores the impact of greening transformation on regional high-quality development from the micro perspective of manufacturing enterprises and in conjunction with macroeconomics.

## **2 Theoretical Analysis and Research Hypothesis**

### **2.1 Green Transformation of Manufacturing Enterprises and High-Quality Development of Regional Economy**

ZAMAN K et al. (2017) pioneered the use of autoregressive distributed lag model to empirically study the relationship between economies of scale, ecological environment and green logistics in European countries, and found that the growth of green logistics is inextricably linked to the healthy development of the regional economy.[7]Using panel data from 11 provinces and cities in the Yangtze River Economic Belt, Siqian Xie et al. (2022) found that the contribution of the resilient development of practitioners led by green logistics to the high-quality development of the economy of the Yangtze River Economic Belt has continued to increase.[8]

Based on the above analysis, hypothesis 1 is proposed: the greening transformation of manufacturing enterprises has a significant positive impact on the high-quality development of regional economy.

### **2.2 Resource Allocation, Greening Transformation of Manufacturing Enterprises and Regional High-Quality Development**

Adjusting and optimizing the way key strategic resources are allocated is an important way for enterprises to achieve sustainable development. Manufacturing enterprises need to continuously fuel their green transformation through advanced technology. Efficient resource allocation can enable resources to flow to the most valuable areas and projects, giving full play to the potential of resources.[9]It promotes the recycling of resources and sustainable development, and lays a solid foundation for the long-term development of the regional economy.

Based on the above analysis, hypothesis 2 is proposed: the green transformation of manufacturing enterprises promotes the high-quality development of the regional economy by optimizing resource allocation.

### 3 Research Design

#### 3.1 Sample Selection and Data Sources

The listed manufacturing enterprises in Shanghai and Shenzhen A-shares in the Yangtze River Delta Economic Zone from 2012 to 2022 are selected as the research sample, and the initial sample is screened as follows: (1) based on the manufacturing industry classification in the 2012 edition of the industry classification of the Securities and Exchange Commission (SEC), the manufacturing enterprises listed before 2012 in the Yangtze River Delta Economic Zone are screened out; (2) the enterprises with ST, \*ST are excluded; (3) the enterprises with serious missing data during the research period are excluded; and finally a total of 4,114 observations are obtained for 387 manufacturing enterprises in the Yangtze River Delta Economic Zone.

#### 3.2 Variable Selection

(1) Explained variable: high-quality development of regional economy. This paper draws on Min Wei and Shuhao Li. (2018)[10]The proposed methodology and indicator system for measuring the level of high-quality development of China's economy constructs a system of evaluation indicators for high-quality development of the economy from the five dimensions , as shown in Table 1.

**Table 1.** System of evaluation indicators for high-quality economic development

Primary index	Secondary index	Tertiary index	Attribute
Innovation	investment in science and education	funding for research and development activities/GDP	+
		Financial science and technology expenditures/financial expenditure	+
Coordination	patent level	patent applications	+
	financial development	balance of deposits in financial institutions/balance of loans to financial institutions	+
Greening	people's livelihood	per capita disposable income	+
	industrial structure	value added of tertiary industry/GDP	+
	contamination treatment	non-hazardous treatment rate of domestic waste	+
Opening	energy consumption	energy consumption per unit of GDP	-
		sulfur dioxide emissions	-
Sharing	status of foreign capital	number of foreign-owned enterprises	+
		total investment by foreign-invested enterprises	+
	foreign trade	total exports and imports	+
	financial situation	financial expenditure/financial revenue	+
	social welfare	medical expenditures/GDP	+
		education expenditure/GDP	+

Firstly, the data were standardized:

$$X_{ij} = \frac{x_{ij}-x_{min}}{x_{min_{max}}}, X_{ij} \text{ is positive indicator.}$$

$$X_{ij} = \frac{x_{max} - x_{ij}}{x_{max} - x_{min}}, X_{ij} \text{ is negative indicator.}$$

$i$  represents city,  $j$  represents evaluation indicators,  $x_{ij}$  is the data for the  $j$ -th indicator in city  $i$  before standardization,  $X_{ij}$  is the data for the  $j$ -th indicator in city  $i$  after standardization,  $x_{max}$  and  $x_{min}$  are the maximum and minimum values of the  $j$ -th indicator, respectively.

$$P_{ij} = \frac{X_{ij}}{\sum_{i=1}^n X_{ij}}$$

Calculate the weight of the  $j$ -th evaluation indicator for city  $i$  :

Calculate the information entropy value of the  $j$ -th indicator:

$$E_j = \frac{-1}{\ln(n)} \sum_{i=1}^n P_{ij} \ln P_{ij}$$

Derive the weight of the  $j$ -th evaluation indicator:

$$w_j = \frac{1-E_j}{\sum_{j=1}^k (1-E_j)} (j = 1, 2, 3, \dots, k)$$

Finally, an index of high-quality development of the regional economy is obtained:

$$Are_i = \sum_{j=1}^k w_j X_{ij}$$

(2)Explanatory variable: greening transition. This paper refers to this paper draws on the idea of Xiaofeng Quan[9]of using the ratio of green transformation outputs and transformation inputs to measure the efficiency of greening transformation.

(3)Mediating variable: resource allocation efficiency. In this paper, we refer to the ideas of CROSSLAND et al[11],Tian Li and Jiehao Zhang[12]to measure the adjustment of resource allocation and novel uniqueness, financial resources are expressed as the ratio of total assets to total liabilities.

(4)Control variables: The control variables used in the empirical model of this paper include: firm size; firm age; return on assets; firm growth; fixed asset turnover ;the governance perspective,as shown in Table 2.

**Table 2.** Variable Definition

Variable Type	Variable Name	Variable Symbol	Variable Measurement
Implicit Variable	high-quality development of the regional economy	Are	index of high-quality development of regional economies
Independent Variable	greening the transition	RD	$\text{Ln}(\text{number of green patent applications}+1)/\text{Ln}(\text{R\&D expenditures}+1)$
Intermediary Variable	resource allocation	Reop	resource allocation efficiency
	size of enterprise	Size	$\text{Ln}(\text{total assets})$
	age of enterprise	Age	observation time—year of establishment of the enterprise
Control Variables	return on assets	Roa	net profit/total assets
	enterprise growth	Growth	total asset growth rate
	fixed asset turnover	Fatr	revenues/average net fixed assets
	proportion of independent directors	Inddir	number of independent directors/number of board members

### 3.3 Model Construction

In order to study the impact of green transformation of manufacturing enterprises in the Yangtze River Delta Economic Zone on regional high-quality development, this paper constructs the following benchmark model for analysis:

$$Are_{i,t} = \alpha_0 + \alpha_1 RD_{i,t} + \alpha_n controls_{i,t} + \varepsilon_{i,t}$$

In the above equation:  $\alpha_0$  denotes the intercept term;  $controls_{i,t}$  denotes the control variables;  $\beta_n$  denotes the estimated coefficients for each factor;  $i$  denotes the firm;  $t$  denotes the year; and  $\varepsilon$  denotes the random error term.

## 4 Empirical Results and Analysis

### 4.1 Descriptive Statistics

Table 3 below shows the descriptive statistics of the main variables selected in this paper. The maximum value is 0.872, and the minimum value is only 0.046, indicating that there is still a large gap in the high-quality development of different regions in the

Yangtze River Delta. Overall, the mean value of the return on assets of the sample firms is within the normal range, but there are still extreme cases.

**Table 3.** Results of descriptive statistics

Variable	Mean	p50	SD	Min	Max
Are	0.440	0.447	0.191	0.046	0.872
RD	0.055	0.038	0.063	0.000	0.226
Roa	22.300	22.200	1.098	20.180	25.800
Age	19.550	19.000	5.524	8.000	35.000
Size	5.423	4.945	6.215	-16.430	23.710
Growth	10.910	7.126	19.730	-26.250	105.600
Fatr	4.019	2.971	3.480	0.588	20.800
Inddir	38.070	37.500	9.118	20.000	60.000

## 4.2 Benchmark Regression Results

This section begins with a regression analysis of model (1), the impact of green transformation of manufacturing firms on high-quality development in the Yangtze River Delta Economic Zone. As shown in Table 4 below, all of the above regression results are positively significant at the 0.01 level, indicating that the greening transformation of manufacturing enterprises has a significant positive impact on the high-quality development of the Yangtze River Delta Economic Zone, and Hypothesis 1 is valid.

**Table 4.** Benchmark regression results

	Are	Are	Are	Are
RD	0.968*** (0.044)	0.172*** (0.022)	0.06725*** (3.485)	0.06029*** (3.077)
Age		0.033*** (0.000)		-0.00508** (-2.225)
Size		0.013*** (0.002)		0.00418* (1.924)
Roa		0.001*** (0.000)		0.00050*** (2.767)
Growth		-0.000 (0.000)		-0.00003 (-0.623)
Fatr		-0.002*** (0.001)		-0.00025 (-0.543)
Inddir		-0.000 (0.000)		-0.00004 (-0.362)
Constant	0.386*** (0.003)	-0.489*** (0.051)	0.25261*** (97.826)	0.23593*** (4.071)
Observations	4,114	4,114	4,114	4,114
R-squared	0.020	0.793	0.857	0.857
ID	YES	YES	YES	YES
YEAR	NO	NO	YES	YES

### 4.3 Robustness Check

#### Adjustment of the Sample Period.

The concept of high-quality development was first proposed at the 19th National Congress of the Communist Party of China (CPC) in October 2017. Therefore, this paper adjusts the sample period to 2018-2022 for regression. After testing, the model still holds.

#### Explanatory Variables Lagged Two Periods.

Considering the long construction period of some listed companies' investment projects, this part substitutes the explanatory variable digital transformation lagged two periods into the regression model. The regression results show that the model is significant after two periods of lagging.

## 5 Heterogeneity Analysis

Since intervening in the strategic decisions of state-owned enterprises is an important way for the government to promote the national strategic plan, this paper expects that the greening transformation of state-owned enterprises will have a greater positive impact on the high-quality development. As shown in Table 5 below, The regression coefficient of the state-owned enterprise sample is larger than that of non-state-owned enterprises, which indicates that the expectation of this paper is valid, i.e., the positive impact of greening transformation of state-owned enterprises on the high-quality development of the Yangtze River Delta Economic Zone is larger than that of non-state-owned enterprises.

**Table 5.** Heterogeneity in the nature of shareholdings

	Are	Are	Are
RD	0.06029*** (3.077)	0.10923** (2.349)	0.04170** (2.039)
Size	0.00418* (1.924)	0.01073* (1.693)	0.00038 (0.172)
Age	-0.00508** (-2.225)	-0.02404** (-2.298)	-0.00266 (-1.271)
Roa	0.00050*** (2.767)	0.00076 (1.542)	0.00033* (1.814)
Growth	-0.00003 (-0.623)	-0.00000 (-0.012)	-0.00001 (-0.179)
Fatr	-0.00025 (-0.543)	0.00143 (1.303)	-0.00073 (-1.510)
Inddir	-0.00004 (-0.362)	-0.00054 (-1.588)	0.00009 (0.747)
Constant	0.40398*** (6.797)	0.17834 (0.837)	0.44042*** (7.684)
Observations	4,114	1,035	3,072
R-squared	0.944	0.922	0.955
ID	YES	YES	YES
YEAR	YES	YES	YES

## 6 Mechanism Analysis

By greening their transformation and adopting environmentally friendly technologies and management methods, manufacturing enterprises can make better use of resources, reduce waste and improve productivity. Therefore, this paper takes resource allocation (Reop) as the mediating variable, and its regression results are shown in Table 6. Column (1) of Table 6 shows that the regression results are significantly positive at the 0.01 level, columns (2) and (3) report the test results of the mediating effect of resource allocation, and the regression results are significantly positive, indicating that the greening transformation of manufacturing enterprises can promote the high-quality development of the regional economy through the optimization of resource allocation.

**Table 6.** Greening transition, resource allocation and high-quality development

	(1) Arc	(2) Reop	(3) Arc
RD	0.06029*** (3.077)	0.96002** (2.111)	0.05837*** (2.980)
Reop			0.00200*** (2.825)
Age	-0.00508** (-2.225)	0.07863 (1.484)	-0.00524** (-2.296)
Size	0.00418* (1.924)	0.07588 (1.505)	0.00403* (1.855)
Roa	0.00050*** (2.767)	-0.00414 (-0.996)	0.00050*** (2.816)
Growth	-0.00003 (-0.623)	0.00135 (1.282)	-0.00003 (-0.683)
Fatr	-0.00025 (-0.543)	0.01987* (1.854)	-0.00029 (-0.629)
Inddir	-0.00004 (-0.362)	0.00191 (0.668)	-0.00005 (-0.393)
Constant	0.23593*** (4.071)	-2.98204** (-2.217)	0.24188*** (4.175)
Observations	4,114	4,114	4,114
R-squared	0.857	0.006	0.858
ID	YES	YES	YES
YEAR	YES	YES	YES

## 7 Conclusions

This paper selects Shanghai and Shenzhen A-share listed manufacturing enterprises in the Yangtze River Delta Economic Zone from 2012 to 2022 as a research sample, and uses linear regression models to explore the impact of greening transformation of manufacturing enterprises on the high-quality development of the regional economy. First,



the greening transformation of manufacturing enterprises has a significant positive impact on the high-quality development of regional economy. Second, the results of heterogeneity analysis show that there is property rights heterogeneity in manufacturing enterprises' influence on regional economic high-quality development through greening transformation, and the greening transformation of state-owned enterprises has a more significant role in promoting regional economic high-quality development. Finally, the mechanism analysis concludes that the greening transformation of manufacturing enterprises can promote the high-quality development of regional economy by improving the efficiency of resource allocation.

For the Yangtze River Delta Economic Zone to better respond to the call of the central government and realize the high-quality development of the regional economy, the green transformation of manufacturing enterprises is crucial. Accordingly, this paper has the following two insights: First, manufacturing enterprises need to actively promote green transformation. Through green transformation, enterprises can develop more green technology and green products, and promote the development of enterprises in an environmentally friendly and sustainable direction. This not only reduces the adverse impact on the environment, but also improves the efficiency of resource allocation and realizes the synergistic development of economic growth and environmental protection. Second, the government needs to actively play a guiding role. Especially for non-state-owned enterprises, the government can formulate relevant policies and regulations and provide incentives to guide enterprises to actively carry out green transformation.

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