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Do Environmental Information Disclosure Policies Inhibit or Promote China's Export Growth?

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Abstract: *Using 29 Chinese provincial and municipal data from 2008 to 2017,We construct a stochastic frontier production model of trade to study the effects of environmental information disclosure (EID) policies on China's export growth. Our analysis shows that:At aggregate level, the EID policies inhibit China's export growth, while there are significant stage differences. From 2008 to 2013, the EID policies significantly inhibit China's export growth. From 2013 to 2017, the effect of EID policies on export growth change from inhibiting export growth to promoting export growth. Research on the impact mechanism shows,the EID policies inhibit export growth through cost increase effect and social effect, and promote export growth through innovation compensation effect. The main reasons why the impact of EID policies on exports has changed from inhibition to promotion are that the cost increase effect and social effect are gradually weakening over time while the innovation compensation effect is gradually increasing over time.*

Keywords: *Environmental information disclosure policies,China's export growth,Stochastic frontier model of trade*

1. Introduction

China's extensive economic growth model of "high pollution, high emissions, and high energy consumption" has brought about the rapid development of China's economy and exports, but it has also brought about extremely serious environmental pollution problems. In order to ensure economic growth and reduce environmental pollution, the Chinese government has issued a series of environmental regulation policies. As innovative environmental regulatory policies, environmental information disclosure (EID) policies have gradually become important guides for companies to practice energy conservation and environmental protection principles (Fang et al, 2019). The impact of EID policies on China's economic growth, especially on China's export growth, has attracted more and more scholar's attention.This paper aims to reveal whether the EID policies inhibit or promote China's export growth, analyze the impact mechanism and investigate the phased changes of EID policies on China's economic growth.

The research on EID policies mainly focuses on two aspects: First,Tu et al. (2019), Lin et al. (2020) studied the factors affecting the effect of EID policies from the perspectives of media supervision, pollution status and enterprise ownership.Second, Ahmad et al. (2019), Zhang et al. (2020) studied the policy effect of EID policies from the aspects of enterprise performance, enterprise innovation and enterprise value.So far, there are only four literatures directly discussing the impact of EID policies on exports, and the research conclusions are divergent.On the one hand, Fang et al. (2019) found that China's EID policies can reduce the export scale of enterprises by strengthening enterprise financing constraints and increasing production costs.On the other hand, Lu et al. (2020) investigated the impact of EID policies on exports, indicating that EID policies can promote enterprise's export.Yang Ye and Xie Jianguo (2020) found that EID policies can contribute to increase the domestic value-added of Chinese companies' exports. The shortcomings of the existing researches are that there are very little researches on the impact of EID policies on exports, and the existing researches are limited to the enterprise level. Moreover, the existing literatures have only studied the overall impact of EID policies on export growth,but failed to pay attention to the phase changes in its impact mechanism and the resulting phase changes in the suppression and promotion of EID policies on export growth.

Therefore, this paper constructs the stochastic frontier production function of trade based on the Cobb Douglas production function, introduces the EID policies into the model, and decomposes the driving force or resistance of China's export growth on the supply side into EID policies, material element input,

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trade potential and trade efficiency, combining the decomposition results of export growth, we study the phase changes of EID policies's impact on China's export growth, and finally examines the mechanism of EID policies's impact on export growth.

This paper makes the following contributions to the existing researches:

Firstly, at the research level, this paper makes up for the lack of macro research on the impact of EID policies on exports.Secondly, in the choice of models and variables, EID policies is introduced into the trade stochastic frontier model as a non-material factor input, and the impact of EID policies on export growth over the years is more intuitively investigated through the decomposition of export growth. Thirdly, in the research results, different from the single promotion or inhibition effect obtained in the existing research literature, this paper first analyzes the impact mechanism of EID policies on export growth from three aspects:cost rise effect, innovation compensation effect and social effect,At the same time, through empirical test, this paper analyzes the phased change of the impact of EID policies on China’s export growth from resistance to driving force.

2. Impact mechanism and research hypotheses

2.1 The impact of the cost increase effect of EID policies on export growth

Under the EID policies policy, enterprises need to hold more environmental protection activities, prepare EID policies reports, and make more investment in pollution control, resulting in the internalization of energy costs and management costs in the production process, and resulting in the rise of enterprise production costs (Geng Jianxin et al, 2007) According to the heterogeneous trade theory, the rise of enterprise production costs will weaken the export competitiveness of enterprises and reduce the profit space across the fixed export costs (Fang Ying and Guo Junjie, 2018). Therefore, the cost increase effect brought by the EID policies will significantly inhibit the export growth.

Hypothesis 1: EID policies inhibit export growth through the cost increase effect

2.2 The impact of innovation compensation effect of EID policies on export growth

According to the "narrow Porter Hypothesis", appropriate environmental policies can stimulate enterprises to carry out technological innovation, and relative technological advantage is an important source of comparative advantage in the process of international trade.The EID policies put forward higher requirements for energy conservation and environmental protection of enterprises. The pressure from government supervision and public opinion forces enterprises to increase investment in green innovation. The resulting technological progress significantly promotes the improvement of enterprise productivity and product quality, so as to promote enterprise production and export (Kang Zhiyong et al, 2018).

Hypothesis 2: EID policies promote export growth through innovation compensation effect

2.3 The impact of social effect of EID policies on export growth

Strict EID policies and high-intensity supervision will reduce the production enthusiasm of enterprises, which is not conducive to expanding production scale and inhibiting export growth.In addition, EID policies have led to the gradual exposure of corporate environmental issues, and enterprises face high-intensity supervision and environmental punishment, which will seriously affect the social reputation of enterprises and reduce the market recognition of enterprises and bring negative social effect, which is not conducive to export growth.

Hypothesis 3: EID policies inhibit export growth through social effect

3. Model setting and variable description

3.1 Model setting and export growth decomposition

Referring to Li Zhaohua and Wu Meng (2017), this paper takes carbon dioxide emission as a material element input and introduces EID policies in institutional arrangements. In the trade inefficiency equation, three factors that may affect trade efficiency are set as the control variables: the level of marketization, transportation infrastructure, and Internet infrastructure.

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This paper refers to Li Zhaohua and Wu Meng (2017), based on the Cobb-Douglas production function, setting the Stochastic Frontier Model of Trade in the form of equation (1) (2):

$$\ln EX_{it} = \alpha_0 + \alpha_1 t + \frac{1}{2}\alpha_2 t^2 + \sum_{n=1}^{N} \beta_n \ln X_{nit} + \sum_{n=1}^{N} \phi_n t \ln X_{nit} + v_{it} - u_{it} \quad (1)$$

$$u_{it} = \varepsilon_0 + \sum_{n=1}^{N} \varepsilon_n Z_{nit} + e_{it} \quad (2)$$

EX_{it} represents the export volume of goods of place i in year t. lnX_{nit} represents the level of EID policies, capital, human capital and carbon emissions.u_{it} is a non negative trade inefficiency term, which is assumed to obey a truncated normal distribution.Z_{nit} represents the influencing factors of trade efficiency, including transportation infrastructure, Internet infrastructure and marketization index, e_{it} is random disturbance.

The growth of export trade can be decomposed as follows:

$$\frac{\dot{EX}}{EX} = \frac{\partial \ln EX}{\partial t} = \frac{\partial \ln f(X,t)}{\partial t} + \frac{\partial \ln f(X,t)}{\partial \ln X}\frac{\dot{X}}{X} - \frac{\partial u}{\partial t} = \alpha_1 + \alpha_2 t + \sum_{n=1}^{N} \phi_n \ln X_{nit} + \sum_{n=1}^{N} (\beta_n + \phi_n t)\frac{\dot{X}_{nit}}{X_{nit}} - \frac{\partial u}{\partial t} \quad (3)$$

Contribution of trade potential to export growth $g_{potential}$ can be obtained from equation (4):

$$g_{potential} = \frac{\partial \ln f(X,t)}{\partial t} = \alpha_1 + \alpha_2 t + \sum_{n=1}^{N} \phi_n \ln X_{nit} \quad (4)$$

Contribution of factor inputs to export growth g_{input} can be obtained by equation (5), and g_{input} can be further decomposed into the material element input contribution of equation (6)and the contribution of EID policies of equation (7).

$$g_{input} = \frac{\partial \ln f(X,t)}{\partial \ln X}\frac{\dot{X}}{X} = \sum_{n=1}^{N} (\beta_n + \phi_n t)\frac{\dot{X}_{nit}}{X_{nit}} \quad (5)$$

$$g_{input1} = \sum_{n=1}^{N-1} (\beta_n + \phi_n t)\frac{\dot{X}_{nit}}{X_{nit}} \quad (6)$$

$$g_{EID} = (\beta_n + \phi_n t)\frac{\dot{EID}_{nit}}{EID_{nit}} \quad (7)$$

Contribution of trade efficiency to export growth g_{TE} can be obtained from equation (8):

$$g_{TE} = -\frac{\partial u}{\partial t} = \frac{TE_{t+1} - TE_t}{TE_t},\ TE_{it} = \frac{E(EX_{it} | u_{it}, X_{it})}{E(EX_{it} | u_{it} = 0, X_{it})} = \exp(-u_{it}) \quad (8)$$

Through equations (3) - (8), the driving force or resistance of export growth is solved into four parts: the contribution of material factor input, the contribution of EID policies,the contribution of changes in trade potential and trade efficiency.

3.2 Variable description and data source

This paper selects 29 provinces in China as the research object, excluding Hong Kong, Macao, Taiwan and Tibet and Hainan provinces with serious data loss.The data comes from China Statistical Yearbook, China Environmental Yearbook, China Industrial statistical yearbook.

The regional export value is calculated by using the total export value of each province's goods at the constant price in 2008.The EID policies index adopts the pollution source information supervision index (PITI) issued by the public environmental research center and the U.S. natural resources Protection Commission to construct the provincial Eid index.For capital investment, refer to Zhang Jun et al. (2004)

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to estimate capital investment with the perpetual inventory method, and the depreciation rate is 9.6%. Human capital is expressed by the weighted average years of education in each province.This paper directly uses the carbon emission data in ceads database.Transportation infrastructure, with reference to Li Zhaohua and Wu Meng (2017), is expressed as the sum of per capita highway and railway mileage in each province.Internet facilities are represented by the number of Internet broadband access ports per capita in each province.The marketization index adopts the marketization index in the report on marketization index of Chinese provinces issued by China economic reform research foundation.

4. Empirical test and result analysis

4.1 Model estimation results

This paper uses STATA16.0 to estimate the stochastic frontier production function, and the results are shown in Table 1:

Table 1 Estimation results of stochastic frontier model

Explanatory variable	coefficient	T ratio	Explanatory variable	coefficient	T ratio
Constant term 1	-4.7485	-1.48	*t*	0.8604***	3.51
lnEID	-0.4893***	3.94	t^2	-0.0117***	-3.85
lnK	0.2770***	2.96	Trade inefficiency equation		
lnC	0.2857	1.59	Constant term 2	4.0253***	23.11
lnHC	5.3560***	-2.83	*MAR*	-0.0263***	-3.91
*t*lnEID*	0.1214***	4.17	*TRA*	-165.8756***	-14.88
*t*lnK*	-0.0041	-0.41	*INT*	-0.2984***	-10.03
*t*lnC*	-0.0152	-1.38	*r*	0.9544***	66.74
*t*lnHC*	-0.4762***	-5.3	σ^2	1.7240***	3.33

Table 1 shows that, The coefficient of lnEID is significantly negative, indicating that EID policies have inhibition effect on export growth, but the coefficient of t*lnEID is significantly positive, indicating that this inhibition effect tends to weaken with time.

4.2 Decomposition of driving force of China's export growth and phase changes of EID policies

The driving forces of China's export growth from 2008 to 2017 are decomposed by using the estimation results in Table1 and above equations (3) - (8). The results are shown in Table 2. During the investigation period, EID policies has an overall inhibition effect on export growth, but there are obvious phased changes, and there are diametrically opposite effects in two stages.

Table 2 Decomposition of the driving forces of China's export growth in 2008-2017

Contribution (%)	EID policies	trade potential	Trade efficiency	Material elements input	Material elements input		
					K	*HC*	*C*
2008-2017	-0.42	4.54	3.00	4.11	2.11	0.96	1.04
2008-2013	-1.84	5.78	3.08	5.71	1.82	2.10	1.79
2008-2009	-2.16	7.42	3.11	7.67	0.95	4.16	2.56
2009-2010	-1.32	6.14	3.09	7.26	2.03	2.14	3.09
2010-2011	-4.12	5.95	3.09	5.40	1.64	1.11	2.65
2011-2012	-1.38	5.22	3.08	4.12	2.04	1.78	0.31
2012-2013	-0.21	4.15	3.04	4.08	2.44	1.29	0.36
2013-2017	1.36	2.98	2.91	2.11	2.47	-0.46	0.10
2013-2014	0.14	3.12	2.99	2.23	2.58	-0.35	0.00
2014-2015	2.40	3.40	2.94	1.46	2.65	-0.81	-0.38
2015-2016	2.63	3.31	2.88	2.48	2.56	-0.66	0.59
2016-2017	0.27	2.10	2.83	2.25	2.08	-0.03	0.20

This paper analyzes the reasons for the phase changes of driving forces of China's export growth as follows.

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Stage 1: From 2008 to 2013, the EID policies significantly inhibite export growth, and its annual average contribution to export growth is - 1.84%.On the one hand, in the early stage of EID policies, the cost of preparing environment report and reducing environmental pollution would increase, which would bring a strong cost increase effect and significantly reduce the cost advantage of export products and inhibit export growth.On the other hand, EID policies have led to the gradual exposure of corporate environmental problems, and the increase in administrative penalties and public complaints faced by companies has significantly inhibited export growth by restraining companies from opening international markets and expanding export channel. In addition, although the implementation of the information disclosure policy can force companies to invest in green innovation, the short-term innovation compensation effect of new R&D investment is not obvious in the early stage, and its role in promoting exports is weak. At this stage, the cost increase effect and social negative effect brought by EID poicies are stronger than the innovation compensation effect, so the EID policies inhibit export growth.

Stage 2: From 2013 to 2017, the impact of EID policies on exports changes from inhibition to promotion. The average annual contribution of EID policies to export growth is 1.36%.

On the one hand, with the accumulation of experience in EID policies and the improvement of environmental conditions, the cost increase effect brought by EID policies is gradually weakened and the inhibition effect on exports is weakened.On the other hand, with the improvement of environmental conditions, companies can demonstrate their environmental protection responsibilities, improve social reputation and obtain government subsidies by disclosing high-quality EID policies. The negative social effect brought about by EID policies is weakened.(Zhang Chen et al., 2019). In addition, with the accumulation of green innovation investment, the innovation compensation effect brought about by EID policies has gradually increased, and the technological advancement brought about by EID policies has significantly promoted the increase in enterprise productivity and the improvement of product quality, which has significantly promoted enterprise production and export. At this stage, the innovation compensation effect brought by EID policies is stronger than the cost increase effect and the negative social effect, so the EID policies promote export growth.

4.3 Impact mechanism test

Cost increase effect (COST) is measured by the investment intensity of environmental pollution control in each province.The innovation compensation effect (TEC) is measured by the number of patent authorizations per capita in each province, and the social effect (SOC) is measured by the ratio of the number of general, major, and particularly significant environmental events exposed by each province over the years to the total population. In addition, capital investment, human capital investment and environmental factor investment are added to the model as control variables.

The first step is to build a model of equation (9) - (11) to test the impact of EID policies on the three effects. The results are shown in Table 3:

$$\ln COST_{it} = \alpha_0 + \alpha_1 \ln EID_{it} + \sum \beta_i control_{it} + \lambda_i + u_t + \varepsilon_{it} \quad (9)$$

$$\ln TEC_{it} = \alpha_0 + \alpha_1 \ln EID_{it} + \sum \beta_i control_{it} + \lambda_i + u_t + \varepsilon_{it} \quad (10)$$

$$\ln SOC_{it} = \alpha_0 + \alpha_1 \ln EID_{it} + \sum \beta_i control_{it} + \lambda_i + u_t + \varepsilon_{it} \quad (11)$$

Table 3 Test results of various effects brought by EID policies

variable	(1) *lnCOST*	(2) *lnCOST*	(3) *lnTEC*	(4) *lnTEC*	(5) *lnSOC*	(6) *lnSOC*
lnEID	0.1242*	0.1323*	1.5418***	0.5861***	0.9243***	0.8269***
_cons	-4.4593***	-10.9109***	-3.1715***	-20.4114***	-0.981	-9.1313***
control variable	no	yes	no	yes	no	yes
Provincial fixed effect	yes	yes	yes	yes	yes	yes
Time fixed effect	yes	yes	yes	yes	yes	yes

The second step is to build a model of equation (12) - (14) to test the impact of various effects on export growth. The test results are shown in Table 4:

$$\ln EX_{it} = \alpha_0 + \alpha_1 \ln COST_{it} + \alpha_2 t * \ln COST_{it} + \sum \beta_i control_{it} + \lambda_i + u_t + \varepsilon_{it} \quad (12)$$

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$$\ln EX_{it} = \alpha_0 + \alpha_1 \ln TEC_{it} + \alpha_2 t * \ln TEC_{it} + \sum \beta_i control_{it} + \lambda_i + u_t + \varepsilon_{it} \quad (13)$$

$$\ln EX_{it} = \alpha_0 + \alpha_1 \ln SOC_{it} + \alpha_2 t * \ln SOC_{it} + \sum \beta_i control_{it} + \lambda_i + u_t + \varepsilon_{it} \quad (14)$$

Table 4 Test results of effects on export growth

variable	(1) *lnEX*	(2) *lnEX*	(3) *lnEX*	(4) *lnEX*	(5) *lnEX*	(6) *lnEX*
lnCOST	-0.2150***	-0.0310*				
*t*lnCOST*	0.0200***	0.0006				
lnTEC			0.5388***	0.4135***		
*t*lnTEC*			0.1286**	0.0021		
lnSOC					-0.1251***	-0.1041***
*t*lnSOC*					0.0326***	0.01922***
_cons	6.4915***	-5.6038**	6.8360***	-3.3301	7.0433***	-9.7319***
control variable	no	yes	no	yes	no	yes
Provincial fixed effect	yes	yes	yes	yes	yes	yes
Time fixed effect	yes	yes	yes	yes	yes	yes

(1) Cost increase effect test

It can be seen from models (1) and (2) in Table3 that the coefficient of lnEID is significantly positive whether control variables are added or not, indicating that EID policies significantly lead to cost increase effect. It can be seen from models (1) and (2) in Table 4 that whether the control variables are added or not, the coefficient of lnCOST is significantly negative, indicating that the cost increase effect brought by EID policies will significantly inhibit export growth. In addition, the coefficient of t*lnCOST is significantly positive, indicating that the inhibition effect of cost increase effect on export tends to weaken with time, which is consistent with the phase change of the cost increase effect analyzed above.

(2) Innovation compensation effect test

It can be seen from models (3) and (4) in Table 3 that the coefficient of lneid is significantly positive whether control variables are added or not, indicating that EID policies significantly enhance technological innovation.It can be seen from models (3) and (4) in Table 4 that whether the control variables are added or not, the coefficient of lnTECis significantly positive, indicating that the enhancement of technological innovation brought by EID policies can significantly promote China's export growth. In addition, the coefficient of t*lnTEC is positive, indicating that the promotion effect of innovation compensation effect on export growth has an increasing trend over time , which is consistent with the phase transition of the innovation compensation effect analyzed above.

(3) Social effect test

It can be seen from models (5) and (6) in Table 3 that the coefficient of lnEID is significantly positive whether control variables are added or not, indicating that EID policies will expose more environmental problems of enterprises and reduce their social reputation. It can be seen from models (5) and (6) in Table 4 that whether the control variables are added or not, the coefficient of lnSOC is significantly negative, indicating that the social negative effect brought by EID policies will significantly inhibit export growth. In addition, the coefficient of t* lnSOC is positive, indicating that the inhibition effect of social effect on export growth tends to weaken over time, which is consistent with the phase change of the social negative effects analyzed above.

5. Conclusions and policy implications

5.1 Research conclusions

This paper studies the impact of EID policies on China's export growth, focusing on the impact mechanism and stage changes. Research shows:

(1) On the whole, during the inspection period, EID policies as a whole has a inhibition effect on China's exports, but there are significant stage differences. From 2008 to 2013, the EID policies significantly inhibite export growth. At this stage, China's export growth mainly rely on the strong driving force of trade potential and material element input. From 2013 to 2017, the effect of EID policies on

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growth has changed from inhibition effect to promotion effect. At this stage, the driving force of China's export growth has shifted to trade potential, trade efficiency and material element input as the mainstay, supplemented by EID policies.

(2) The impact mechanism research shows that: EID policies will inhibit export growth through cost increase effect and social negative effect, and promote export growth through innovation compensation effect. The main reasons why the impact of EID policies on exports has changed from inhibition to promotion are that the cost increase effect and social effect are gradually weakening over time while the innovation compensation effect is gradually increasing over time.

5.2 Policy implications

(1) The impact of the implementation of the EID policies policy on China's exports has obvious phase characteristics. In the early stage of policy implementation, cost increase effect and social negative effectwill put greater pressure on enterprises' production and export. Appropriate environmental protection subsidies and financial support can be adopted to encourage enterprises to disclose environmental information and appropriately reduce the negative effect of environmental disclosure.

(2) The innovation compensation effect brought about by the EID policies is its main driving force to promote export growth. Encouraging enterprise technological innovation, increasing the technological content and added value of export products, and at the same time focusing on improving the technological disadvantages of the central and western regions, and achieving regional coordinated development are necessary conditions for the innovative compensation effect of the EID policies policy to continue to drive export growth.

(3)It's necessary to improve the reward and punishment system of the EID policies. Through a complete reward and punishment system, adequate incentives are given to "environmentally good enterprises" with high levels of EID policies and good environmental conditions, and publicity on public platforms can reduce the negative social effect brought about by EID policies to a certain extent, and reduce its inhibition effect on export growth.

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