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Sustainability of enterprise export expansion from the perspective of environmental information disclosure

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ABSTRACT

The export of Chinese firms is facing problems of low added value and high energy consumption. Various environmental control methods have emerged to promote the sustainable development of exports. Environmental information disclosure has an important impact on the development of enterprises in recent years. Can it promote exports? Based on the Heckman model, this study uses matched data from the China Industry Business Performance Data and China Stock Market and Accounting Research Database to investigate whether environmental information disclosure can influence the export of enterprises. Findings show that environmental information disclosure can promote decision-making for exports. Nonlinear results show that environmental information disclosure and hard environmental information disclosure showed a U-shaped relationship to export scale, whereas *EIDS* displayed an inverted U-relationship with export scale. To further verify the impact paths, the cost effect of environmental information disclosure is unconducive to export, whereas innovation, financing, and subsidy effects can increase export scale. However, the social trust effect of environmental information disclosure remains unclear.

1. Introduction

In recent years, “Made in China” has become a common phrase around the world. An explosive growth in exports has made China one of the world’s largest exporter. However, the competitive advantage of manufacturing in China is the high consumption of cheap labor and energy rather than relying on technological innovation. This context partly explains why China’s exports show great vulnerability when faced with external shocks and even experience continued deterioration amid the boom of exports. Departing from high consumption, high pollution, and cheap exports is urgent if China wants to upgrade from the context of “Made in China” to “Created in China.”

Environmental information disclosure, as a new type of environmental supervision mode, is significant in achieving the coordinated control of environmental pollution. This mode is not only beneficial to the harmonious coexistence in society, the government, and enterprises, but also has an important strategic significance for the future development of enterprises. In recent years, environmental information disclosure has received increased attention. The publication of the “governance guidelines for listed companies” in 2002 provided the top-listed enterprises in China with increased environmental and social responsibility with emphasis on disclosing environmental information behavior. Environmental information disclosure can not only strengthen the government’s supervision of enterprise environmental governance, but also aggravate the pressure of enterprise cost and technological innovation, which may be unconducive to the accumulation of profits and export behavior (Zeng et al., 2010). However, as a new method of supervision, environmental information disclosure can strengthen the environmental protection relationship among the government, society, and enterprises and improve the reputation, social trust, and international market demand of enterprises, thus promoting export performance. To date, the downward pressure of China’s economic development is increasing; the external environment faced by import and export is tight, and the trade situation is not optimistic. Is China’s environmental information disclosure helpful or resistant to the export of enterprises? Especially at the micro level, how will environmental information disclosure affect the export behavior of enterprises? The solution to these problems

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will be of great significance to the formulation of environmental information disclosure policy and adjustment of trade strategy for enterprises.

Current research on environmental information disclosure focuses on two aspects, namely, influencing factors and economic consequences of environmental information disclosure. A large number of studies show that shareholder interest (De Villiers and Van Staden, 2010), environmental regulatory pressure (Ahmad et al., 2019), media supervision (Tu et al., 2019), ownership structure (Liu et al., 2010; Pucheta-Martinez et al., 2019), and other factors can affect the environmental information disclosure behavior of enterprises. In terms of the economic consequences of environmental information disclosure, studies have confirmed that environmental information disclosure will exert an impact on corporate value (Plumlee et al., 2015) and corporate financing constraints (Dilla et al., 2019). However, the studies on the impact of environmental information disclosure on enterprises' exports are few. Therefore, this study provides marginal contribution for theory and practice.

In theory, this study applies legitimacy, stakeholder, voluntary information disclosure, neoclassical, new trade, and information transmission theories to investigate the export effect of enterprises. By refining the cost, innovation, subsidy, financing, and social trust effects of environmental information disclosure on export, the mechanism of environmental information disclosure on enterprise export in theory is discussed.

In practice, first, this study provides direct empirical evidence on whether environmental information disclosure can directly promote export, and finds a U-shaped relationship between environmental information disclosure and enterprise export. Second, this study compares the differences between soft environmental information disclosure (*EIDS*) and hard environmental information disclosure (*EIDH*) on the export of enterprises, which can provide a reference for future environmental information disclosure strategies of enterprises. Finally, this study examines the cost effect, innovation effect, subsidy effect, financing effect, and social trust effect of environmental information disclosure on export, which can help to provide comprehensive policy recommendations for promoting enterprise export.

The remainder of this study is structured as follows. Section 2 provides the literature review. Section 3 discusses the mechanism analysis and Hypothesis. Section 4 presents the methodology. Section 5 analyzes the empirical results and discussion. Section 6 concludes and poses the implications.

2. Literature review

2.1. Environmental information disclosure and enterprise behaviors

Research on the impact of environmental information disclosure on enterprises focuses on enterprise value and enterprise financing.

We consider the impact of environmental information disclosure on corporate value. First, many studies proposed that environmental information disclosure is beneficial to corporate value. For example, Rosa et al. (2015) collected annual and sustainability reports of 50 Brazilian companies and found that environmental information disclosure can improve the economic performance of enterprises. (Ahmad et al.2019) argued that a strict environmental information disclosure mechanism can improve the innovation ability of enterprises and enhance the competitiveness and profits of companies based on pollution information transparency indexes. Second, other studies considered that environmental information disclosure is unconducive to corporate value. For example, Hassel et al. (2005) put forward that the disclosure of environmental information is unfavorable to company value in the Swedish security market. Third, several studies showed that environmental information disclosure is unrelated to corporate value. For example, Cormier and Mangan (2007) selected 337 German companies as the research object and used coding tools to measure the level of environmental information disclosure. The results showed that the relationship between environmental information disclosure and corporate value was non-significant.

Studies on the impact of environmental information disclosure on corporate financing presented that environmental information disclosure can ease the financing constraints of enterprises. For example, Luo et al. (2019) found that the cost of debt financing decreased by 0.31% for every 1% increase in the quality of environmental information disclosure. Dilla et al. (2019) established that the quality of environmental information has an important impact on investor confidence of enterprises, that is, companies with a high quality of environmental information disclosure can obtain high investor support, thus reducing financing costs.

2.2. Environmental regulation and enterprise export

The studies on the direct impact of environmental information disclosure on enterprises' exports are few, whereas those on the impact of environmental regulation on enterprises' exports are numerous. Therefore, the present study focuses on environmental regulation and enterprises' exports.

Scholars who hold that environmental regulation has a negative impact on export argued that strict environmental regulation measures, as a new constraint for firms to maximize profits, increase the cost of export enterprises. This increase in cost not only affects the labor productivity of export enterprises but also affects the trade interest and trade structure of a country. Murty et al. (2006) explored the Indian Sugar Company and found that the company's pollution control cost increased by 15% for every 1% increase in environmental regulation intensity, which exerted a negative impact on export. Arouri et al. (2012) argued that Romania's stringent environmental regulations may increase the cost of enterprises, which may lead to loss of competitiveness, that is, a decline in exports on the one hand and an increase in imports on the other hand. Shi and Xu (2018) found that a strict environmental regulation in pollution-intensive industries can reduce the possibility of enterprises' export.

Other studies pointed out that environmental regulation can effectively promote the export of enterprises. For example, Levinson and Taylor (2010) proposed that environmental regulation does not benefit export behavior. Porter's Hypothesis posits that environmental control is unfavorable to export. Wang et al. (2016) found that strict environmental regulations exerted a positive impact on China's export transformation and upgrade and improved the export of green high-value-added manufactured goods. Yang et al. (2017) inspected the impact of environmental regulation on the export of graphite resources in China. The results showed that environmental regulation can promote R&D investment in the national graphite industry and promote the export scale of enterprises by improving the quality of graphite products. Eisenbarth (2017) hypothesized that environmental regulation has a significant positive impact on the export scale of 10 industries, such as ferrous and non-ferrous metal smelting, and the effect on the leather, fur down and metal product industries is unclear. Moreover, Li et al. (2019) suggested that environmental regulation can promote export scale by enhancing the technological innovation ability of the new energy automobile industry and by improving the quality of export products.

Although the above mentioned stream of research does not directly involve environmental information disclosure and enterprise export, it can help analyze the influence paths of

environmental information disclosure on enterprise export. The cost effect of environmental information disclosure may be unfavorable to enterprise value, but its innovation effect can significantly promote enterprise value. Cost and innovation effects can also be applied to the influence path of environmental information disclosure on exports. Furthermore, in analyzing the influence of environmental regulation on enterprise export, this paper divides impact into negative and positive according to the results, which correspond to the cost effect of environmental regulation and Porter's Hypothesis. Relevant theories of industrial export can also facilitate the understanding of the influence mechanism of environmental information disclosure on export.

3. Mechanism analysis and hypotheses

3.1. Direct influence of environmental information disclosure on export

The direct impact of environmental information disclosure on exports can be explained based on the following theories. First, legitimacy theory states companies must abide by certain social norms, actively bear the responsibility of social environmental protection, and adopt environmental information disclosure to prove their legitimacy (Suchman, 1995). In addition, based on voluntary information disclosure theory, disclosing environmental protection behavior and attitude can reduce environmental risk (Porter and Der Linde, 1995). Therefore, environmental information disclosure is a means of distinguishing high-quality enterprises from other enterprises, which can improve the market recognition of enterprises and promote export decisions. Second, stakeholder theory states that a company adopts a certain manner of information disclosure to reveal its attitude toward and investment on environmental protection to relevant stakeholders and gain their attention and support (Moser and Martin, 2012). Therefore, environmental information disclosure can reduce information asymmetry between enterprises and consumers, reduce information barriers between exporters and importers, and thus promote the export scale of enterprises. Therefore, this study puts forward the following Hypothesis.

Hypothesis 1. Environmental information disclosure can promote export decision and export scale.

3.2. Influence path of environmental information disclosure on export

3.2.1. Cost effect

The cost of environmental information disclosure of enterprises can be divided into four categories, namely, resource consumption, resource stock maintenance, environmental development, and environmental information reporting costs (Lu and Abeysekera, 2017). The resource consumption and maintenance costs of resource stock are mainly the energy-saving measures of enterprise producers. Environmental development cost denotes the additional cost of environmental protection activities held by enterprises, and environmental information report cost pertains to the human and material resources spent in preparing environmental reports. Environmental investment and other environmental costs consume certain resources; thus, environmental information disclosure cost is inevitable. First, based on neoclassical theory, bearing environmental responsibility entails the payment of certain expenditure and high investment cost. Strict environmental supervision will increase the cost of enterprises, and a certain balance exists between corporate interests and costs. Standard neoclassical theory also supports the cost Hypothesis, that is, enterprises increase their investment to reduce environmental pollution and marginal benefits, which hinders export decisions. Second, according to new trade theory, environmental costs undoubtedly stimulate production costs, which is not beneficial to export (Melitz, 2003). Environmental information disclosure will not only attract the attention of environmentally friendly individuals, but also lead to the internalization of pollution control cost under a high level of supervision, which will result in increased enterprise production costs. However, entry to international export markets have strong barriers, and enterprises with high production costs may be unable to exceed sunk costs, which is unfavorable to export. Therefore, this study puts forward the following hypothesis.

Hypothesis 2a. Environmental information disclosure will increase production cost, which is not conducive to export.

3.2.2. Innovation effect

Environmental supervision and environmental policy will force enterprises to carry out green technology innovation (Rothenberg and Zyglidopoulos, 2010). The information disclosure of listed companies will inevitably improve the attention and supervision pressure of enterprises, and the motive force of technological innovation and green production of enterprises will become emphatic. Therefore, environmental information disclosure can encourage enterprises to improve production technology, thus enhancing the international competitiveness of products (Albrizio et al., 2017). That is, environmental information disclosure mainly through innovation compensation effect to achieve competitiveness. In addition, the technological innovation of enterprises can significantly improve the quality of export products, which further promotes export. Therefore, this study puts forward the following Hypothesis:

Hypothesis 2b. Environmental information disclosure will improve technological innovation and promote export.

3.2.3. Subsidy effect

Environmental information disclosure can attract additional government subsidies for enterprises, which promote exports. The mechanism can be explained based on stakeholder and voluntary information disclosure theories. Many studies showed that local governments have a close interest relationship with enterprises, that is, reputation community (Spraggon, 2013). Local governments target environmental protection and emission reduction with enterprises as the subject of pollutant discharge and environmental protection. The government focuses on whether or not enterprises can cooperate to carry out environmental protection. Second, based on voluntary information disclosure theory, an enterprise's active disclosure of environmental information is beneficial not only to the establishment of a good reputation, but also to the environmental protection work of the relevant government departments. Third, based on the interest relationship between the government and enterprises in environmental governance and to obtain subsidies, enterprises will take the initiative to disclose environmental information, whereas the government will decide whether enterprises meet the standards for obtaining government subsidies. This decision is based on the level of environmental information disclosure of enterprises. A high level of environmental information disclosure will enhance the credibility of enterprises because of information asymmetry, which is also in line with legitimacy theory of information disclosure (Endres et al., 2015). The government deems that enterprises who disclose information are supporters of environmental protection policies and abide by the law and will provide enterprises with a certain environmental compensation.

Therefore, the government will increase the provision of certain subsidies to enterprises who comply with environmental information disclosure either as an encouragement or compensation.

When enterprises obtain certain government subsidies, they will promote export (Girma et al., 2010). Government subsidies can first overcome the sunken cost of enterprise exports and push enterprises to cross the export threshold. Moreover, government subsidies can significantly reduce the search cost of foreign information and establishment of sales channels faced by exports and increase the export participation rate of enterprises (Alston and Gray, 2010). In addition, foreign markets frequently pose high requirements for the quality of domestic products, and enterprises can meet the needs of foreign countries by increasing R&D investment after receiving subsidies, which in turn promotes export participation. Therefore, this study puts forward the following Hypothesis.

Hypothesis 2c. Environmental information disclosure will increase the proportion of government subsidies, thereby promoting export.

3.2.4. Financing effect

According to signal transmission and stakeholder theories, several companies adopt a method of disclosing environmental information to convey their development status to stakeholders. Creditors can decide whether or not to increase loans or raise loan interest rates to protect the personal interest of bondholders based on the environmental performance and business attitude of enterprises (Liu and Anbumozhi, 2009). Most investors will maintain a low risk assessment for enterprises with good environmental performance due to risk aversion preference, thereby promoting the bank loans of enterprises. These investors find that environmental information disclosure can alleviate the cost of debt financing. Enterprises subject to strict financing constraints may have negative export behavior. Compared with traditional international trade theory, heterogeneous enterprise trade theory explains the export differences across enterprises within the same industry. Melitz (2003) explained that only highly productive enterprises can make a large profit on exports to compensate for fixed costs. Chaney (2016) introduced liquidity constraints into the Melitz model and found a negative impact of financing constraints on exports. By exploring the internal resources of enterprises in coping with sunk cost related to export, Bellone et al. (2010) concluded that when enterprises are unable to obtain external financing, they face a certain debt constraint, whereas a new entrant to export enterprise should use its working capital to pay for sunk costs. Considering the impact of environmental information disclosure on financing constraints and the impact of financing constraints on exports, environmental information disclosure can promote export by relaxing financing constraints. Therefore, this study puts forward the following Hypothesis.

Hypothesis 2d. Environmental information disclosure can alleviate financing constraints, which is conducive to export.

3.2.5. Social trust effect

Based on legitimacy and voluntary information disclosure theories, many listed companies will endeavor to actively disclose positive environmental information to avoid the negative impact of pollution on enterprises (Brammer et al., 2006). On the one hand, good reputation is an intangible asset for enterprises based on corporate reputation theory, which improves product competitiveness. Enterprises that disclose high-quality environmental information will increase the public's sensitivity to and promote the market share of the enterprise (Costantini and Mazzanti, 2012). On the other hand, investors assess enterprises' performance in terms of environmental responsibility by analyzing annual and social responsibility reports to decide whether or not to invest. Therefore, environmental information disclosure may strengthen the proportion of enterprise recognition and market share, thereby facilitating export behaviors.

Many scholars believe that the negative social impact of environmental information disclosure is notable (Rothenberg and Zyglidopoulos, 2010). First, environmental information disclosure may be detrimental to the reputation of companies that are subject to high regulatory costs. These negative factors may compromise market value and reduce competitiveness. Second, companies with positive financial performance may negatively disclose environmental information because investors may perceive companies that disclose environmental information to be burdened with potential environmental problems, which reduces social trust. Third, environmental information should be reasonably disclosed, such that excessive disclosure may indicate that enterprises should bear increased environmental responsibility and a large amount of environmental investment to win the recognition of the public. However, maximizing the normal investment of enterprises is possible, which may result in the decreased enthusiasm of export. Therefore, this study puts forward the following Hypothesis.

Hypothesis 2e. The social trust impact of environmental information disclosure on export is unclear. Disclosure will increase market share and promote export to a certain extent, whereas excessive information disclosure will exhaust the normal investment of enterprises, which is unfavorable to export.

3.3. Influence of different types of environmental information disclosure on export

The guideline for environmental information disclosure of listed companies issued by the Ministry of Environmental Protection in 2010 requires listed companies to disclose environmental information. Item 9 and Item 10 stipulate "information to be disclosed in the annual environmental report" and "encouraging listed companies to disclose the following environmental information in the annual environmental report". The former includes information such as the occurrence of major environmental problems, the completion of total emission reduction tasks, and the payment of pollutant discharge fees according to law, etc. The latter includes the environmental protection concept of operators, the environmental management organization structure and environmental protection objectives of listed companies, and other environmental information, etc. According to the environmental information disclosure guidelines for listed companies, the Ministry of Environmental Protection emphasizes that listed companies should disclose information on various environmental issues and other hard indicators, while the requirements for soft indicators such as environmental protection objectives and environmental protection concepts of listed companies are encouraging.

In order to compare the impact of different types of environmental information on the economic behavior of enterprises, this paper divides the evaluation indexes into hard index (*EIDH*) and soft index (*EIDS*) with reference to this guide (Kosajan et al., 2018). The index of *EIDH* pertains to revealing the shortage of environmental protection and investment in environmental protection using quantitative indexes, such as R&D expenditure of environmental performance and related environmental fine expenditure. The index of *EIDS* reveals the determination and initiative of environmental protection using qualitative indexes, such as enterprise environmental protection policy and environmental protection goal (Luo et al., 2019).

EIDH reflects the negative environmental impact of enterprises in daily production and operation. Based on sustainable development theory, stakeholders pay increased attention to the sustainability of enterprises and fulfillment of environmental responsibilities due to the increasingly severe environmental pollution (Meng et al., 2014). Hard environmental information intuitively reveals the consumption of resources and its negative impact on the environment. Disclosing a large amount of hard environmental information influences consumers and investors' assessment of the environmental protection potential of enterprises, which may reduce the financing convenience and social trust of enterprises. Thus, the promotion of enterprises' export becomes limited.

EIDS reflects the subjective efforts of enterprises to undertake environmental responsibility and importance attached to environmental responsibility. Disclosing soft environmental information can enhance the information transparency of enterprises. When enterprises disclose more soft environmental information, consumers and investors are likely to maintain high expectations regarding the development ability of enterprises. Such expectation is conducive to improving financing convenience and social trust of enterprises, thus promoting the export of enterprises. Therefore, this study puts forward the following Hypothesis.

Hypothesis 3. Different types of environmental information disclosure have different impacts on export, among which *EIDS* is more conducive to export.

Fig. 1 summarizes the main research hypotheses of this study.

4. Methodology

4.1. Econometric model

The export behavior of enterprises is related to environmental information disclosure. Thus, the export decision of an enterprise may not be entirely random. Therefore, using the traditional *OLS* and *Probit* estimation methods will produce certain selective errors. To address this concern, this study adopts the *Heckman two-step* model, which is divided into two stages. The first is the export decision model, that is, whether enterprises opt to export, and the second pertains to the modified export scale model to investigate the factors that influence the export scale of exported enterprises. The *Heckman two-step* model can effectively identify whether the role of environmental information disclosure is achieved by affecting the export decision or by acting on the export scale of enterprises. The empirical models are set as follows:

$$P\{EXPD_{it}=1\}=\beta_0+\beta_1 EID_{it}+\beta_2 EXPD_{it-1}+\sum\beta_i Controls_{it}+\tau_i+\tau_t+\mu_{it} \quad (1)$$

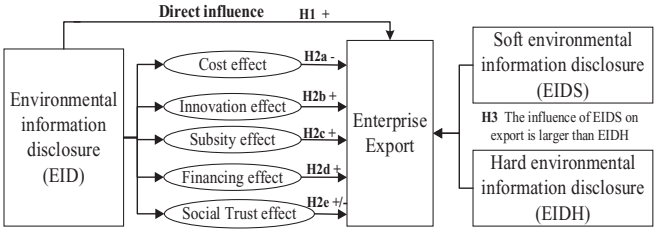

Fig. 1. Mechanism framework.

$$EXPS_{it}=\beta_0+\beta_1 EID_{it}+\sum\beta_i Controls_{it}+\gamma_i+\gamma_t+\nu_{it} \quad (2)$$

where $EXPD_{it}$ is a dummy variable that indicates whether or not enterprise i is exported. $EXPD_{it}$ takes a value of 1 when the enterprise is an export enterprise. Otherwise, it is 0. EID_{it} denotes environmental information disclosure. $EXPD_{it-1}$ refers to a lag of one term for the export dummy variable. τ_i and τ_t represent regional- and time-fixed effects, respectively, in the export decision equation. μ_{it} refers to the random disturbance term of the export decision equation. In equation (2), $EXPS_{it}$ denotes the export scale, which was measured using the logarithmic value of the export delivery value of the enterprise. γ_i, and γ_t represent regional- and time-fixed effects, respectively, in the export scale equation. ν_{it} pertains to the random disturbance term of the export scale equation. $Controls_{it}$ refers to control variables.

4.2. Variables

4.2.1. Environmental information disclosure (EID)

The quality of environmental information disclosure is typically measured by the *EID* index. Based on the annual social responsibility reports published by listed companies, we utilized Wiseman (1982) index to evaluate environmental information disclosure. Records of non-disclosure of environmental information, disclosure of general non-amount information, disclosure of quantity information, and disclosure of amount information are given values of 0, 1, 2 and 3, respectively. The total score of *EID* quality is obtained by summing up each indicator. The calculation formula of the environmental information disclosure score is derived as follows:

$$EID_{it}=\sum_{i=1}^{n} eid_{ijt}$$

where EID_{it} denotes the total score of environmental information items disclosed by company i in year t, eid_{ijt} is the score of environmental information item j of company i in year t, where $j=1, 2, 3, \ldots, 10$, which includes 10 categories of environmental information. The higher the score of the *EID* index is, the higher the quality of environmental information disclosure is.

Table 1 presents the contents of environmental information disclosure according to the statistics of environmental information disclosed by listed companies. Hard environmental information indicators include items (1), (2), (3), (6), (7), (8) and (10), whereas soft environmental information indicators include items (4, (5) and (9).

The trend of *EID* in Fig. 2 reflects that the disclosure quality of various environmental indicators is annually increasing with an obvious growth trend. The value of *EID* reached 6508 in 2013 from 2,852 in 2007, which indicates that the trend of environmental information disclosure is gradually optimized in China.

Based on the Classification of Environmental Protection Verification Industry of Listed Companies and the guide to environmental information disclosure of listed companies, the industries of listed companies can be divided into 9 heavily polluted, such as thermal power, pharmaceutical, chemical, and papermaking industries and 11 non-heavily polluted, such as communications, tourism, real estate, finance, and commerce industries. Table 2 provides the values of *EID* of each industry. Notably, we observe significant industry differences in *EID*, among which the value of *EID* in heavy polluted industries is higher, such as the metallurgy (11002), thermal power (10001), and chemical (8101) industries, whereas non-heavily polluted industries have poor disclosure performance, such as the software (398), tourism (311), and

Table 1
Evaluation indexes and types of environmental information disclosure.

Item	Content	Type
(1)	Enterprise environmental protection investment and environmental technology development	Hard
(2)	Environmental-related government grants, financial subsidies and tax breaks	Hard
(3)	Emission and reduction of pollutants in enterprises	Hard
(4)	Information related to ISO environmental system certification	Soft
(5)	Ecological environment improvement measures	Soft
(6)	The influence of government environmental protection policy on enterprises	Hard
(7)	Loans related to environmental protection	Hard
(8)	Legal action, compensation, fine and reward related to environmental protection	Hard
(9)	The concept and goal of enterprise environmental protection	Soft
(10)	Other items of income and expenditure related to the environment	Hard

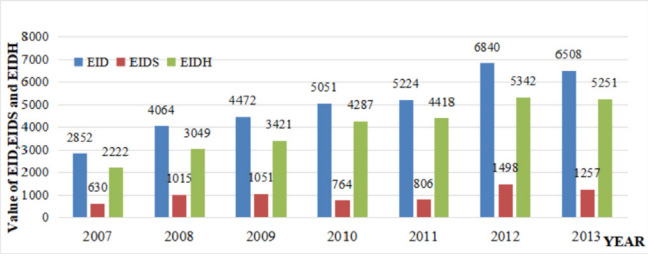

Fig. 2. Trend of environmental information disclosure (2007–2013).

Table 2
Environmental information disclosure for different industries.

Heavy polluted industries	EID	Non-heavy polluted industries	EID
Metallurgy	11002	Real estate industry	1381
Thermal power	10001	Transportation Industry	1233
Chemical industry	8101	Construction industry	1126
Mining industry	3670	Communication industry	1077
Spinning and weaving	2987	Agricultural processing	852
Papermaking	1833	Mechanical industry	710
Brewing industry	1299	Financial industry	501
Building materials	132	Trade and business	411
Pharmaceutical industry	59	Software industry	398
		Tourism industry	311
		Electron industry	28

Note: The EID value of each industry refers to the aggregate value from 2007 to 2013.

electronic (28) industries. In the institutional environment of voluntary environmental information disclosure in China, heavy-polluted industries are under strict supervision and are provided with more initiatives for environmental information disclosure.

4.2.2. Interaction effect variables

In the mechanism analysis, we investigate the cost, innovation, financing, subsidy, and social trust effects of environmental information disclosure on enterprises' exports. To test whether or not environmental information disclosure will affect exports through the paths mentioned above, we use the following variables to test the impact of *EID* and their interaction terms on export.

(1) Cost of production (*COST*). The cost of an enterprise is measured by the ratio of main business cost to enterprise sales. To eliminate the influence of sales quantity, we describe production cost by the ratio of main business cost to enterprise sales.
(2) Innovation (*INN*). This variable is measured by the number of patent applications per capita per year. The number of patent applications is derived from the China Stock Market & Accounting Research database (CSMAR).
(3) Financing capability (*FIN*). In this paper, the current ratio is used as a measure of financing ability (Greenaway and Kneller, 2007). The current ratio is the ratio of current assets to current liabilities. It is used to measure the ability of a company's current assets to repay liabilities before the maturity of short-term debts. Generally speaking, the higher the current ratio, the stronger the liquidity of the enterprise assets, the stronger the solvency, and the stronger the financing ability.
(4) Government subsidy (*SUB*). This variable is measured by the ratio of subsidized income to sales (Luo et al., 2019).
(5) Market share (*MAR*). Jansen and Nahuis (2003) pointed out that market share can reflect the trust of enterprises in the consumer market. For enterprises, the market share is the most important market measure. The market share leader can control the initiative, occupy the first position in the minds of consumers, and promote the export of enterprises (Wang et al., 2017). Market share (*MAR*) refers to the proportion of sales of an enterprise in the entire industry and measured by the ratio of annual sales of an enterprise to the total sales of the industry to which the enterprise belongs (Zeng et al., 2010).

4.2.3. Control variables

Considering that the export of enterprises is affected by other factors, based on the existing research (Spraggon, 2013; Yang et al., 2017; Luo et al., 2019), the basic characteristics of enterprises (enterprise scale, age, total factor productivity) and the financial characteristics of enterprises (enterprise capital intensity, profit margin, directors' shareholding ratio) are selected as control variables.

(1) Enterprise size (*SIZE*). It is measured by the logarithm of the number of employees in the enterprise. Generally speaking, the larger the enterprise scale is, the stronger the stability of the enterprise operation is, which is the basis for the steady growth of the enterprise (Girma et al., 2010). Therefore, it is estimated that its impact on the export is positive.
(2) Enterprise age (*AGE*). It is measured by the difference between the year of the current year and the year of the enterprise's opening (Shi and Xu, 2018). The life cycle theory states that enterprises have different growth laws in different life stages, and the age of enterprises has an important influence on the growth of enterprises. Many mature enterprises may have stable cooperative relations, thus promoting the export.
(3) Total factor productivity (*TFP*). According to the theory of heterogeneous firm trade, firm productivity and export scale

show a positive correlation (Melitz, 2013). This paper uses LP estimation method to measure the total factor productivity.

(4) Capital intensity (*CAP*). Enterprises with higher capital intensity have higher technology and capital level, which is more conducive to improving export performance (Sosin and Fairchild, 2009).

(5) Enterprise profit margin (*PRO*). Enterprises with high profit margin are very active in export decision-making and export scale because they have enough capital to resist export risks (Yi and Wang, 2012).

(6) Directors' shareholding ratio (*DIR*). The higher the shareholding ratio of directors, the stronger the ability of shareholders to intimidate the management, and the stronger the decision-making efficiency of the management, which is conducive to promoting work efficiency and enterprise export (Bellone et al., 2010).

4.3. Data source

The sample is from the China Stock Market & Accounting Research database (CSMAR) and China Industry Business Performance Data. Among them, CSMAR database is an economic and financial research database with large scale, accurate information and comprehensive data in China. It is developed by guotai'an company based on the academic research needs and the professional standards of international famous databases. CSMAR database series is the only database product selected for research service system of Wharton Business School (WRDS) in Greater China. It has been highly recognized by Nobel laureate Robert William Fogel. At present, the content has been expanded to 15 series and 115 sub databases, including more than 2000 tables, tens of thousands of indicators and more than 40,000 fields, including stocks, companies, funds, bonds, derivatives, economy, industry, money market, overseas, sectors, information, technology finance, special topics, etc. The data can be traced back to 1949. So far, more than 1000 universities (such as Harvard University, Peking University, etc.) and research institutions (such as Boshi fund, China Securities, etc.), more than 15,000 customers, and more than 17,000 high-quality papers published in first-class journals have used CSMAR database.

The sample covers data from 2007 to 2013. This period was selected because the China Stock Market & Accounting Research (CSMAR) database was established in 2007, whereas the latest year with available data from the China Industry Business Performance Data is 2013. The data cover the size, output value, profit, and number of employees and export information of enterprises. However, they lack detailed information about enterprise information disclosure. Thus, data from the CSMAR and China Industry Business Performance Data were matched and constitute the research sample of this study.

Owing to discrepancies of certain enterprise information in the database, we further screened data as follows. We omitted enterprises established before 1949. Second, we excluded samples with missing, zero, or negative value in any item, such as industrial output value, sales value, fixed asset data, and interest expenditure. Third, samples with a substantial lack of information disclosure were filtered out. Lastly, samples with less than 10 employees were rejected. Thus, the total number of enterprise samples used for analysis is 708. Table 3 presents the main variables.

5. Empirical results and discussion

5.1. Baseline results

This study uses the Heckman two-step method to test the impact of environmental information disclosure on export. Table 4 provides the baseline results. As the coefficients of *Mills lambda* have passed the significance test, using the method is reasonable. In addition, the lag value of export decision ($EXPD_{-1}$) is significantly positive, which not only meets the effective identification conditions of the Heckman model, but also shows that previous export decisions can promote export in the current period. Considering that environmental information disclosure items can be divided into soft and hard indexes, the influence of *EIDH* and *EIDS* are also considered, as shown in columns (3)–(6).

Next, we analyze the effect of *EID* on export. The coefficients of *EID* under columns (1)–(2) are significantly positive, which indicates that *EID* is beneficial to the export decision and expansion of export scale. Thus, Hypothesis 1 is supported.

In columns (3)–(4), *EIDH* can significantly promote export decision. However, its impact on export scale is negative. When *EIDH* increases by 1%, the export incidence of enterprises also increases by 0.032%, whereas the export scale decreases by 0.011%. The reason behind this mechanism is that *EIDH* can improve recognition and social trust, render enterprises confident in trade activities, and thus facilitate export decisions. For enterprises that already had export behavior, higher *EIDH* indicates that enterprises face higher pressure. The burden of environment governance and the supervision and control of enterprise export become increasingly stringent, which is not conducive to the expansion of export scale.

The coefficient of *EIDS* under column (5) is significantly positive, that is, *EIDS* can improve the export incidence of enterprises because it is mainly derived from the qualitative expression of enterprise environmental protection attitude and determination. Promoting confidence in environmental protection can also improve the reputation of enterprises, which is conducive to overseas market development. In column (6), the impact of *EIDS* on export scale is not significant at this stage.

By analyzing the control variables, the coefficient of *SIZE* is significantly positive. The larger the enterprise scale is, the easier it is to form scale effect in export, so as to encourage enterprises to make more profits by using the international market. The coefficient of *AGE* is significantly positive, this may be because the longer the age is, the more experience the enterprise has accumulated, and a certain brand effect and international export supply and marketing relationship will be formed. The coefficient of *TFP* is significantly positive, indicating that high productivity enterprises are more inclined to export, which is in line with the theoretical expectation of heterogeneous enterprise trade theory (Melitz, 2003). The coefficient of *CAP* is significantly positive, which is contrary to the conclusion of traditional factor endowment theory. The possible explanation for this is that China's export in the world is relatively excellent at present. The trend has changed from labor-intensive products to capital intensive products, so enterprises with higher capital labor ratio tend to export (Alessandria and Choi, 2014). The coefficient of *PRO* is significantly positive, indicating the positive correlation between enterprise profit rate and export. The coefficient of *DIR* is significantly positive, which also shows that the higher the management efficiency is, the better the export is.

5.2. Nonlinear regression results

Based on the baseline regression in Table 4, the positive and negative effects of different environmental information disclosure on export scale are relatively different, where *EID* is the sum of *EIDS* and *EIDH*. The reason for the difference in regression results may be the nonlinear relationship (Fig. 3). According to the 3 fitting curves between *EID*, *EIDS*, *EIDH*, and export scale (*EXPS*), *EID* and *EIDH* may have U-shaped and EIDS inverted U-shaped relationships, respectively, with *EXPS*.

Table 3
Description of variables.

Variable	Abbr.	Description	Mean	Std	Min	Max
Dependent variables						
Export decisions	EXPD	EXPD = 1, else = 0	0.36	0.18	0.00	1.00
Export scale	EXPS	Logarithmic value of export value	3.83	1.28	0.00	17.80
Core independent variables						
Environmental information disclosure	EID	Total score of each information disclosure item	2.62	1.97	0.00	16.00
Soft environmental information disclosure	EIDS	Total score of 4, 5 and 9 items	0.56	0.18	0.00	7.00
Hard environmental information disclosure	EIDH	Total score of 1,2,3,6,7,8 and 10 items	2.06	1.71	0.00	15.00
Interaction effect variables						
Cost of production	COST	The ratio of main business cost to enterprise sales	0.28	0.13	0.00	0.60
Innovation	INN	Number of per-person patent application	0.01	0.09	0.00	3.40
Financing capability	FIN	The ratio of interest expense to fixed assets	0.39	0.24	0.07	0.52
Government subsidy	SUB	The ratio of government subsidy income to enterprise sales	0.27	0.14	0.03	0.52
Market share	MAS	Ratio of the annual sales to the total sales of its industry	0.26	0.17	0.03	0.39
Control variables						
Enterprise scale	SIZE	The number of employees (in logs)	4.00	2.03	0.01	6.69
Enterprise age	AGE	Firm age (in logs)	6.09	4.98	0.01	6.08
Total factor productivity	TFP	Calculated by LP method[a]	5.13	4.19	−4.40	9.82
Capital intensity	CAP	The ratio of real capital stock to annual sales	0.21	0.15	0.02	0.75
Enterprise profit margin	PRO	The ratio of net profit to the sales	0.36	0.12	0.01	0.82
Directors' holding shares ratio	DIR	Proportion of directors holding shares in CSMAR database	0.12	0.04	0.00	0.17

[a] LP method is a method proposed by Levinsohn and Petrin (2003) to estimate TFP, which can better overcome the endogenous problem.

Table 4
Baseline results.

	(1)	(2)	(3)	(4)	(5)	(6)
	EXPD	*EXPS*	*EXPD*	*EXPS*	*EXPD*	*EXPS*
EID	0.073** (2.09)	0.063* (1.68)				
EIDH			0.082*** (4.89)	−0.076** (−2.08)		
EIDS					0.074*** (3.98)	0.075 (1.55)
SIZE	0.022*** (3.97)	0.002*** (3.99)	0.012*** (4.01)	0.032*** (3.97)	0.086*** (3.97)	0.001*** (4.01)
AGE	0.034* (1.72)	0.002* (1.76)	0.304* (1.84)	0.033* (1.74)	0.035* (1.83)	0.134* (1.73)
TFP	0.035*** (6.95)	0.245*** (5.92)	0.025*** (5.95)	0.033*** (7.96)	0.044*** (10.95)	0.204*** (5.93)
CAP	0.015*** (3.48)	0.015*** (3.52)	0.015*** (3.49)	0.008*** (3.48)	0.011*** (3.49)	0.025*** (3.48)
PRO	0.895** (2.42)	0.903** (2.45)	0.933** (2.44)	0.902** (2.44)	0.898** (2.43)	0.881** (2.38)
DIR	2.561* (1.83)	2.569* (1.73)	2.521* (1.71)	2.541** (2.02)	2.541*** (3.02)	2.558*** (4.03)
$EXPD_{-1}$	0.001*** (3.33)		0.244*** (3.87)		0.933*** (4.67)	
CONS	3.136*** (35.02)	3.155*** (35.29)	3.125*** (35.79)	3.137*** (35.58)	3.14*** (31.46)	3.125*** (34.98)
Mills lambda	0.113**		0.043***		0.197***	
Wald test	678.18***		7781.27***		651.30***	

Note: The value in parentheses is the T statistics; ***, * *, * indicate 1%, 5% and 10% significant levels, respectively.

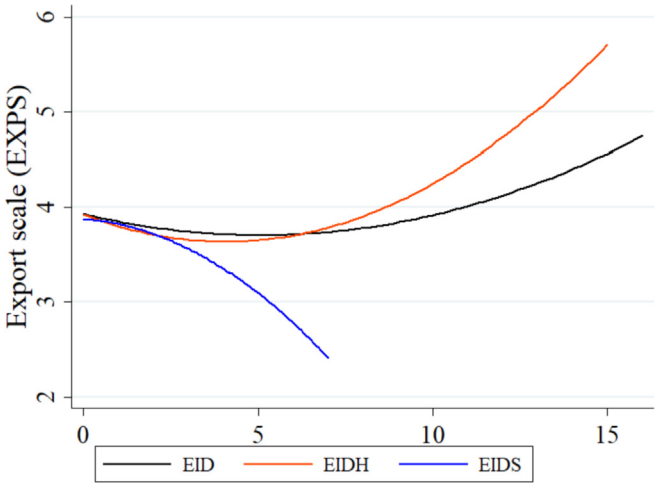

Fig. 3. Fitting curves between *EID*, *EIDH*, *EIDS* and export scale (*EXPS*).
Note: Drawn by the Stata 14. software.

Therefore, we add the quadratic terms *EID_sq*, *EIDS_sq*, and *EIDH_sq* into the baseline regression models to test the existence of nonlinear relations in Table 5.

The coefficients of the quadratic term (*EID_sq*) in columns (1)–(2) are significantly positive, with a U-curved relationship between *EID* and export scale. That is, *EID* is initially unconducive to the export scale but becomes positive after reaching a certain critical point. The reason behind this notion is that *EID* will stimulate enterprises to make a large investment in environmental protection, thus crowding out enterprise export investment, which is unconducive to export. However, this scenario will gradually transform into technological innovation that promotes export. At the same time, the long-term establishment of environmental protection reputation will enhance market demand, consumer satisfaction, and other mechanisms, thus expanding export scale.

The coefficients of *EIDS_sq* under columns (3)–(4) are significantly negative, which indicates that the relationship between *EIDS* and export scale is an inverted U shape, that is, *EIDS* first promotes export scale, produces positive effects, and turns negative after reaching a certain critical value. *EIDS* will aggravate the burden of corporate environmental responsibility, and leaders of listed companies may over-invest in environmental protection to strengthen personal social evaluation, which will easily lead to loss of profits,

Table 5
Nonlinear regression results.

	(1)	(2)	(3)	(4)	(5)	(6)
	EXPD	*EXPS*	*EXPD*	*EXPS*	*EXPD*	*EXPS*
EID_sq	0.014*** (2.99)	0.208*** (5.07)				
EID	−0.075** (−2.03)	−0.057** (−2.00)				
EIDS_sq			−0.256*** (−7.99)	−0.084* (−1.74)		
EIDS			0.501** (2.00)	0.081* (1.75)		
EIDH_sq					0.072** (2.01)	0.054** (2.09)
EIDH					0.072 (0.49)	−0.001** (−2.42)
SIZE	0.075** (2.05)	0.024** (2.07)	0.079** (2.07)	0.047** (2.05)	0.070** (2.05)	0.025** (2.07)
AGE	0.426* (1.74)	0.431* (1.76)	0.429* (1.86)	0.425* (1.78)	0.425* (1.74)	0.427* (1.79)
TFP	0.042*** (3.97)	0.055*** (3.99)	0.032*** (4.01)	0.042*** (3.97)	0.077*** (3.97)	0.113*** (4.01)
CAP	0.645* (1.73)	0.293 (1.02)	0.603** (2.15)	0.033 (1.23)	0.645* (1.73)	0.022 (0.94)
PRO	0.754** (2.05)	0.197** (2.25)	0.272 (1.03)	0.016 (0.36)	0.754** (2.05)	0.202 (0.92)
DIR	0.016* (1.67)	0.015 (1.59)	0.016* (1.68)	0.024** (2.17)	0.655** (2.29)	0.345** (2.12)
$EXPD_{-1}$	0.325*** (9.16)		0.539*** (7.47)		0.115** (2.14)	
CONS	0.307*** (36.03)	0.304*** (34.06)	0.303*** (34.57)	0.306*** (36.34)	0.306*** (36.79)	0.309*** (37.24)
Mills lambda	0.064**		0.031**		0.053***	
Wald test	117.78***		274.82***		873.26***	

Note: ***, * *, * indicate 1%, 5% and 10% significant levels, respectively.

which is therefore unconducive to export.

The coefficients of *EIDH_sq* under columns (5)–(6) are significantly positive, which indicates that *EIDH* has a U-shaped effect on export scale, that is, *EIDH* initially inhibits export and generates a negative effect. The effect is then converted into a positive one after reaching a certain critical point. The reason behind this tendency is that *EIDH* implies that enterprises are under the pressure of environmental pollution fines and environmental management investment, which is unconducive to increasing financing and market shares. In addition, when information is public to a certain extent, the recognition of enterprises increases, financing constraints are eased, and export is improved.

5.3. Influence path test

Results in Table 6 were utilized to test for the presence of cost, innovation, financing, subsidy, and social trust effects on the influence of *EID* on export, as previously mentioned.

(1) Cost effect. The coefficients of *COST* under columns (1)–(2) are significantly negative, which indicates that the increase in enterprise cost is one of the influencing factors that hinder the enterprise export. The coefficients of the interaction term *EID*COST* are also negative, which shows that the increase in production cost caused by *EID* has a certain inhibition effect on export scale, which is consistent with Hypothesis 2a. This finding indicates the cost effect caused by *EID*.

(2) Innovation effect. In column (3)–(4), the coefficients of *INN* are significantly positive, that is, technological innovation can promote export scale. Currently, the export of Chinese enterprises has changed from quantitative to quality expansion, and the influence of technological innovation in export should not be underestimated, which is the reason for the high coefficients of *INN*. The coefficients of the interaction item *EID*INN* are significantly positive, which indicates that *EID* will exert further external regulatory pressure to technological transformation, which forces enterprises to carry on innovation compensation and promotes export scale.

(3) Financing effect. In columns (5)–(6), the influence coefficients of *FIN* on export scale are significantly positive. The stronger the financing ability is, the more beneficial it is to the export of enterprises, which is consistent with the conclusions of other studies (e.g., Costantini and Mazzanti, 2012). The coefficients of the interaction term *EID*FIN* are significantly positive, that is, *EID* relaxes the financing constraints of enterprises by strengthening the trust and recognition of debtors to enterprises, thereby strengthening the promotion of financing capacity toward export.

(4) Subsidy effect. The coefficients of *SUB* in columns (7)–(8) are significant, which indicates that the subsidy effect on listed companies can promote export. In addition, the coefficients of interaction *EID*SUB* are also significantly positive, that is, environmental information disclosure can strengthen the interaction between government and enterprises. Based on stakeholder theory, the efficiency of government subsidies to information disclosure enterprises will increase, thus promoting export.

(5) Social trust effect. The coefficients of *MAS* in column (9)–(10) pass the 1% significance test and are positive, which indicates that the higher the market share is, the more favorable it is for export. However, the coefficients of the interaction term *EID*MAS* fail to pass the significance test. The reason may be that environmental information disclosure cannot only enhance the corporate reputation to attract more investment, and may be because of the large exposure to negative information intensified the concerns of the investors and trade manufacturer, reduce social trust, the uncertainty caused by such dual impacts can lead to the fact that environmental information disclosure has no significant effect on export by social trust.

5.4. Heterogeneity test

5.4.1. Dividing the samples according to region

We divide the data according to the provinces where enterprises locate, namely, central, western, and eastern regions. Results show that compared with the central and western regions, the environmental information disclosure of enterprises in eastern regions has a greater impact on exports. The main reasons include two points, namely, the eastern region has more financial resources, listed companies and higher quality of environmental information disclosure than the central and western regions. Therefore, environmental information disclosure has a greater impact on enterprises export in the eastern region. Second, the eastern region has the highest level of openness and export opportunities. Appropriate disclosure of environmental information will strengthen the

Table 6
Regression results of impact paths.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	EXPD	*EXPS*	*EXPD*	*EXPS*	*EXPD*	*EXPS*	*EXPD*	*EXPS*	*EXPD*	*EXPS*
EID	0.002*** (4.98)	0.044* (1.88)	0.039** (2.31)	0.043*** (2.81)	0.042* (1.69)	0.084** (2.02)	0.128** (2.46)	0.201*** (4.01)	0.036* (1.81)	0.004*** (4.08)
COST	−0.248*** (−4.22)	−0.009** (−2.28)								
*EID*COST*	−0.672* (−1.81)	−0.024** (−2.24)								
INN			0.033* (1.81)	1.288* (1.88)						
*EID*INN*			0.002** (2.01)	0.024*** (4.08)						
FIN					0.041** (2.29)	0.089** (2.08)				
*EID*FIN*					4.462*** (8.94)	0.006*** (4.24)				
SUB							0.033** (2.14)	0.881* (1.82)		
*EID*SUB*							0.026* (1.84)	0.084*** (3.08)		
MAS									0.002** (2.01)	0.043*** (4.88)
*EID*MAS*									0.004 (1.03)	0.081 (1.01)
SIZE	0.036 (0.32)	0.023*** (4.69)	0.066** (2.24)	0.203*** (24.63)	0.303** (2.02)	0.478*** (4.64)	0.247*** (4.2)	0.024***(8.64)	3.282*** (7.22)	0.404***(24.64)
AGE	0.03 (0.82)	0.024*** (6.47)	0.027** (2.48)	0.022*** (3.48)	4.423*** (3.62)	0.234*** (3.42)	0.024** (2.36)	0.028***(3.42)	0.303** (2.02)	0.026***(3.46)
TFP	0.002** (2.02)	0.868** (2.09)	0.247 (0.82)	0.266** (2.43)	3.282*** (20.22)	0.622** (2.46)	0.036 (0.32)	0.208** (2.46)	4.423*** (3.62)	0.867** (2.43)
CAP	0.004* (1.83)	0.444* (1.72)	0.224*** (3.08)	0.443* (1.82)	0.032* (1.76)	0.628** (2.04)	0.703 (0.82)	0.486* (1.84)	0.282*** (20.22)	0.224* (1.68)
PRO	0.386*** (7.34)	0.434 (0.72)	2.037** (2.22)	0.304* (1.83)	0.043** (2.46)	0.203* (1.78)	0.002** (2.02)	0.202* (1.68)	0.032* (1.76)	0.004* (1.84)
DIR	0.026 (0.74)	0.402** (2.24)	0.227 (0.46)	0.083*** (4.64)	3.784*** (3.86)	0.203*** (4.63)	0.004* (1.83)	0.403***(4.64)	0.036** (2.26)	0.024** (2.01)
EXPD$_{-1}$*	0.086*** (3.66)		0.284*** (8.87)		0.274*** (4.67)		0.026*** (8.66)		0.267*** (7.27)	
CONS	3.233*** (7.46)	0.402** (2.26)	0.034** (2.24)	0.028*** (4.68)	3.784*** (3.77)	0.287*** (4.23)	0.386*** (7.34)	0.763***(4.24)	3.767*** (3.27)	0.274***(4.84)
Mills lambda	0.108***		0.1116***		0.106***		0.201***		0.104***	
Wald test	116.38***		366.67***		806.84***		868.66***		606.06***	

Note: ***, * *, * indicate 1%, 5% and 10% significant levels, respectively.

communication between enterprises from the import and export sides, which is beneficial to export.

5.4.2. Dividing the samples according to ownership types of enterprises

The influence of enterprises with different ownership types on environmental information disclosure is obviously different (Chen et al., 2014). State-owned enterprises (SOE) may disclose environmental information more actively. The ownership forms of enterprises include SOE, collective holding, private enterprises (PRE), foreign-funded enterprises (FOE), among others. Considering that SOE, PRE, and FOE constitute the largest proportions, we focus on these ownership types. The coefficients of *EID* are significant in columns (1)–(2) and columns (5)–(6), but not significant in columns (3)–(4), which indicates that SOE and FOE may have more advantages in environmental information disclosure. When the level of environmental information disclosure increases by 1%, the export incidence of SOE increases by 0.021%, whereas the export incidence of FOE increases by 0.058%. When the level of environmental information disclosure increases by 1%, the export scale of SOE increases by 0.017%, whereas the export scale of FOE increases by 0.022%.

5.4.3. Dividing the sample according to pollution level

Considering that enterprises with different pollution levels have varying quality of environmental information disclosure (Table 2), heavy-polluted enterprises, such as metallurgical, thermal power, and chemical industries disclose more environmental information. Results in Table 9 indicate that the coefficients of *EID* under columns (1)–(2) are significantly higher than that in columns (3)–(4), which indicates that environmental information disclosure has a greater promotion effect on the export of heavy-polluted enterprises. On the one hand, heavy-polluted enterprises are under the greater pressure of social supervision. By continuously disclosing environmental information, these enterprises obtain more social trust and financing support, which is conducive to export. On the other hand, heavy-polluted enterprises can obtain favorable impression from the government by disclosing environmental information. With the increase in government subsidies, it is conducive to the expansion of enterprise export.

5.5. Discussion

Currently, research on the direct impact of *EID* on enterprise export is lacking. The existing literature on EID mainly focused on enterprise performance, enterprise financing cost, and enterprise cash flow. Few scholars have studied the impact of environmental information disclosure on export behavior. The present study observed a U-shaped relationship between EID and enterprise export, which is innovative in practice and in theory.

The U-shaped relationship between *EID* and enterprise export is reasonable because the impact of environmental regulation on

enterprise export can be divided into cost effect and Porter's Hypothesis in the analysis of existing literature on environmental regulation and enterprise export. Scholars insisted that environmental regulation cannot promote export due to high costs. However, other scholars proposed that the innovation incentives generated by environmental regulation can improve product quality, thereby promoting enterprise export. This study concludes that environmental information disclosure cannot promote export when *EID* fails to reach a certain level, but its impact on export becomes positive when it reaches this value.

In terms of practice, we take the Shanghai Petrochemical Enterprise as an example. By actively disclosing environmental information, the enterprise has been successively awarded the title "National Customer Satisfaction Enterprise" for several years. Although the cost of environmental information disclosure is much higher than the short-term environmental benefits, enterprises that publish timely social responsibility reports and transparently convey environmental information obtain stakeholder support. Long-term environmental benefits bring the advantages of sustainable development to enterprises.

In terms of theory, this paper clarifies the impact mechanism of environmental information disclosure on the export of enterprises by legitimacy, stakeholder, voluntary information disclosure, neoclassical, new trade, and information transmission theories in Section 3.2. These theories verify the scientific results of heterogeneity analysis. For example, (1) the information transmission theory reveals that enterprises can gain more trust from trade manufacturers through positive information disclosure, while the openness of the eastern region is higher. Therefore, the conclusion that the eastern enterprises have the greatest impact on exports through environmental information disclosure in Table 7 is supported by theory. (2) The existence of stakeholder theory proves the enthusiasm of state-owned enterprises in environmental information disclosure. Due to the closer relationship between state-owned enterprises and the government, Table 8 shows that it is reasonable for Chinese enterprises to promote exports by disclosing more environmental information. (3) The existence of legitimacy theory proves that pollution intensive enterprises are more inclined to disclose environmental information, which verifies the result that heavy polluting enterprises can improve export performance by disclosing more environmental information in Table 9.

Considering the impact paths of environmental information disclosure on enterprises export, this study concludes that cost effect is non-conducive, whereas financing, innovation, and subsidy effects are conducive to enterprises export. Social trust effect remains unclear. Compared with existing studies, the cost and innovation effects of environmental regulation on enterprises exports have been verified (Costantini and Crespi, 2008), whereas the subsidy, financing, and social trust effect of environmental regulation have received less attention. However, Fonseka et al. (2019) focused on the environmental information disclosure of the energy industry and found that the environmental information disclosure of natural gas, thermal power, and hydropower enterprises can reduce the financing cost of enterprises, which is beneficial to the understanding on the financing effect of environmental information disclosure in export theory. In addition, Liu et al. (2010) analyzed environmental information disclosure from the perspective of accounting. The results show that it can facilitate iron and steel enterprises to obtain additional government subsidies. Lu and Abeysekera (2017) proposed that environmental information disclosure can promote consumer and investor confidence and improve the social trust of enterprises. These studies can indirectly support the rationality of the path analysis of environmental information disclosure.

By comparing the export effects of different types of environmental information disclosure, we found that *EIDS* has a large positive impact on enterprise exports. This finding is supported by other studies, such as Luo et al. (2019), who pointed out that *EIDS* can enhance investor confidence and Cheng et al. (2017) who found that *EIDS* can promote stock price. This result may also be related to the status quo of China's information disclosure. To date, China's environmental information disclosure is in the initial stage. *EIDH* occurs less often, whereas the opposite is true for *EIDS* due to high cost of *EIDH*. In testing the non-linear relationship, the impact of *EIDS* on enterprises' export initially increases then decreases. That is, in the early stage of information disclosure, *EIDS* promotes exports. However, in the case of excessive disclosure, it will have a negative impact. Therefore, in future enterprise planning, the proportion of soft environmental information should be moderately reduced, whereas the proportion of hard environmental information should be increased.

5.6. Limitations

The limitations of this study are as follows. First, the data adopted are matching data from the China Industry Business Performance Data and CSMAR databases, which were used to analyze the impact of environmental information disclosure on enterprise exports. The latest updated data from the China industrial enterprise database is 2013. Thus, the empirical data cannot be generalizable after 2013. This point can be further improved after

Table 7
Regression results of different regions.

	Eastern		Central		Western	
	(1)	(2)	(3)	(4)	(5)	(6)
	EXPD	*EXPS*	*EXPD*	*EXPS*	*EXPD*	*EXPS*
EID	0.996** (6.35)	0.936*** (5.95)	0.043*** (5.96)	0.066*** (5.95)	0.015*** (5.17)	0.063** (6.64)
SIZE	1.669*** (2.77)	0.696** (2.44)	0.966** (2.14)	0.006 (0.24)	0.026 (0.19)	0.044 (0.42)
AGE	0.461 (0.99)	0.476 (1.04)	0.414 (0.67)	0.066** (2.44)	0.066* (1.72)	0.044** (2.44)
PRO	4.104*** (4.04)	4.12*** (6.97)	2.996*** (4.44)	0.002*** (4.97)	0.002*** (4.97)	0.002*** (4.96)
CAP	0.001 (0.21)	0.047 (1.06)	0.004 (0.96)	0.066** (2.06)	0.066** (2.49)	0.066** (2.06)
TFP	0.046* (1.71)	0.604*** (2.84)	0.016*** (4.47)	0.016*** (4.46)	0.266* (1.67)	2.694** (2.01)
DIR	0.202*** (4.69)	0.416** (2.19)	0.006*** (4.72)	0.066 (1.27)	0.066 (1.27)	0.022 (1.27)
$EXPD_{-1}$	0.024*** (4.44)		0.114*** (7.67)		0.266*** (4.00)	
CONS	0.444*** (6.46)	4.006*** (7.96)	0.646*** (4.21)	6.007*** (4.07)	0.006*** (4.69)	0.101*** (6.12)
Mills lambda	0.114***		0.166***		0.164***	
Wald test	77.260***		94.096***		110.607***	

Note: ***, * *, * indicate 1%, 5% and 10% significant levels, respectively.

Table 8
Regression results of different ownership.

	State-owned enterprises (SOE)		Private enterprise (PRE)		Foreign-funded enterprise (FOE)	
	(1)	(2)	(3)	(4)	(5)	(6)
	EXPD	*EXPS*	*EXPD*	*EXPS*	*EXPD*	*EXPS*
EID	0.021*** (3.42)	0.017** (2.48)	0.001 (0.42)	0.014 (0.56)	0.058*** (3.91)	0.022*** (3.86)
SIZE	0.002** (2.15)	0.092*** (5.95)	0.049*** (5.96)	0.022*** (5.95)	0.055*** (5.08)	0.099** (2.24)
AGE	0.002*** (9.98)	0.015*** (9.49)	0.015*** (9.48)	0.015*** (9.48)	0.014*** (9.29)	0.114* (1.81)
TFP	0.016* (1.89)	0.159* (1.82)	0.016* (1.86)	0.286*** (5.11)	0.099** (2.11)	0.899 (0.68)
CAP	0.088*** (9.28)	0.066* (1.82)	0.066 (0.28)	2.699** (2.09)	0.098* (1.81)	0.692* (1.81)
PRO	0.088*** (2.99)	0.086*** (5.95)	0.055*** (2.95)	0.182* (1.69)	0.004* (1.89)	0.051** (2.29)
DIR	0.002*** (9.98)	0.015*** (9.49)	0.002*** (9.98)	0.899** (2.19)	0.016* (1.86)	0.286*** (5.11)
EXPD-1	0.088** (2.56)		0.088** (2.54)		0.116*** (5.22)	
CONS	0.424* (1.89)	2.544 (1.02)	0.426* (1.84)	0.106 (0.19)	0.989*** (8.95)	4.462*** (8.94)
Mills lambda	0.908***		0.904***		0.699***	
Wald test	996.62***		694.65***		699.89***	

Note: ***, * *, * indicate 1%, 5% and 10% significant levels, respectively.

Table 9
Regression results of different trade firms.

	Heavy-polluted enterprise		Non-heavy polluted enterprise	
	(1)	(2)	(3)	(4)
	EXPD	*EXPS*	*EXPD*	*EXPS*
EID	1.886*** (4.52)	2.991*** (3.07)	0.044*** (5.26)	0.014*** (4.94)
SIZE	0.077 (0.19)	0.073 (0.72)	0.087 (0.19)	0.077 (0.82)
AGE	0.077** (2.35)	0.087** (2.23)	0.077** (2.42)	0.077** (2.33)
TFP	0.002*** (4.97)	0.002*** (3.97)	0.002*** (3.07)	0.002*** (5.98)
CAP	0.088** (2.17)	0.088** (2.17)	0.087** (2.49)	0.088** (2.57)
PRO	0.425* (1.84)	0.423* (1.83)	0.427* (1.85)	0.424* (1.83)
DIR	0.307*** (3.47)	0.309*** (3.35)	0.305*** (3.80)	0.308*** (3.72)
EXPD-1	0.245*** (3.94)		0.628*** (4.17)	
CONS	0.301*** (7.40)	0.242*** (7.51)	0.419*** (6.94)	0.165*** (7.38)
Mills lambda	0.022***		0.122***	
Wald test	393.23***		1038.18***	

Note: ***, **, * indicate 1%, 5% and 10% significant levels, respectively.

updating the database. Second, this study analyzes the impact of environmental information disclosure on the export of enterprises. However, obtaining environmental information disclosure data of non-listed companies is difficult because environmental information disclosure is only reported in listed companies, which results in a small sample size and is non-conducive for empirical analysis.

6. Conclusion and implications

Environmental problems caused by high levels of input, energy consumption, and pollution have seriously restricted the high-quality development of China's exports. At the same time, the government calls on listed companies to disclose environmental information to protect the environment. As a new form of environmental control measure, will environmental information disclosure affect the export of enterprises? This study analyzes this problem.

The empirical results show that: (1) *EID* has a significant influence on the enterprise's export decision. (2) The study found that *EID* and *EIDH* display a U-shaped relation to export scale, whereas *EIDS* has an inverted U-shaped relationship with export scale. (3) We further verify the impact mechanism of environmental information disclosure, that is, the cost effect of environmental information disclosure is unconducive to export. Innovation, financing, and subsidy effects significantly increase export scale, whereas the social trust effect of environmental information disclosure remains unclear.

The implications of this study are as follows.

First, the relationship between environmental information disclosure and enterprise export is nonlinear with phased characteristics of the impact of environmental responsibility performance on export. Initial environmental information disclosure may lead to increased production cost and innovation pressure for enterprises. Especially, the *EIDH* index is likely to place enterprises under more pressure from environmental governance, which is unconducive to enterprise performance and export behavior. At the same time, *EIDS* aims to promote the export of enterprises by promoting a positive image. When information disclosure reaches a certain level, hard environmental information can be transformed into the financing ability of the enterprises, innovation value, and other factors to promote export. Conversely, soft environmental information can be transformed into the financing ability, innovation value, and other factors of enterprises. Disclosure is manifested as excessive investment in social influence, which results in low efficiency of capital allocation. This scenario is unconducive to export. Therefore, reasonably grasping the proportion of the two types of information in enterprise environmental information disclosure is important for the development of enterprises. Environmental information disclosure has always been an encouragement to enterprises from the government and society. Moderate information disclosure is conducive not only for social trust in enterprises, but also for the development and promotion of prosperity of China's trade market.

Second, significant industry differences were observed in the export effect of environmental information disclosure. For non-heavy polluted industries, private industries and enterprises from the western region with poor disclosure quality, improving the laws and regulations of environmental information disclosure to be

more meticulous, further clarifying the responsibilities of enterprises in environmental information disclosure, and formulating specific standards of information disclosure and detailed rules of rewards and punishments are necessary.

Author contribution statement

Juan Lu: Conceptualization, Methodology, Software,Writing-Original draft preparation,Writing- Reviewing and Editing.

Bin Li: Supervision, Data curation.

He Li: Visualization, Investigation,Writing- Original draft preparation.

Yalong Zhang: Software, Validation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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