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Environmental regulation, green innovation, and export product quality: What is the role of greenwashing?

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ABSTRACT

To facilitate sustainable growth, green innovation, and industrial upgrading, it is important to explore the relationship between environmental regulations and firm performance. Green innovation is increasingly being recognized as an important determinant of the quality of export products, which plays a critical role in international business and finance. Therefore, this paper empirically examines the impact of green innovation on export product quality at the firm level using relevant data from Chinese exporters. First, we identify a positive relationship between green innovation and export product quality. Second, environmental regulations are observed to have a negative effect on green innovation for highly-polluting firms but do not significantly impact those with lower levels of pollution. Third, our research reveals that the negative effects only exist in those highly-polluting firms that exhibit greenwashing behavior, with financial constraints strengthening these impacts. Therefore, this study reveals that the greenwashing suppression effect curbs the efficiency of environmental regulations on green innovation.

1. Introduction

Export promotion is known to play a major role in driving advancements in infrastructure and the sustainable growth of a country (Calderon & Servén, 2004; Ismail & Mahyideen, 2015; Xing, 2018; Zhang, 2022a). Improvements in product quality are dependent on increasing an organization's efficiency by coordinating its activities, which relate to several dimensions of firm performance (Benner & Tushman, 2002). The existing literature has paid precise attention to the relationships between product quality and its determinants, including customer satisfaction (e.g., Singh, 2008), operational performance (e.g., Lo, Yeung, et al., 2009), financial performance (e.g., Kaynak & Hartley, 2005), and innovation (e.g., Pekovic & Galia, 2009). China has been actively participating in global value chains by taking advantage of low-cost labor and complete industrial system since the open-door policy; however, this growth mode has caused major pollution and led to several environmental problems (Zhang & Jin, 2021). As a result, the implementation of a series of environmental regulations with pollution reduction targets has been assessed regularly, with the assessment results impacting promotions. Currently, research in the field focuses on whether China's new environmental regulation policies are consistent with export-oriented growth strategies, particularly whether environmental regulations have adverse impacts on economic growth. The existing studies focus primarily on the relationship between environmental regulations and export in China (Hering & Poncet, 2014; Shi & Xu, 2018).

It is worth exploring how environmental regulations affect export product quality in Chinese export firms and what the potential proxies may be. This is because the traditional growth pattern is characterized by high energy consumption and pollution emissions; thus, pollution control is a key dimension of sustainable and high-quality growth. However, the implementation of environmental regulations has several associated costs. There is an urgent need to investigate how the firms afford these additional costs and how potential "greenwashing" behaviors may affect the product quality and development targets. Moreover, there are several concerns regarding green innovation-oriented environmental protection and its contribution to high-quality development. Therefore, this paper attempts to answer the above research questions through the construction of a dataset that includes firm-level product quality, basic characteristics, and environmental regulation. To identify the relationship between environmental regulations and firm product quality, we construct a unique database by merging the fundamental firm-level variables from CSMAR and firm-level product quality data obtained from Chinese Customs. In addition, the greenwashing

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mechanism uses ESG disclosures obtained from the Bloomberg ESG Database. ESG performance data is obtained from the Thomson Reuters database. Finally, the firm-level unbalanced database is obtained for the years 2013–2015.

Our econometric estimations have provided several empirical results. First, the fundamental results suggest that green innovation measured by green patents is significantly associated with export product quality. Second, we found that environmental regulations significantly restricted green innovation in general. However, when focusing on highly-polluting and low-polluting industries, we observed that this effect was significant only in firms belonging to highly-polluting industries. Third, in the presence of negative restriction effects, greenwashing mechanisms were stronger in highly-polluting firms. Furthermore, we found that highly-polluting firms that were experiencing a high level of financial constraints tried to greenwash, and consequently, the quality of the export product suffered.

This paper contributes to three aspects of the related literature. First, we used highly disaggregated product-level trade transaction data to calculate export product quality and investigate how product quality is motivated by environmental regulations (Elrod & Malik, 2017; Porter & Van der Linde, 1995; Stavropoulos, Wall, et al., 2018). This analysis revealed that environmental regulation curbs green innovation, resulting in decreasing export product quality; these findings extend the existing literature because we specifically examined the green innovation channels through which the environmental regulations impact export product quality. Second, we constructed a framework and calculated an indicator to measure greenwashing to identify the mechanism of the negative relationship between environmental regulations and green innovation for highly-polluting firms. Heavily-polluting firms that are significantly affected by environmental regulations tend to decrease the export product quality; however, this is not the case for low-polluting firms. These findings contribute to the development of a better understanding of the differing impacts of environmental regulation on export product quality among firms (Bernard, Redding, et al., 2010; Shi & Xu, 2018). Third, we identify the incentives that motivate highly-polluting firms to greenwash and explain why such firms decrease the quality of their export products. We show that greenwashing induces heavily-polluting firms to decrease the level of innovation in green innovation projects, thus causing a decline in export product quality. Therefore, our empirical results enrich the existing literature that discusses the ways in which environmental regulations hurt firm performance through constraining the credit issue (Manova, 2013; Minetti, Murro, et al., 2019; Minetti & Zhu, 2011).

Although a few studies have explored the relationship between environmental regulation and firm performance (Filipescu, Prashantham, et al., 2013; Golovko & Valentini, 2011; Lachenmaier & Wößmann, 2006; Zhang, 2022a), a limited number of studies have addressed the link between environmental regulation and export product quality. The motivations for the firms' behavior in such scenarios and the effects are not well studied. Therefore, this paper tries to investigate the link between environmental regulation and firm export product quality by uncovering the greenwashing mechanisms. In doing so, this paper attempts to better understand the effects of firms' environmental communication decision making, strategies and potentially misleading disclosures. In this paper, we describe the dataset that we constructed for this purpose and introduce the empirical methodology used.

2. Literature review

2.1. Export product quality and innovation

The debate regarding the direction of causality between export products and innovation appears in the extant literature (e.g. Cassiman & Golovko, 2011; Filipescu et al., 2013; Golovko & Valentini, 2011; Lachenmaier & Wößmann, 2006; Monreal-Pérez, Aragón-Sánchez, & Sánchez-Marín, 2012; Zhang, 2022a).

Based on the Schumpeterian novel theory of creative destruction, product innovation is widely agreed to play a pivotal role in firm productivity and economic growth. In particular, small and medium-sized enterprises (SMEs) can gain a competitive advantage by introducing advanced and upgraded products with novel and technological features that meet the market's demands. Furthermore, firms might successfully enter new foreign markets as well as increase shares in existing markets through product upgradation and differentiation in both horizontal and vertical dimensions (Becker & Egger, 2013; Rehman & Noman, 2022). Branstetter, Fisman, et al. (2011) theoretically demonstrate how the technological activities of local firms could develop and contribute to reforming the economy after patent revisions. Their empirical findings suggest that sales, employment, physical investment, and R&D are increasing, along with an expansion in the variety of export products. In addition, a significant increase in the export of high-technology products after patent reforms has also been observed in emerging economies (Maskus & Yang, 2018).

Previous studies have also analyzed the potential mechanisms that can help explain the relationship between export products and innovation. The major benefits of innovation oriented towards export behaviors are the development of differentiated products, improvements in product quality, decreasing costs, and the correction of internal systems to respond to technological changes and external uncertainty. This provides a competitive advantage and an increase in market share, and facilitates entry into and expansion of export markets (Azar & Ciabuschi, 2017; Cassiman, Golovko, et al., 2010; Damijan, Kostevc, et al., 2010; Filipescu et al., 2013; Golovko & Valentini, 2011). Several prior studies are conducted in developed economies and illustrate that innovation has a significant effect on product export performance and not vice versa (Nassimbeni, 2001). Research has also shown that innovation significantly contributes to firm exports directly through the provision of improved or new products and services, and indirectly through the allocation of firms' existing resources and capabilities (Love & Roper, 2015). Several studies also suggest that technological innovation facilitates the export activities of firms because product and process innovations are related to the development or application of new technologies (Becker & Egger, 2013; Radicic & Djalilov, 2019). This effect has been observed to be greater in SMEs; those that invest in technological innovation perform better in the export markets (Radicic & Djalilov, 2019).

2.2. Environmental regulation, green innovation, and export product quality

Since the establishment of the Porter hypothesis, dynamic innovation has been introduced into the analytical framework for providing firms with a competitive advantage. Consequently, previous studies have explored the "innovation compensation" and "first-mover advantage" effects induced by environmental regulations (Zhang, 2021; Zhang & Kong, 2021, 2022). These regulations force the firms to improve green innovation through their operational mechanisms and institutional guarantees (Arfaoui, 2018; Zweimüller & Brunner, 2005). As a result, firms are forced to carry out technological innovation projects to minimize their costs under the condition that their pollution discharges are restricted (Hamamoto, 2006). In addition, they might encourage firms to incorporate related environmental protection policies into their development guides, allowing them to strengthen environmental protection through market signals and provide motivation to work towards green innovation (Zhang, 2022a, 2022b). Recent empirical tests have confirmed that environmental regulation plays a positive role in firms' technological advancement (Wang & Shao, 2019). The main reason for this is that the increasing environmental pollution costs might add additional competitive pressure and induce firms to expand their investment in innovation, which has a significant "compensation effect" on sustainable growth and export sophistication (Jaffe & Palmer, 1997;

Zhang, Wang, et al., 2018). Empirical studies have confirmed that stringent environmental regulations play a vital role in export growth with respect to energy innovations (Costantini & Crespi, 2008) and export expansion (Costantini & Mazzanti, 2012; Martín-Tapia, Aragón-Correa, et al., 2010; Rubashkina, Galeotti, et al., 2015).

In contrast, a series of theoretical studies suggest that environmental regulations may restrict export sophistication by inhibiting firms' technological innovation behaviors (Barbieri, Ghisetti, et al., 2016; Borghesi, Cainelli, et al., 2015). The main explanation for this is that environmental regulations might bring firms additional pollution control costs, which may cause a decline in their innovation investment (Zhang & Du, 2020). This would result in an obvious "offset impact" on technological innovation (Barbieri et al., 2016; Borghesi et al., 2015). Several empirical studies suggest that environmental regulation hurts the export competitiveness of Organization for Economic Co-operation and Development (OECD) countries (Hwang & Kim, 2017) and that stringent environmental regulation makes firms less likely to export (Hering & Poncet, 2014; Shi & Xu, 2018). As a result, pollution reduction caused by environmental regulation results in additional production costs and consequently decreases export product quality (Deng, Wu, et al., 2021). Therefore, empirical evidence has not reached unanimous conclusions because of the challenges faced due to the unchanged assumptions of technology, the production process, and consumer demand.

2.3. Environmental regulation and greenwashing decisions

Environmental regulation might cause highly competitive pressures for firms that are significantly regulated, causing them to behave differently (Zhang, 2022b; Zhang & Kong, 2022). In addition to the decision making that is required to overcome the challenges and gain market power through innovation (Filipescu et al., 2013; Wang & Shao, 2019; Awawdeh, Ananzeh, El-khateeb, & Aljumah, 2022), environmental regulation can also lead to the spread of censured decision making such as greenwashing (El Ghoul, Guedhami, et al., 2018; Sadiq & Nonthapot, 2022; Shleifer, 2004). If greenwashing decisions are made by a firm's competitors, it might also adopt such behaviors to overcome the costs incurred due to environmental regulations (Ho, Chen, & Wu, 2022). It might be used by a firm as an alternative corporate strategy to disseminate untrue or inaccurate environmental information to mislead external financing tunnels when it performs badly in environmental outcomes (Radu & Francoeur, 2017). As a result, the disadvantage for non-greenwashing firms might lead them to change their decision making, which results in a spread of such behavior. This can improve the firm's image, reduce financial costs, and increase profits by attracting responsible consumers and investors (Zhang, 2022a; Zhang & Luecy, 2022). However, evidence suggests that such products might be challenged with negative market reactions for those firms that are more inclined to engage in greenwashing in the first place (Du, 2015). In the long-term, greenwashing firms might be costlier from both customers and investors sides (Arouri, El Ghoul, et al., 2021).

3. Data and empirical methodology design

3.1. Data sources

To identify how the quality of the export products of the listed firms responds to environmental regulation through green innovation, we constructed firm-level variables by merging the basic characteristics of the firm with the product and price information in the destination countries obtained from transaction trade data. The firm-level characteristics were obtained from the China Stock Market & Accounting Research (CSMAR) and the annual reports of Chinese A-listed firms. We included the key features of the firm, including industry affiliations, ownership, labor information, IPO year, detailed assets and debts, sales, exports, and related financial variables (Zhang, 2021). In addition, variables constructed to indicate firm-level product quality were obtained from the Chinese Customs database, which contains comprehensive information regarding the firms' export behavior, such as export price, export value, product categories (at the HS 8-digitcode level), exporting destination, trading partners, and trade mode. We merged this information with the CSMAR data by using the firms' basic information, such as firm names, ID, year, zip code, and phone numbers. Therefore, we can calculate the export product quality (Ge, Lai, et al., 2015; Zhang & Du, 2020).

Additionally, we evaluated the difference between firms' ESG disclosure scores and ESG real performance scores as proxies for greenwashing estimation. The ESG disclosure data were obtained from the Bloomberg ESG Database.[1] Furthermore, the three pillar scores, i.e., the environmental, social, and governance dimensions, were obtained from Asset4, which were used as indicators of ESG real performance. The Thomson Reuters' database, which contains key metrics describing the various aspects of ESG, was used to obtain ESG performance data.

Using the listed firms' ID and year as the keys for data matching, a database was then created, which contained 1859 observations between 2013 and 2015.

3.2. Empirical model

To estimate the impact of environmental regulation on product quality and to frame this adjustment in the context of the firm's green innovation activities, we employed the fixed effect model. The econometric model proposed for determining the relationship between green innovation, environmental regulation, and export product quality is as follows:

$$Quality_{i,t} = \beta_0 + \beta_1 \times Green\ innovation_{i,t} + \beta_i \times Controls_{i,t} + \mu_t + \tau_j + \varepsilon_{i,t} \quad (1)$$

The potential mechanisms through which environmental regulation affects export product quality and robustness and heterogeneous effects were explored. To investigate the moderating effects of the proxies of greenwashing and financial constraints of environmental regulation on product quality, the following model was used:

$$\begin{aligned} Green\ innovation_{i,t} =& \beta_0 + \beta_1 \times Environmental\ regulation_{i,t} \\ &+ \beta_i \times Controls_{i,t} + \mu_t + \tau_j + \varepsilon_{i,t} \end{aligned} \quad (2)$$

where *i, j,* and *t* indicate the firm, industry, and year, respectively.

The measurement of the export product quality is discussed further in section 3.3. The key independent variable that we focused on is environmental regulation. We used the logarithm of the number of environmental penalty cases at the provincial level and it presents the forcemeat level of the environmental regulation. In addition, several firm-level characteristics were also employed as control variables in the empirical estimations. Return over assets (ROA), firm age, and firm size were also controlled, and time and industry fixed effects were also estimated in our econometric models.

3.3. Variable discussions

3.3.1. Export product quality measurement

Following the regression back-calculation method from the consumer's side, we calculate the demand residuals to qualify the product qualities. The consumption decision is a function of the price adjustment after the change in product quality; this is the price-performance ratio. If two firms produce the same product but price them differently and gain

[1] Bloomberg brings together firms' ESG information from annual reports, Corporate Social Responsibility reports, and proprietary Bloomberg surveys. Bloomberg ESG data covers >120 categories, including environmental, social and governance indicators, for over 50 countries.

Table 1
Summary statistics.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Obs	Mean	Std.Dev.	Min	Max	Low	High	Diff.
Quality Firm	1859	0.734	0.113	0.012	1	0.765	0.716	0.049***
Green Innovation	1840	0.378	0.694	0	3.178	0.437	0.280	0.157***
Greenwashing	1859	0.111	1.119	−2.706	3.277	−0.094	−0.140	0.046
ESG Performance	1859	0.324	0.101	0.150	0.500	0.326	0.321	0.005
SA Index	1811	−3.176	0.070	−3.283	−2.900	−3.171	−3.184	0.013***
ROA	1823	0.040	0.046	−0.126	0.190	0.037	0.046	−0.009***
SOE Dummy	1862	0.236	0.425	0	1	0.205	0.287	−0.082***
Age	1842	1.814	0.729	0	3.178	1.751	1.921	−0.169***
Size	1755	7.407	1.337	3.002	9.652	7.246	7.669	−0.423***

Note: Diff. shows the significant gaps between the variable means of lowly-polluting and heavily-polluting firms, and *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

different market shares, it indicates gaps in the quality of the product. If the same product produced by two different firms with the same market price gain different market shares, it demonstrates that the product with a higher market share is of higher quality. This is because quality is the core determinant of the market share when the product category and price are fixed. Accordingly, product quality is calculated as follows:

The quantity exported by firm i to country m in year t is defined as:

$$q_{i,m,t} = p_{i,m,t}^{-\sigma}\theta_{i,m,t}^{\sigma-1}\left(E_{m,t}/P_{m,t}\right) \tag{4}$$

where $q_{i,\,m,\,t}$, $p_{i,\,m,\,t}$, and $\theta_{i,\,m,\,t}$ represent the export quantity, price and quality information of the products. σ is the substitution elasticity of different products, $\sigma > 1$, and $E_{m,\,t}$ and $P_{m,\,t}$ represent the consumer expenditure and price index of country m at year t. We take the logarithm of Eq. (4) to derive Eq. (5).

$$lnq_{i,m,t} = c_{m,t} - \sigma lnp_{i,m,t} + \varepsilon_{i,m,t} \tag{5}$$

where $c_{m,\,t} = lnE_{m,\,t} - lnP_{m,\,t}$ varies according to country m at year t and is a dummy variable. $\varepsilon_{i,\,m,\,t} = (\sigma - 1)ln\theta_{i,\,m,\,t}$ is a residual that contains product quality information. Regression is performed following Eq. (5) and the firms' product quality function is obtained as follows:

$$Quality_{i,m,t} = ln\theta_{i,m,t} = \varepsilon_{i,m,t}/(\sigma-1) = \left(lnq_{i,m,t} - ln\widehat{q}_{i,m,t}\right)/(\sigma-1) \tag{6}$$

We standardize the product quality given by Eq. (6) according to the HS6 code and derive Eq. (7).

$$Quality_{i,m,t_r} = \left(Quality_{i,m,t} - minQuality_{i,m,t}\right)\Big/\left(maxQuality_{i,m,t} - minQuality_{i,m,t}\right) \tag{7}$$

where $maxQuality_{i,\,m,\,t}$ *and min* $Quality_{i,\,m,\,t}$ represent the maximization and minimization of product quality for a given HS6 code product and export country at year t. The value of this indicator ranges between 0 and 1, and we obtain the general firm-level product quality by summarizing the indicator according to the export value. The firm-level product quality is shown in Eq. (8).

$$Quality_{firm_{i,t}} = \left(Value_{i,m,t}\Big/\sum_{i,m,t\in\Omega} Value_{i,m,t}\right) \times Quality_{i,m,t_r} \tag{8}$$

where Ω represents the full set of the export target countries for a given product and at a given year for firm i, and $Value_{i,\,m,\,t}$ is the export value for firm i to country m at year t.

Table 2
Baseline regressions.

	(1)	(2)	(3)	(4)
VARIABLES	Quality_Firm	Quality_Firm	Green Innovation	Green Innovation
Green Innovation	0.004***	0.004***		
	(0.000)	(0.001)		
Regulations			−0.357**	−0.243**
			(0.175)	(0.041)
ROA		−0.002		0.415**
		(0.087)		(0.076)
SOE Dummy		−0.001		0.093
		(0.001)		(0.064)
Age		0.001		0.097***
		(0.003)		(0.006)
Size		0.007***		0.021***
		(0.000)		(0.002)
Constant	0.900***	0.867***	0.495	0.397**
	(0.046)	(0.030)	(0.407)	(0.069)
Year Fixed Effects	Y	Y	Y	Y
Industry Fixed Effects	Y	Y	Y	Y
Observations	1824	1693	1824	1693
R-squared	0.202	0.209	0.102	0.116

Note: Robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1.

3.3.2. Greenwashing score evaluation

The main variable that has a moderating effect is greenwashing. According to Yu, Van Luu, et al. (2020), greenwashing firms are those that seek to display a sustainable growth impression by disclosing ESG data but not consistently achieving their real ESG targets. A firm's peer-relative greenwashing indicator is considered to calculate the degree of a firm's sustainability and its alignment with the greenwashing definition. Therefore, this indicator is evaluated by calculating the difference between the normalized measure of a firm's relative number to its peers in the distribution of the ESG disclosure score and a normalized measure a firm's relative position to its peers in the distribution of ESG real performance score. A larger difference demonstrates that the firm outwardly appears to do well but does poorly in terms of real environmental performance.

We take the difference between normalized measurements of firms' relative distribution of the ESG disclosure and real performance scores as firms' relative greenwashing variable. A higher value of the variable indicates that firms are seeking to create a better, more sustainable image.

$$Greenwashing_{i,t} \stackrel{\text{def}}{=} \left(\frac{ESG_{disclose\,i,t} - \overline{ESG_{disclose}}}{\sigma_{disclose}}\right) - \left(\frac{ESG_{real\,i,t} - \overline{ESG_{real}}}{\sigma_{real}}\right) \tag{9}$$

4. Summary statistics and empirical findings

4.1. Summary statistics

The mean of the main dependent variable, export product quality, was approximately 0.734, and the standard deviation fluctuated around 0.113. In the context of green innovation, the average ratio was 37.8%, while the standard deviation fluctuated around 0.694. In particular, the greenwashing level was 11.1%, while the standard deviation fluctuated

Table 3
Heterogeneity between heavily and lowly-pollution firms.

	(1)	(2)	(3)	(4)
VARIABLES	Green Innovation	Green Innovation	Green Innovation	Green Innovation
	Heavily-pollution	Lowly-pollution	Heavily-pollution	Lowly-pollution
Regulations	−0.828**	−0.046	−0.679**	0.060
	(0.112)	(0.175)	(0.078)	(0.106)
ROA			0.785*	0.286
			(0.243)	(0.318)
SOE Dummy			0.142***	0.084
			(0.006)	(0.092)
Age			0.130***	0.085**
			(0.006)	(0.011)
Size			0.040*	0.007
			(0.013)	(0.008)
Constant	1.115***	0.344	0.310	0.820**
	(0.082)	(0.199)	(0.421)	(0.153)
Year Fixed Effects	Y	Y	Y	Y
Industry Fixed Effects	Y	Y	Y	Y
Observations	684	1140	649	1044
R-squared	0.144	0.081	0.143	0.104

Robust standard errors in parentheses.
*** p < 0.01, ** p < 0.05, * p < 0.1.

around 1.119; this indicates that it was varying significantly. Moreover, the mean value of the alternative indicator of firm sustainable performance measured by real ESG performance was 32.4%. In addition to the sustainable growth variables of a firm, we also included control variables in our study. The financial constraints variable was measured by the SA Index, the average value of which was −3.176; the negative value of this index demonstrates that the firm was subject to several financial constraints. The ROA measure of profitability was approximately 4%, the average logarithm of firm age was 1.814, and the size was approximately 7.407 (See Table 1).

We observed that the means of the key variables differed significantly for heavily-polluting and low-polluting firms. Columns 6–7 show the means for firms belonging to these two groups, and column 8 presents the significance of the differences. The firms with lower levels of pollution were found to perform better in terms of increasing export production quality, which was a key dependent variable, and green innovation, which was the moderator variable. There was no significant difference in greenwashing and ESG performance between the two groups. However, the other control variables also displayed significant differences between groups.

4.2. Empirical findings

The empirical results of the fundamental estimation are provided in detail in Table 2. We found that green innovation significantly drives the improvement of export product quality, and the results were consistent when the control variables were both included and excluded in the estimation (columns 1–2). The marginal contribution of green innovation to export product quality was 0.4% at the 1% significance level. We observed that environmental regulation had a significant negative impact on green innovation at the 5% significance level, and the findings held whether the control variables were included in the estimations or not (columns 3–4).

These are economically meaningful results, and the findings can help derive the mechanism that environmental regulation might curb the export product quality through decreasing green innovation performance.

5. Heterogeneity and mechanism explorations

5.1. Heterogeneity effect across different industries

Energy consumption intensity and pollution intensity are known to be highly related to the sectoral structure, which is closely associated with activities in the production processes (Duro, Alcántara, et al., 2010). Moreover, the incentive provided by environmental regulations to make changes in the industrial structure can improve energy efficiency, which could lead to cleaner and greener growth. The investigation into highly-polluting and low-polluting industries can help reshape such regulations and promote high-quality growth and environmental improvement.

The empirical evidence shown in Table 3 supports our hypothesis. We divided our observations into two categories, i.e., highly-polluting and low-polluting industries. The findings for highly-polluting firms are presented in columns 1 and 3, which demonstrate that the curbing effect on green innovation caused by environmental regulation was significant at the 5% significance level. However, this impact was insignificant for the low-polluting industries. These results indicate that the negative impact on green innovation and product quality due to environmental regulation exists largely in highly-polluting firms.

Table 4
Greenwashing mechanism exploration.

	(1)	(2)	(3)	(4)
VARIABLES	Green Innovation	Green Innovation	Green Innovation	Green Innovation
	Heavily-Greenwashing	Heavily-Non-Greenwashing	Lowly-Greenwashing	Lowly-Non-Greenwashing
Regulations	−1.009*	−0.391	−0.079	0.226*
	(0.241)	(0.120)	(0.261)	(0.034)
ROA	−0.098	1.154	0.741	0.045
	(0.553)	(0.699)	(0.698)	(1.336)
SOE Dummy	−0.096	0.298	−0.049	0.159**
	(0.126)	(0.063)	(0.090)	(0.003)
Age	0.106	0.149	0.027	0.115
	(0.090)	(0.065)	(0.055)	(0.066)
Size	0.015	0.056	−0.014	0.017
	(0.058)	(0.010)	(0.016)	(0.034)
Constant	0.189	−0.751	1.340**	−0.444
	(0.617)	(0.425)	(0.244)	(0.078)
Year Fixed Effects	Y	Y	Y	Y
Industry Fixed Effects	Y	Y	Y	Y
Observations	295	354	497	547
R-squared	0.166	0.174	0.125	0.118

Note: Robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1.

Table 5
Financial constraint mechanism exploration.

	(1)	(2)	(3)	(4)
VARIABLES	Green Innovation	Green Innovation	Green Innovation	Green Innovation
	Heavily-Greenwashing	Heavily-Non-Greenwashing	Lowly-Greenwashing	Lowly-Non-Greenwashing
Regulations	−21.745**	−23.704	−22.562*	3.224***
	(2.751)	(9.083)	(7.015)	(0.882)
SA Index	4.003	7.653	6.384**	−2.390***
	(1.451)	(2.846)	(1.129)	(0.895)
Regulations*SA Index	−6.505**	−7.358	−7.168*	0.862***
	(0.963)	(2.805)	(2.167)	(0.270)
ROA	−0.099	1.171	0.575	1.081
	(0.525)	(0.727)	(0.549)	(1.402)
SOE Dummy	−0.086	0.261*	−0.052	0.167
	(0.105)	(0.039)	(0.082)	(0.237)
Age	0.024	0.196	0.030	0.142
	(0.131)	(0.041)	(0.021)	(0.111)
Size	0.008	0.065	−0.009	−0.032
	(0.053)	(0.013)	(0.017)	(0.044)
Constant	13.983*	23.387	22.119**	−7.683***
	(3.591)	(9.398)	(3.770)	(2.682)
Year Fixed Effects	Y	Y	Y	Y
Industry Fixed Effects	Y	Y	Y	Y
Observations	293	351	491	196
R-squared	0.187	0.180	0.147	0.084

Note: Robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1.

5.2. Greenwashing mechanism exploration across different industries

It is interesting to explore why green innovation in highly-polluting firms suffers due to environmental regulations, which results in a decline in product quality. Greenwashing is a potential barrier that prevents highly-polluting firms from contributing to green innovation activities and improving product quality. Table 4 presents the relationship between environmental regulations and green innovation by separating the observations into two groups – firms that do and do not display greenwashing behaviors.

Column 1 in Table 4 shows the highly-polluting firms with greenwashing behaviors; we observe that the coefficients of environmental regulation are −1.009 and significantly associated with green innovation. However, our findings show that the coefficients of environmental regulation are insignificant for low-polluting firms (column 2). Previous literature has shown that heavily-polluting firms might incur higher costs and face greater financial constraints while innovating in green projects than those incurred by low-polluting firms (e.g., Zhang, 2021; Zhang, 2022a, 2022b). This finding helps explain why environmental regulations reduce the efficiency of highly-polluting firms in terms of green innovation; their subsequent greenwashing behavior results in misallocation of funds. For low-polluting firms with greenwashing behavior, the effects of environmental regulation are not significant. However, lowly-polluting firms without greenwashing behavior are strongly motivated and perform well in terms of green innovation (column 4). This finding supports the Porter Hypothesis; therefore, our findings demonstrate that the Porter Hypothesis is conditionally held for Chinese firms.

5.3. Financial constraints motivation

To further explore the motivation behind firms adopting

Table 6
Robustness tests with direct mechanism exploration and ownerships.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Quality_Firm	Quality_Firm	Quality_Firm	Quality_Firm	Quality_Firm
	All Samples	Heavily-pollution	Lowly-pollution	SOEs	Non-SOEs
Green Innovation	0.002	−0.002	0.016***	−0.011	0.006
	(0.004)	(0.004)	(0.000)	(0.006)	(0.003)
Green Innovation*Greenwashing	−0.009***	−0.011**	−0.002	−0.013	−0.009*
	(0.001)	(0.002)	(0.001)	(0.012)	(0.003)
Greenwashing	0.003	0.002	0.006	0.010	0.002**
	(0.001)	(0.003)	(0.004)	(0.007)	(0.000)
ROA	−0.002	0.159	−0.305*	0.113**	−0.016
	(0.093)	(0.104)	(0.087)	(0.023)	(0.105)
SOE Dummy	−0.000	−0.018**	0.022*		
	(0.002)	(0.002)	(0.006)		
Age	0.001	0.008	−0.010***	0.030**	−0.007
	(0.003)	(0.004)	(0.000)	(0.006)	(0.002)
Size	0.007***	0.005**	0.009**	0.001	0.007**
	(0.000)	(0.001)	(0.001)	(0.005)	(0.001)
Constant	0.884***	0.948***	0.562***	0.943***	0.887***
	(0.037)	(0.043)	(0.020)	(0.039)	(0.077)
Year Fixed Effects	Y	Y	Y	Y	Y
Industry Fixed Effects	Y	Y	Y	Y	Y
Observations	1693	1044	649	377	1316
R-squared	0.212	0.207	0.209	0.359	0.199

Note: Robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1.

Table 7
Robustness tests: alternative measurement of greenwashing.

	(1)	(2)	(3)
VARIABLES	Quality_Firm	Quality_Firm	Quality_Firm
	All Samples	Heavily-pollution	Lowly-pollution
Green Innovation	0.027	0.116	−0.118
	(0.076)	(0.133)	(0.086)
Green Innovation*Greenwashing	−0.388*	−0.388***	−0.476
	(0.099)	(0.013)	(0.389)
Greenwashing	0.008***	0.005**	0.014**
	(0.000)	(0.001)	(0.003)
ROA	0.012	0.179	−0.330**
	(0.081)	(0.094)	(0.067)
SOE Dummy	0.002	0.006	−0.001
	(0.003)	(0.003)	(0.002)
Age	0.007***	0.006***	0.010***
	(0.001)	(0.000)	(0.001)
Size	0.863***	0.902***	0.533***
	(0.029)	(0.027)	(0.024)
Year Fixed Effects	Y	Y	Y
Industry Fixed Effects	Y	Y	Y
Observations	1681	1034	647
R-squared	0.207	0.197	0.198

Note: Robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1.

greenwashing behavior, we attempt to use the financial constraints mechanism. Based on the estimation strategy discussed in section 4.4, we incorporate the SA Index, which indicates the degree of financial constraints due to environmental regulation. Table 5 presents the empirical results of this analysis.

Column 1 shows that environmental regulation significantly increases the greenwashing behavior of highly-polluting firms and decreases their level of green innovation. While column 2 still presents this effect for without firms are insignificant. For low-polluting firms, financial constraints are not the key driver for greenwashing behavior or declines in green innovation (columns 3–4).

6. Robustness tests

6.1. The direct mechanism of greenwashing and ownership of the export product quality

To analyze the robustness of the greenwashing mechanism that affects green innovation and export product quality, we examine the significance of the greenwashing and green innovation variables. Columns 1–3 of Table 6 show the estimation results. Column 1 illustrates that there is a significant negative impact of the joint effect of the two variables on export product quality. More specifically, this significant effect exists only in the group of heavily-polluting firms (column 2) and does not hold for low-polluting firms (column 3). These joint effects are consistent with our main findings regarding the greenwashing mechanism.

Column 4 shows that the joint effect of greenwashing and green innovation is insignificant; however, the joint effect is significantly associated with export product quality (column 5). Our estimations are consistent with our findings regarding greenwashing behaviors in heavily-polluting firms that curb green innovation, resulting in a decline in export product quality. In addition, we further investigate the greenwashing mechanism across different types of ownership, such as state-owned enterprises (SOEs) and privately-owned firms.

6.2. Alternative measurement of greenwashing

To identify whether our suggested greenwashing mechanism holds during the measurement of greenwashing, we re-estimated our greenwashing indicator by calculating the difference between real ESG performance and disclosure ESG score. Table 7 presents the estimation results obtained by using the alternative measurement process for greenwashing. Our empirical findings demonstrated that the joint effect of greenwashing and green innovation on export product quality was significant for the full samples (column 1). Moreover, our results are consistent with our previous findings according to the heterogeneity effect between heavily-polluting and low-polluting industries. The joint effect of greenwashing and green innovation on export product quality was significant for heavily-polluting firms, but not for lowly-polluting firms (columns 2–3).

Table 8
Robustness tests: alternative measurement of ESG real performance.

	(1)	(2)	(3)
VARIABLES	Quality_Firm	Quality_Firm	Quality_Firm
	All Samples	Heavily-pollution	Lowly-pollution
Green Innovation	0.039***	0.041**	0.021**
	(0.002)	(0.005)	(0.003)
Green Innovation*ESG	−0.108***	−0.128**	−0.014
	(0.005)	(0.016)	(0.011)
ESG	0.038*	0.033	0.056
	(0.012)	(0.025)	(0.047)
ROA	−0.002	0.157	−0.303*
	(0.093)	(0.104)	(0.091)
SOE Dummy	0.000	−0.017**	0.022*
	(0.002)	(0.002)	(0.006)
Age	0.001	0.008	−0.010***
	(0.003)	(0.004)	(0.000)
Size	0.007***	0.005**	0.009**
	(0.000)	(0.001)	(0.001)
Constant	0.866***	0.913***	0.550***
	(0.038)	(0.029)	(0.011)
Observations	1693	1044	649
R-squared	0.213	0.207	0.208

Note: Robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1.

6.3. ESG disclosure level effect on export product quality

Greenwashing behavior is more likely to exist in the firms that incorrectly disclose their ESG performance as being high. We used the ESG disclosure level to investigate whether over-disclosed ESG scores can decrease the green innovation performance and curb export product quality. We present the empirical results in Table 8. On including the full samples, we observed that the joint effect of ESG disclosure level and green innovation was negatively and significantly associated with

Table 9
Instrument variable regressions.

	(1)	(2)	(3)
VARIABLES	Regulations	Green Innovation	Green Innovation
$Regulation_{iv}$		−0.264***	−0.263***
		(0.031)	(0.032)
Wind Speed	−0.334*		
	(0.202)		
ROA	−0.077		−0.148
	(0.056)		(0.887)
SOE Dummy	−0.021		0.624
	(0.039)		(0.462)
Age	0.018*		−0.037
	(0.011)		(0.139)
Size	−0.000		0.008
	(0.002)		(0.054)
Constant	1.120***	0.415***	0.337
	(0.186)	(0.052)	(0.260)
Year Fixed Effects	Y	Y	Y
Industry Fixed Effects	Y	Y	Y
Observations	1633	1209	1183
R-squared	0.141	0.075	0.086

Note: Robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1.

export product quality. Furthermore, the significant negative effect still held for heavily-polluting firms, but not for low-polluting firms.

These findings support our hypothesis that heavily-polluting firms use the strategy of incorrectly disclosing their ESG score as high and consequently decreasing green innovation.

6.4. Instrumental variable test

The concerns regarding potential endogeneity could be valid if the firms' decisions, such as the degree of greenwashing, are taken into account when environmental regulations are formulated (Zhang, 2022b). To overcome this potential endogeneity problem, the average city-level wind speed was chosen as the instrumental variable related to the level of environmental regulations. Because high wind speed is more likely to make pollution dissipate fast, cities with high wind speeds might face fewer regulations. Furthermore, wind speed is randomly determined by meteorological conditions, which cannot directly affect firms' green behavior; therefore, it meets the requirements of exogeneity (Geng, Liu, et al., 2021).

We present the results of our estimation using a two-stage least squares model, including average wind speed as the instrumental variable, in Table 9. The result of the first step is shown in Column 1 and suggests that average wind speed is significantly negatively related to the level of environmental regulation. Columns 2 and 3 provide the results of the second step, i.e., the fixed-effects models using the instrumental variable. Our findings show that the main coefficients remain negative and are significant, which is consistent with our fundamental results and implies that our findings are reliable.

7. Conclusions and policy implications

7.1. Conclusions

By constructing a unique database consisting of firm-level product quality data and other fundamental variables, this paper investigates the impact of environmental regulation on export product quality; in particular, it examines the differences in the impacts on heavily-polluting and low-polluting firms.

Our econometric estimations have provided several empirical results. First, the fundamental results suggest that green innovation measured by green patents is significantly associated with export product quality. Second, we found that environmental regulations significantly restricted green innovation in general. However, when focusing on highly-polluting and low-polluting industries, we observed that this effect was significant only in firms belonging to highly-polluting industries. Third, in the presence of negative restriction effects, greenwashing mechanisms were stronger in highly-polluting firms. Furthermore, we found that highly-polluting firms that were experiencing a high level of financial constraints tried to greenwash, and consequently, the quality of the export product suffered.

7.2. Policy implications

This paper provides a basis for various policy improvements and has several practical implications. First, the major market players for environmental regulation, i.e., firms, have to pay additional attention to eco-friendliness to improve export product quality. In an era of significant changes in the global economy and industrial landscape, the improvement of product quality is based on increasing an organization's efficiency by coordinating firms' activities, which is related to several dimensions of their sustainable performance and environmental regulation targets. As demonstrated by our results, product quality matters greatly for firms' substantial growth and enforcing green behaviors such as green innovation. Second, a recommendation for the government departments and policymakers in charge of environmental regulation is that financial institutions should issue financing towards green targets or green innovation, such as green credit. Our findings show that financial constraints curb green innovation and make it more difficult for firms to improve product quality. Therefore, the relevant government or financial institutions should try to establish a system to help identify green innovation projects and address financial distress. Finally, firm environmental disclosure information, such as ESG, should be fully considered. This not only includes the disclosing data, but financial institutions and government departments should also consider the ESG rating data to issue credit. The financing sources should efficiently allocate funds to product quality improvement projects by helping to decrease greenwashing behaviors.

Author statement

Submission of this article has not been published previously.

Data availability

Data will be made available on request.

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References

Arfaoui, N. (2018). Eco-innovation and regulatory push/pull effect in the case of REACH regulation: Empirical evidence based on survey data. *Applied Economics, 50*(14), 1536–1554.

Arouri, M., El Ghoul, S., et al. (2021). Greenwashing and product market competition. *Finance Research Letters, 42*, Article 101927.

Awawdeh, A. E., Ananzeh, M., El-khateeb, A. I., & Aljumah, A. (2022). Role of green financing and corporate social responsibility (CSR) in technological innovation and corporate environmental performance: A COVID-19 perspective. *China Finance Review International, 12*(2), 297–316.

Azar, G., & Ciabuschi, F. (2017). Organizational innovation, technological innovation, and export performance: The effects of innovation radicalness and extensiveness. *International Business Review, 26*(2), 324–336.

Barbieri, N., Ghisetti, C., et al. (2016). A survey of the literature on environmental innovation based on main path analysis. *Journal of Economic Surveys, 30*(3), 596–623.

Becker, S. O., & Egger, P. H. (2013). Endogenous product versus process innovation and a firm's propensity to export. *Empirical Economics, 44*(1), 329–354.

Benner, M. J., & Tushman, M. (2002). Process management and technological innovation: A longitudinal study of the photography and paint industries. *Administrative Science Quarterly, 47*(4), 676–707.

Bernard, A. B., Redding, S. J., et al. (2010). Multiple-product firms and product switching. *American Economic Review, 100*(1), 70–97.

Borghesi, S., Cainelli, G., et al. (2015). Linking emission trading to environmental innovation: Evidence from the Italian manufacturing industry. *Research Policy, 44*(3), 669–683.

Branstetter, L., Fisman, R., et al. (2011). Does intellectual property rights reform spur industrial development? *Journal of International Economics, 83*(1), 27–36.

Calderon, C. A., & Servén, L. (2004). *The effects of infrastructure development on growth and income distribution* (Available at SSRN 625277).

Cassiman, B., & Golovko, E. (2011). Innovation and internationalization through exports. *Journal of International Business Studies, 42*(1), 56–75.

Cassiman, B., Golovko, E., et al. (2010). Innovation, exports and productivity. *International Journal of Industrial Organization, 28*(4), 372–376.

Costantini, V., & Crespi, F. (2008). Environmental regulation and the export dynamics of energy technologies. *Ecological Economics, 66*(2–3), 447–460.

Costantini, V., & Mazzanti, M. (2012). On the green and innovative side of trade competitiveness? The impact of environmental policies and innovation on EU exports. *Research Policy, 41*(1), 132–153.

Damijan, J. P., Kostevc, Č., et al. (2010). From innovation to exporting or vice versa? *The World Economy, 33*(3), 374–398.

Deng, Y., Wu, Y., et al. (2021). On the relationship between pollution reduction and export product quality: Evidence from Chinese firms. *Journal of Environmental Management, 281*, Article 111883.

Du, X. (2015). How the market values greenwashing? Evidence from China. *Journal of Business Ethics, 128*(3), 547–574.

Duro, J. A., Alcántara, V., et al. (2010). International inequality in energy intensity levels and the role of production composition and energy efficiency: An analysis of OECD countries. *Ecological Economics, 69*(12), 2468–2474.

El Ghoul, S., Guedhami, O., et al. (2018). Corporate environmental responsibility and the cost of capital: International evidence. *Journal of Business Ethics, 149*(2), 335–361.
Elrod, A. A., & Malik, A. S. (2017). The effect of environmental regulation on plant-level product mix: A study of EPA's cluster rule. *Journal of Environmental Economics and Management, 83*, 164–184.
Filipescu, D. A., Prashantham, S., et al. (2013). Technological innovation and exports: Unpacking their reciprocal causality. *Journal of International Marketing, 21*(1), 23–38.
Ge, Y., Lai, H., et al. (2015). Multinational price premium. *Journal of Development Economics, 115*, 181–199.
Geng, Y., Liu, W., et al. (2021). Environmental regulation and corporate tax avoidance: A quasi-natural experiment based on the eleventh five-year plan in China. *Energy Economics, 99*, Article 105312.
Golovko, E., & Valentini, G. (2011). Exploring the complementarity between innovation and export for SMEs' growth. *Journal of International Business Studies, 42*(3), 362–380.
Hamamoto, M. (2006). Environmental regulation and the productivity of Japanese manufacturing industries. *Resource and Energy Economics, 28*(4), 299–312.
Hering, L., & Poncet, S. (2014). Environmental policy and exports: Evidence from Chinese cities. *Journal of Environmental Economics and Management, 68*(2), 296–318.
Ho, J. C., Chen, T.-H., & Wu, J.-J. (2022). Are corporate social responsibility reports informative? Evidence from textual analysis of banks in China. *China Finance Review International, 12*(1), 101–120.
Hwang, J. A., & Kim, Y. (2017). Effects of environmental regulations on trade flow in manufacturing sectors: Comparison of static and dynamic effects of environmental regulations. *Business Strategy and the Environment, 26*(5), 688–706.
Ismail, N. W., & Mahyideen, J. M. (2015). The impact of infrastructure on trade and economic growth in selected economies in Asia. In *Asian Development Bank Institute Working Paper Series, No. 553*.
Jaffe, A. B., & Palmer, K. (1997). Environmental regulation and innovation: A panel data study. *Review of Economics and Statistics, 79*(4), 610–619.
Kaynak, H., & Hartley, J. L. (2005). Exploring quality management practices and high tech firm performance. *The Journal of High Technology Management Research, 16*(2), 255–272.
Lachenmaier, S., & Wößmann, L. (2006). Does innovation cause exports? Evidence from exogenous innovation impulses and obstacles using German micro data. *Oxford Economic Papers, 58*(2), 317–350.
Lo, C. K., Yeung, A. C., et al. (2009). ISO 9000 and supply chain efficiency: Empirical evidence on inventory and account receivable days. *International Journal of Production Economics, 118*(2), 367–374.
Love, J. H., & Roper, S. (2015). SME innovation, exporting and growth: A review of existing evidence. *International Small Business Journal, 33*(1), 28–48.
Manova, K. (2013). Credit constraints, heterogeneous firms, and international trade. *Review of Economic Studies, 80*(2), 711–744.
Martín-Tapia, I., Aragón-Correa, J. A., et al. (2010). Environmental strategy and exports in medium, small and micro-enterprises. *Journal of World Business, 45*(3), 266–275.
Maskus, K. E., & Yang, L. (2018). Domestic patent rights, access to technologies and the structure of exports. *Canadian Journal of Economics/Revue canadienne d'économique, 51*(2), 483–509.
Minetti, R., Murro, P., et al. (2019). Financial constraints, firms' supply chains, and internationalization. *Journal of the European Economic Association, 17*(2), 327–375.
Minetti, R., & Zhu, S. C. (2011). Credit constraints and firm export: Microeconomic evidence from Italy. *Journal of International Economics, 83*(2), 109–125.
Monreal-Pérez, J., Aragón-Sánchez, A., & Sánchez-Marín, G. (2012). A longitudinal study of the relationship between export activity and innovation in the Spanish firm: The moderating role of productivity. *International Business Review, 21*(5), 862–877.
Nassimbeni, G. (2001). Technology, innovation capacity, and the export attitude of small manufacturing firms: A logit/tobit model. *Research Policy, 30*(2), 245–262.
Pekovic, S., & Galia, F. (2009). From quality to innovation: Evidence from two French employer surveys. *Technovation, 29*(12), 829–842.
Porter, M. E., & Van der Linde, C. (1995). Toward a new conception of the environment-competitiveness relationship. *Journal of Economic Perspectives, 9*(4), 97–118.
Radicic, D., & Djalilov, K. (2019). The impact of technological and non-technological innovations on export intensity in SMEs. *Journal of Small Business and Enterprise Development, 26*(4), 612–638.
Radu, C., & Francoeur, C. (2017). Does innovation drive environmental disclosure? A new insight into sustainable development. *Business Strategy and the Environment, 26*(7), 893–911.
Rehman, F. U., & Noman, A. A. (2022). China's outward foreign direct investment and bilateral export sophistication: A cross countries panel data analysis. *China Finance Review International, 12*(1), 180–197.
Rubashkina, Y., Galeotti, M., et al. (2015). Environmental regulation and competitiveness: empirical evidence on the porter hypothesis from European manufacturing sectors. *Energy Policy, 83*, 288–300.
Sadiq, M., Nonthapot, S., et al. (2022). Does green finance matter for sustainable entrepreneurship and environmental corporate social responsibility during COVID-19? *China Finance Review International, 12*(2), 317–333.
Shi, X., & Xu, Z. (2018). Environmental regulation and firm exports: Evidence from the eleventh five-year plan in China. *Journal of Environmental Economics and Management, 89*, 187–200.
Shleifer, A. (2004). Does competition destroy ethical behavior? *American Economic Review, 94*(2), 414–418.
Singh, P. J. (2008). Empirical assessment of ISO 9000 related management practices and performance relationships. *International Journal of Production Economics, 113*(1), 40–59.
Stavropoulos, S., Wall, R., et al. (2018). Environmental regulations and industrial competitiveness: Evidence from China. *Applied Economics, 50*(12), 1378–1394.
Wang, X., & Shao, Q. (2019). Non-linear effects of heterogeneous environmental regulations on green growth in G20 countries: Evidence from panel threshold regression. *Science of the Total Environment, 660*, 1346–1354.
Xing, Z. (2018). The impacts of information and communications technology (ICT) and E-commerce on bilateral trade flows. *International Economics and Economic Policy, 15*(3), 565–586.
Yu, E. P., Van Luu, B., et al. (2020). Greenwashing in environmental, social and governance disclosures. *Research in International Business and Finance, 52*, Article 101192.
Zhang, D. (2021). Marketization, environmental regulation, and eco-friendly productivity: A Malmquist–Luenberger index for pollution emissions of large Chinese firms. *Journal of Asian Economics, 76*, Article 101342.
Zhang, D. (2022a). Environmental regulation and firm product quality improvement: How does the greenwashing response? *International Review of Financial Analysis, 80*, Article 102058.
Zhang, D. (2022b). Green financial system regulation shock and greenwashing behaviors: Evidence from Chinese firms. *Energy Economics, 106064*.
Zhang, D., & Du, P. (2020). How China "Going green" impacts corporate performance? *Journal of Cleaner Production, 258*, Article 120604.
Zhang, D., & Jin, Y. (2021). R&D and environmentally induced innovation: Does financial constraint play a facilitating role? *International Review of Financial Analysis, 78*, Article 101918.
Zhang, D., & Kong, Q. (2021). How does energy policy affect firms' outward foreign direct investment: An explanation based on investment motivation and firms'performance. *Energy Policy, 158*, Article 112548.
Zhang, D., & Kong, Q. (2022). Do energy policies bring about corporate overinvestment? Empirical evidence from Chinese listed companies. *Energy Economics, 105*, Article 105718.
Zhang, D., & Luecy, B. M. (2022). Sustainable behaviors and firm performance: The role of financial constraints' alleviation. *Economic Analysis and Policy, 74*, 220–233.
Zhang, Y., Wang, J., et al. (2018). Impact of environmental regulations on green technological innovative behavior: An empirical study in China. *Journal of Cleaner Production, 188*, 763–773.
Zweimüller, J., & Brunner, J. K. (2005). Innovation and growth with rich and poor consumers. *Metroeconomica, 56*(2), 233–262.