A study on the Impact of Environmental Regulations on the Quality of Exported Products in China's Manufacturing Industry

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Abstract: The proportion of export commerce in China's manufacturing has grown substantially in past decades. The strategy model of "low quality, low price, high pollution, high consumption, and high emissions" has led to severe environmental problems in China, resulting in a "big but not strong" trade problem for the manufacturing industry. In this study, environmental regulations' effects on the quality of exported goods in 30 Chinese provinces between 2006 and 2020 are examined. Additionally, the paper further investigates whether there is threshold effect in environmental regulations. As shown in the findings, environmental regulations have a substantial effect on the exported products' quality. Moreover, the effect of environmental restrictions on the exported products quality in China's manufacturing industry varies depending on the level of environmental regulation. Environmental regulations have a greater encouraging influence on the quality of exports at a lower level. This research is essential for the revolution and modernising of manufacturing in China and the encouragement of environmentally friendly economic development.

Keywords: Environmental regulation; manufacturing industry; Export product quality; Threshold effect

1 Introduction

China has emerged as the world's largest exporter in recent years as a result of its growing engagement in commerce around the world. In the new global division of labor system, China, with its abundant labor and energy resources advantages, continues to integrate into the Global Value Chain (GVC) as a "world factory". Nonetheless, the manufacturing industry keeps getting involved in international division of labor through low-value-added processing trade, resulting in a lower status in the global value chain, which is also one important feature of China's manufacturing industry. It is urgent to shift from "Made in China" to "Created in China" and change the current situation of high investment, high pollution, low quality and cheap exports.

The definition of "regulation" in the academic community is currently uncertain, but regulation usually refers to the use of legal or institutional tools to achieve economic and social policy goals [1]. With the emergence of environmental pollution problems, environmental regulation (ER) has gradually been incorporated into the research scope of regulatory economics. Currently, scholars' research on environmental regulations and export product quality (EPQ) mainly focuses on three aspects. Firstly, environmental regulations motivate betterment of export

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merchandise quality. Yang et al. (2022) evaluated a diversity of environmental regulation's effect on the export technology structure of fluctuating technological levels[2]. Secondly, environmental regulations have an adverse impact on the quality of exported products. The 'Pollution Paradise Hypothesis' maintains that resource-intensive production processes are shifting from economies with stricter environmental rules to those with fewer restrictions to mitigate costs and expand profit margins [[3]. Thirdly, the impact of environmental regulations on the quality of exported products exhibits a non-linear relationship[4]. Using the Porter hypothesis, Liu & Xie (2020) examined how stricter environmental regulations have affected China's industrial sector's ability to export goods[5]. According to the findings, environmental regulation has beneficial effects on the export competitiveness of China's manufacturing sector. But this impact is non-linear and embraces a "U-shaped" tendency.

Research on the implications of environmental regulation on export products quality has moved forward significantly. However, differences in measurement methods, research perspectives and model selection have led to widely varying findings, coupled with few studies exploring the impact of the degree of environmental regulation on product quality[6]. In recent years, China's environmental regulation system has been gradually improved, not only effectively improving environmental quality, but also raising the level of production processes of enterprises. So, what effect does environmental regulation have? More importantly, what is the impact of different levels of environmental regulation on manufacturing products? This is a question worth exploring.

Since environmental protection is gaining more of a priority, and that the quality of products is growing increasingly significant, the intention of this study is to assess the implications that environmental regulations have on manufactured export products quality adopting a fixed effects model for 30 Chinese provinces from 2006 to 2020. This study helps to promote the high-quality transformation of manufacturing industry in China, promote sustainable economic development and thus enhance the international competitiveness of products.

2 Methodology and research design

2.1 Empirical moder

Based on the foregoing investigation, a subsequent benchmark regression model was came about:

$$\mathrm{EPQ}_{it} = \beta_0 + \beta_1 \mathrm{ER}_{\mathrm{i,t}} + \beta_2 \mathrm{Controls} \delta_{\mathrm{i}} + \theta_{\mathrm{i}} + \varepsilon_{\mathrm{i,t}} \quad (1)$$

Where EPQ_{it} is the explanatory variable, which is calculated based on the product consumption demand function. Environmental regulation ($\mathrm{ER}_{\mathrm{i,t}}$) is the core explanatory variable. Completed investments in industrial pollution control as a percentage of the secondary industry's value added are used for determining $\mathrm{ER}_{\mathrm{i,t}}$. Control variables are economic development level (GDP); degree of openness to the outside world (Open); foreign direct investment (FDI); number of people employed (HR); and transport infrastructure (Tra). And δ_{i}symbolises the fixed effects of province i that do not shift over time, then θ_{i} controls for time fixed effects, $\varepsilon_{\mathrm{i,t}}$ denoting the random disturbance term.

2.2 Data Description

Before empirical testing can be carried out, descriptive statistics need to be performed on the data for each variable. This is to get a general idea of the distribution of the data and to identify if there are any outliers. In this paper, the data was processed using the data processing software Stata 17.0 and the means of each variable were greater than the standard deviation, allowing for the next step of the empirical test (Table 1).

Table 1. Descriptive statistics

Variables	Obs.	Mean	SD.	Min	Max
EPQ	425	0.598	0.060	0.398	0.850
ER	425	0.347	0.299	0.004	2.451
LnpGDP	425	10.567	0.615	8.657	12.065
LnOpen	425	0.237	0.223	0.006	0.998
LnFDI	425	13.428	1.591	7.990	16.705
LnHR	425	12.084	1.246	7.224	16.711
LnInfra	425	0.600	0.266	0.064	1.165

3 Empirical results

3.1 Baseline regression result

Table 2 shows, in column 1, the direct influence of ER intensity on exported goods quality. At the 5% level of significance, the estimated coefficient of ER is positive, reflecting that such regulations benefit in enhancing the EPQ. Looking at the results for the other control variables, it was found that the estimated coefficient of GNP per capita was negative but passed the 1% significance test, which was not in line with the expected results, probably because the higher level of economic development in areas with stringent ER and HR is not suitable for the long-term development of manufacturing firms based on long-term benefits[7]. The estimated coefficient of Open to the outside world is significantly positive, and firms in open regions have more opportunities to touch and absorb advanced experience and technology from other countries or regions, which helps to improve the EPQ [7]. At the 1% level of significance, the calculated coefficient of FDI is positive, showing that the influx of foreign capital will result in the introduction of cutting-edge technology and expertise, ultimately leading to an increase in EPQ. The estimated coefficient of HRis positive but insignificant. This suggests that the number of people employed in manufacturing has little effect on EPQ and that it may be skilled and highly skilled employees that influence EPQ . The estimated coefficient for transport infrastructure is positive at the 1% level of significance, with good transport infrastructure implying ease of transport and attracting high quality manufacturing firms to locate.

Table 2. Baseline regression result

Variables	(1)
	EPQ
ER	0.0172**
	(2.08)
LnpGDP	0.0468***
	(-2.88)
LnOpen	0.1171***
	(3.55)
LnFDI	0.0134***
	(3.60)
LnHR	0.0013
	(0.17)
LnInfra	0.1954***
	(3.30)
Constant	0.6375***
	(4.42)
Province FE	YES
Year FE	YES
Observations	425
R^2	0.403

3.2 Analysis of threshold effects

The benchmark regression results indicate thatER have a positive correlation with the EPQ. To verify the existence of relevant threshold values, single, double, and triple threshold tests were conducted using ER as the threshold variable. The main statistical method was based on the "bootstrap" method, in which the correlation statistic with specified confidence deviations was obtained by repeated sampling 300 times with Stata to obtain the results of the threshold effect test [9]. Further, to avoid chance estimation bias due to subjective assumptions, it was necessary to verify that there were no significant differences in the parameters of the sample groups across the threshold intervals. Table 3 reveals that there are no double- or triple-threshold features in the association between ER and the EPQ.

Table 3. Threshold effect test results

Variable	Threshold numbers	F-value	P-value	Threshold	95% confidence interval
	Single	17.31	0.0300**	0.746	

Environment regulations (ER)	Double	4.22	0.7900	(0.2999, 0.8735)
	Triple	5.82	0.5933	

Table 4. Panel threshold model estimation results

Variable: Environment regulations (ER)	
Explanatory variable	Coefficient
ER·1(ER≤ 0.746)	0.5867
ER·1(ER≤ 0.746)	0.0074

The estimation results for the single threshold model are shown in Table 4. They show that the impact coefficient of EPQis greater than zero at the 5% level, confirming that ERcan improve the EPQ. However, under different levels of environmental regulation, the impact of ER on EPQ varies. There is a threshold value of 0.746. When ER is at a lower level (ER ≤ 0.746), the impact coefficient of EPQ is 0.5867. When ER water reaches a higher level (ER>0.746), the impact coefficient of EPQ is 0.0074, indicating that ER has a more significant promoting effect on EPQ at a lower level. This is because ER can put pressure on businesses to allocate more in R& D and new technological to cut down on environmental costs, make exported products more technically complex, and strengthen the quality of those stuff.

3.3 Robustness Test

In order to assure the robustness of the empirical findings and eliminate the problem of heteroskedasticity caused by outliers in the variable data, referring to the effort of Shang et al (2023)[10], the estimated coefficients of ER were all significantly positive, in line with the results of the baseline regression, by applying 1% bilateral tailing to the core explanatory variables, the explanatory variables and the control variables respectively (Table 5), indicating that the estimated coefficients of ER on EPQ. The estimated coefficients of ER are strongly positive, which is in line with the results of the benchmark regression. This reveals that ER have a substantial impact on EPQ. In addition, the values of the estimated coefficients are significantly higher after tailoring compared to the baseline regression, implying that the promotion effect of ER on EPQ has increased after removing the outliers.

Table 5. Robustness analysis results

Variables	(1)	(7)
	EPQ_sw	*EPQ_sw*
ER_sw	0.0186*	0.0213**
	(1.82)	(2.18)
LnpGDP_sw		-0.0316**
		(-1.99)
LnOpen_sw		0.1063***
		(3.27)

LnFDI_sw		0.0115***
		(2.73)
LnHR_sw		0.0036
		(0.49)
LnInfra_sw		0.1868***
		(3.26)
Constant	0.5172***	0.5201***
	(61.23)	(3.61)
Province FE	YES	YES
Year FE	YES	YES
Observations	425	425
R^2	0.362	0.417

Notes:*** $p < 0.01$,** $p < 0.05$,* $p < 0.1$; t − statistics in brackets

4 Conclusions and policy implications

This research uses panel data to examine how environmental regulations affect the exported goods quality, and it employs a threshold effect model to look at how the level of environmental regulations affects product quality. The key results are:

First, the environmental regulations effectively promote the upgrading of export product quality. The basic regression results indicate that the relationship between the promotion of environmental regulation on the quality of Chinese manufacturing export products is smooth without the control variables and after the inclusion of them.

Second, the threshold effect test highlights that there is a promotion effect of environmental regulation intensity on inter-provincial export product quality and there is a threshold value, and the promotion effect will be weakened when environmental regulation crosses this value.

Thirdly, robustness tests show that the promotion relationship between the two is robust. To eliminate the effect of data outliers on the results, 1% bilateral tailing is applied to the data for all variables in this research. The association between environmental regulation promotion and export product quality are found to remain robust.

This study proposes several policy suggestions grounded in the theoretical and empirical findings: the first step is to increase the stringency of environmental regulations to promote trade transformation and upgrading. This is due to the fact that environmental regulations have an overall facilitating influence on the quality of export products. Secondly, enhance the independent research and development capabilities of enterprises and transform the path of technological innovation. Thirdly, the benchmark regression results displays that the education level of workers has little impact on the quality of exported products in the manufacturing industry. Therefore, the government should protect the rights and interests of workers at the legal system level, such as requiring enterprises to establish a reasonable employee salary system and truly leverage the power of trade unions.

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