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Applied Artificial Intelligence
An International Journal

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/uaai20

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To cite this article: Ye Feng (2023) Green Progress of Cross-border E-Commerce Industry Utilizing Random Forest Algorithm and Panel Tobit Model, Applied Artificial Intelligence, 37:1, 2219561, DOI: 10.1080/08839514.2023.2219561

To link to this article: https://doi.org/10.1080/08839514.2023.2219561

Published online: 09 Jun 2023.

APPLIED ARTIFICIAL INTELLIGENCE
2023, VOL. 37, NO. 1, e2219561 (2120 pages)
https://doi.org/10.1080/08839514.2023.2219561

Green Progress of Cross-border E-Commerce Industry Utilizing Random Forest Algorithm and Panel Tobit Model

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ABSTRACT

As both economies and trade broadly globalize, cross-border e-commerce (CBEC) as a branch of international trade has shown great potential for development. The construction of a CBEC realizes the integration and utilization of resources between the CBEC trading platform as the core element and other components of the system, cross-border logistics, payment enterprises, suppliers, and demanders, and improves the overall economic benefits. A model of economic progress at the expense of the environment emerges in the radical development of companies that do not consider the environment and simply earn high incomes at the cost of consuming resources. In this context, it is of great theoretical and empirical importance to examine how to improve the production efficiency of the CBEC supply chain, improve ecological quality and realize the production mode of "low input, high output, and low pollution." In this study, we evaluate the green development of the CBEC industry and study the factors that affect its efficiency level. According to the results of influencing factors, this paper mainly uses the random forest algorithm and panel Tobit approach to investigate the affecting attributes of environmental efficiency and suggest policies to improve the green progression efficiency of the CBEC industry.

ARTICLE HISTORY
Received 30 March 2023
Revised 24 May 2023
Accepted 25 May 2023

Introduction

More than 200 years of industrialization have modernized some countries, but both resources and the environment suffer from wide-scale destruction, and environmental problems are becoming increasingly prominent. The accumulation of "industrial waste" grows daily basis, and progressively becomes a dominant problem for every single country on earth. 5 million tons of yearly waste in 1947 has raised to more than 700 million tons in 2021. Industrialized nations contribute 95% of it. This is not in line with the international trends in the new economic environment. Cross-border logistics breaks the restrictions between countries and provides convenience for the flow of products for retail

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CBEC, which increases the profit rate of traditional foreign trade from nearly 5% to over 30% for foreign trade e-commerce. Under the general trend of maintaining sustainable environmental development, the green transformation of the CBEC logistics packaging industry is imperative (Zhang and Zhang 2022).

Since the reform and adaptation of market-based principles, the economy of China has been progressing at a high ratio and gradually occupying an indispensable and important position in the international economy. The GDP of China in 2019 was as high as 986,515.2 billion yuan, up 7.31% year-on-year, and in 2020 it was 1,015,986.22 billion yuan, up 3.00% year-on-year, and in 2021 was 1,143,669.7 billion yuan, a boost of 12.57% over the preceding year (Xiao 2022), as shown in Figures 1 and 2.

Under the background of the existing policy support and the rapid progress of e-commerce, China's CBEC ushered in an explosive growth period, forming a certain industrial cluster and transaction scale.

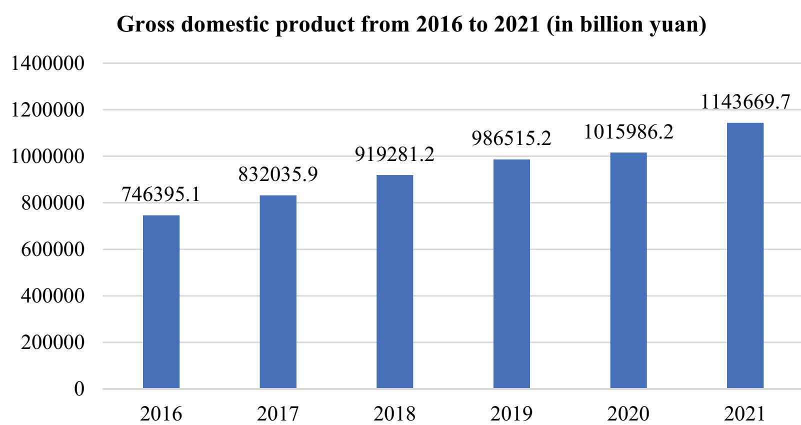

Figure 1. Gross domestic product 2016~2021.

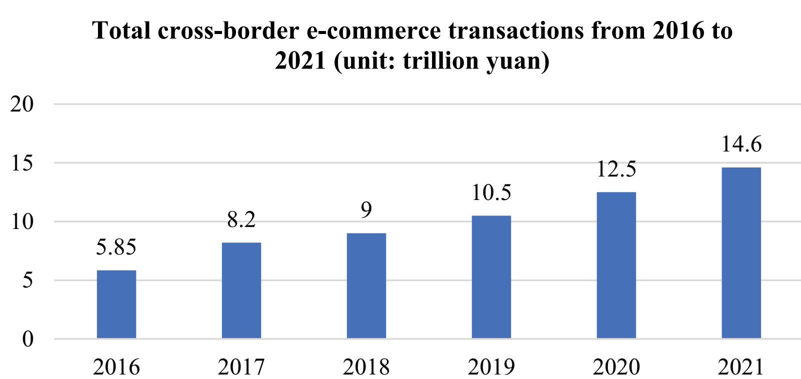

Figure 2. Total cross-border e-commerce transactions from 2016 to 2021.

In 2023, the scale of China's CBEC transactions is anticipated to expand to 9 trillion yuan, accounting for 19% of the overall foreign trade scale, with a yearly mean growth ratio of nearly 30%. In terms of numbers, more than 50,000 CBEC platform businesses and more than 200,000 domestic businesses execute CBEC through various platforms. While the economy has achieved significant progress, environmental issues are becoming more visible, and the traditional economic growth model of "high energy consumption," "poor output," "high pollution," and environmental sacrifice is no longer acceptable for long-term prosperity. China is about to face the daunting task of coordinating economic and environmental development, as well as the pressing need for economic change. As a result, it is critical to speed up the adjustment of industrial structure, promote economic transformation, and seek a win-win mode that grows the economy and protects the environment, per the Party's and the central government's important documents (Chen et al. 2022). At present, countries and regions around the world are paying great attention to reducing carbon dioxide production when developing their economies. Therefore, when our packaging could reduce the pressure on the local nature concerning the logic of cross-border goods, the target country will be more willing to buy the corresponding products from our country. Therefore, developing environment-friendly packaging, reducing pollution, and realizing sustainable development are becoming the mainstream of CBEC globally (Xia 2021).

Materials and Methods

Related Concepts

The Connotation of CBEC

CBEC could be simply defined as under the setting of incessant advancement of technology level, people's work and life are almost inseparable from the CBEC platform. The incessant advancement of CBEC not only eliminates the barriers between countries but also provides convenience to consumers. In the information age, CBEC carries out commodity transactions, including cross-border shopping and non-cross-border shopping, based on saving human resources and financial resources through online platforms to achieve global business interconnection. The international trading environment fully reflects the characteristics of globalization. In the time of mobile Internet, CBEC has broken the traditional face-to-face transaction form through modern information technology and realized online platform as the medium, paperless as the transaction mode, and finally realized digital transmission.

At this point, China's e-commerce development has matured, and the pertinent dataset is increasingly being integrated with statistics collected nationally and regionally. CBEC has been a developing idea stressing the breaking down of national or regional barriers to meet the strong demand for foreign items from customers in a "sunny" manner. According to (Xiaoye and Pei 2021), CBEC in a broad setting relates to the cross-border B2B mode. Transactions of trade conducted offline between domestic and foreign enterprises have been moved to online platforms; in a limited setting, CBEC mostly relates to cross-border retail (i.e., cross-border B2C mode), which refers to a cross-border commerce activity in which buyers and sellers from different customs borders reach a type of cross-border business activity. CBEC models are divided into three categories by (Xing 2021): B2B, B2C, and C2C. B2B2C and O2O models have emerged as CBEC approaches have been still under investigation and innovated. The attributes of CBEC, according to (Yang 2021), are diversification and mesh-like framework, short cycle time and high efficacy, small batch size and high frequency, and raising regulatory difficulties.

CBEC can be divided into B2B, B2C, and C2C types when the types of transactions are a concern. B2B refers to the CBEC platform in which both the supply and demand are enterprises, and the profits are made through advertising and membership. B2C refers to the online retail model in which enterprises directly connect to consumers, such as Tmall in the B2C industry, which is not directly involved in selling goods but provides a platform for sellers. C2C refers to the CBEC platform in which both the supply and demand are consumers. Cross-border e-commerce can be split into the platform, self-run, and hybrid type according to the operation mode of the platform. Platform mode refers to a company allocating a platform for domestic and foreign businesses to sell goods on it. The self-run mode does not provide a single platform, only an official business, in line with the model of independent operation; The hybrid model is both a platform model and a proprietary model.

Some scholars (Jiang et al. 2021) also analyze the concept of CBEC from a system perspective and believe that it mainly consists of information flow with "cloud" attributes, capital flow with "virtual finance" attributes, logistics with property rights attributes, and "human" attributes. The concept of e-commerce is mainly composed of 4 fundamental constituents: information flow with "cloud" features, capital flow with "virtual finance" features, logistics with property features, and "human" attributes. The "three flows" are: capital flow is the flow of funds formed during the transaction on the CBEC platform; logistics is the collection of spatial location movement of commodities in the whole cross-border transaction; information flow relates to the communication and information exchange in the whole business activity, which is the premise of realizing capital flow and logistics. From the directional analysis of commodity exchange flow, logistics is generally consistent with the direction of commodity movement; capital flow and movement of the commodity in the reverse direction; the flow of information is a two-way motion, and the "three flows" are interrelated and interacted with each other (Jiang et al.). In summary, cross-border e-commerce, alias CBEC, is called CBEC trade, or e-commerce for short. CBEC can help encourage both integration and global trade in the economy and is of huge strategic importance. To a great extent, CBEC has taken the lead in breaking down the barriers between countries and promoting borderless trade, and it has also caused substantial alterations in the world's economy and trade. For businesses, the open, multi-dimensional, and three-dimensional multilateral economic and trade cooperation approach constructed by CBEC has substantially brought opportunities to step into the international market and significantly encouraged the optimal allocation of multilateral resources and mutual benefits among businesses for consumers, CBEC makes it very simple for them to obtain information about other countries and buy goods at competitive prices.

The Connotation of Green Progress Efficacy in CBEC

Regarding environmental efficiency, academics hold varying viewpoints, and there is no universal definition. Different perspectives worldwide include eco-efficiency, enterprise, and input-output to define what environmental efficiency means.

When ecological efficacy is a concern, the definition of ecological efficiency was initially put forward by the WBCSD in 1992, which consists of resource efficiency and environmental efficiency (Wu). Since then, there have been international scientific studies on ecological efficiency. Schaltegger and Sturn (Wang 2021) think that ecological efficiency is the ratio of economic growth rate to environmental damage. Some well-known international economic organizations have also defined ecological efficiency. The United Nations' new environmental project working group (ukep) (Su Li and Wang 2021) believes that ecological efficiency creates a lot of economic benefits under the given resource and electric energy constraints. The International Finance Corporation (IFC) (Cheng and Min 2021) defines ecological efficiency as selecting effective production and manufacturing methods to improve resource utilization and maintain the concept of sustainable development. (Chen 2021) emphasized that environmental efficiency is the ratio of economic output rate to environmental load, which is used to measure the environmental cost of companies' economic improvement, and is the main indicator value to measure whether the economic environment is sustainable. Under the condition that the environment is the input of resources and funds, environmental efficiency stipulates the minimum input of resources and funds and the highest economic output rate, which can make more rational use of environmental resources (Niu, Zhang, and Zhang 2022). Although there are differences between ecological efficiency and environmental efficiency in concept, most experts and scholars use the ratio of economic growth value to environmental harm to measure the value of efficiency, which combines the measurement of resource utilization rate and the harm of economic theme activities to the environment.

From the perspective of the company, (Shuzhong and Liang 2021) studied the sustainable harm of environmental efficiency of economic development to the economic environment from the perspective of environmental efficiency of power businesses and selected the ratio of total environmental load to the sum of total sales and fossil energy consumption to express the environmental efficiency of Japanese power enterprises, which is extremely important. The environmental efficiency is the embodiment of network resource utilization and production capacity. The company can improve environmental efficiency by improving network resource utilization and production capacity.

From the perspective of capital input and output, (Qiu and Yang 2021) and others think that environmental efficiency refers to the rate of the least unexpected yield to the real unexpected yield that can be established under the given technical strength under the condition that the capital input and expected output will not change. (Zhizhen et al. 2021) thinks that environmental efficiency refers to the specific pollution development potential that can be fundamentally reduced at present under the condition that the capital input of maintenance attributes and the yield of economic development will not change. (Liu 2020) think that environmental efficiency is an index value that considers the specific unexpected derivation and the middle distance between the best pollution discharge of the management decision-making independent variable (economic development actor), and the input and expectation derivation will not change. From the perspective of political economy, efficiency refers to the analysis of how to minimize the probability of pollution fundamentally within the known perspective of capital input and output, with the forefront of environmental production and manufacturing as the selected reference target.

In general, the paper regards environmental efficiency as an evaluation index of economic development and environmental hazards, and fundamentally reduces the unexpected output from the original level of the economy with stable capital input and expected output, the distance between the economy and the best management decision-making module, and its development potential to fundamentally reduce pollutant emissions at present. The higher the environmental efficiency, the higher the utilization ratio of network resources for economic development, and the more harmonious the relation between CBEC and the environment.

Influencing Factors of Green Progression of CBEC

In this paper, the influencing attributes of green development efficiency of CBEC are analyzed by utilizing the environmental Kunetz curve' theory based on 3 levels: economic, institutional, and geographical (Zhou 2020). The economic level factors are industrial structure, economic scale, and

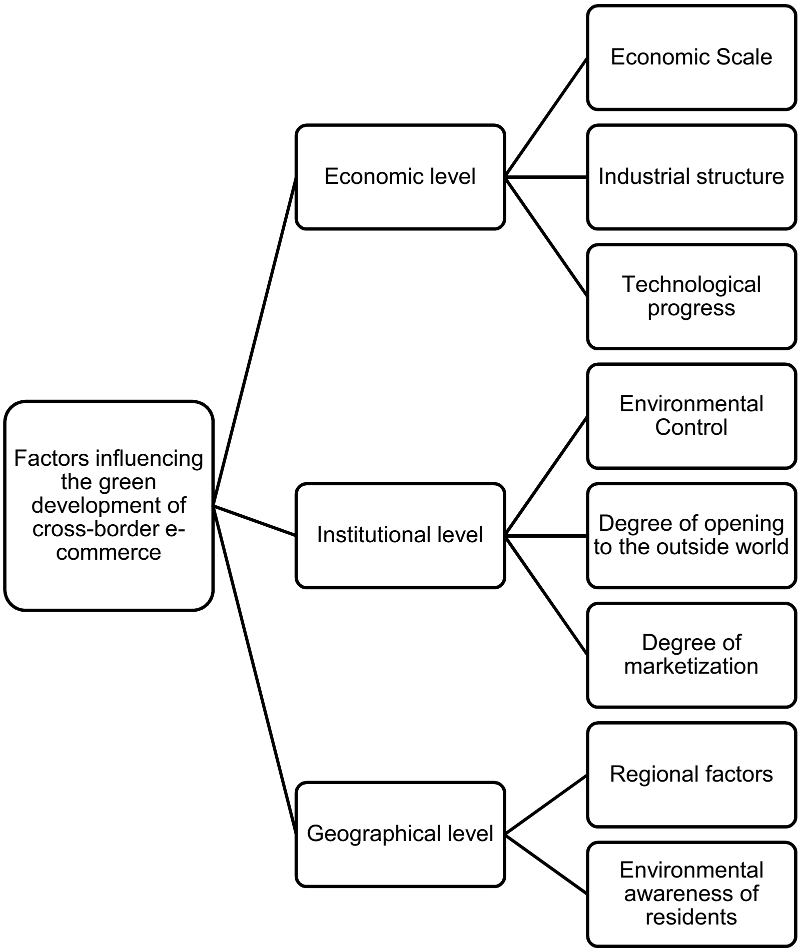

Figure 3. Attributes impacting the green progression of CBEC.

technological progress, the institutional level factors are the degree of global openness, marketization, and environmental control, and the regional level factors are regional population density and environmental awareness of residents (Li and Ning Wang 2021). The details are shown in Figure 3.

Research Methodology

The random forest algorithm employs two methods to estimate the harm of explanatory variables to eco-environmental efficiency because they both have their own advantages and limitations.

The first method, based on the increase of arbitrary transformation, is a relatively simple approach that transforms each explanatory variable to increase its range. This method allows us to identify which explanatory variables are most sensitive to changes, but it does not provide a direct measure of the harm caused by each variable.

The second method, based on the increase of purity of connection points, is more complex but provides a direct measure of the harm caused by each variable. This method examines the reduction in the purity of connection points when each variable is removed from the analysis, allowing us to identify the variables that have the greatest impact on eco-environmental efficiency.

By using both methods, we can gain a more comprehensive understanding of the relationship between explanatory variables and eco-environmental efficiency, and identify which variables are most important in determining eco-environmental efficiency.

Random Forest Approach (RFA)

The RFA is a method proposed by Leo Breiman and belongs to the category of machine language. Once proposed, the Random Forest Algorithm has been widely used to measure affecting attributes in the fields of economics, CBEC, astronomy, medicine, and mathematics (Na 2020).

The random forest algorithm is composed of multiple $\{h(x\theta_k)\}$ decision trees, where the construction of the decision trees is determined $\{\theta_k\}$ by random vectors. A decision classification $\{h(x\theta_k)\}$tree is composed of independent identically distributed $\theta_1\theta_2\ldots\theta_k$random vectors, given random vectors X and Y, and a classification tree consisting of k $(h_1(X), h_2(X), \ldots, h_n(X))X's$ as, defining the $mg(X, Y) = av_k I(h_k(X) = Y) - maxav_k I(h_k(X) = j)$ edge mapping. This marginal function describes the extent to which the mean number of votes correctly classified Y for vector X excels the mean number of votes received in any other category. The larger the margin is, the higher the confidence level of the classification would be.

Extending to the RFA, if the tree numbers in the forest are large. As the tree numbers in the forest increase, the generalization error of the PE^*classification tree tends $\theta_i$to the random vector.

$$P_{x,y}(P_\theta(h(X,\theta) = Y) - \max P_\theta(h(X,\theta) = j) < 0) \tag{1}$$

The generalization error, denoted as PE*, is an estimate of how well a machine learning model will perform on new, unseen data. It measures the difference between the expected error of the model on the training data and the expected error of the model on new, unseen data.

The generalization error can be estimated using techniques such as cross-validation, where the model is trained and tested on different subsets of the available data. The generalization error is an important metric in machine learning, as it indicates the extent to which a model has overfit the training data, and therefore how well it is likely to perform on new data.

The term "generalization error PE^*" refers to the estimated generalization error of a machine learning model. The "^" symbol is used to indicate that the value is an estimate, rather than the true value. The generalization error is an important concept in machine learning, as it provides a measure of how well a model is likely to perform in practice, and can be used to guide model selection and parameter tuning.

The above equation shows that a key feature of random forest is that it is not easy to overfit. As the total quantity of trees increases in the forest, the generalization error PE ^ * of the classification tree tends to the upper bound and then forms an unbiased estimation of the internal structure of the generalization error. The outcomes indicate that as the whole quantity of trees increases in the forest, the random forest has a good management scale, which can test the level of interaction and necessity between the sample plates.

The principle of any forest is to select and create a forest composed of several decision tree algorithms, and each tree in the forest is not crossed. When a new group member wants to be added, each tree in the forest will distinguish its attributes, and then classify them. The final result is the tree with more classification conclusions in all trees. This is equivalent to submitting a conclusion to various authoritative experts skilled in a certain industry, who can inquire and vote on the conclusion.

In recent years, RFA has become more and more perfect in concept and method and has been widely used in every discipline. In this article, we use the random forest algorithm to rank the necessity of each element that endangers green ecological efficiency.

Panel Tobit Model

This paper aims to explore the green development of cross-border e-commerce (CBEC) businesses, taking into account the market's reaction to such development, the market value of the enterprise's recognition, and the Tobin Q value. The Tobin Q value is chosen as a metric to gauge the value of the underlying CBEC. The Tobit model is used to analyze the Tobin Q value, which is a model with restricted independent variables, originally proposed by Tobin for analyzing expenditure on durable goods among scientific researchers. To ensure a more accurate analysis, the Tobin Q value is analyzed by distinguishing between disconnected and distributed data (limited to the internal structure of a given region) and tail-distributed data (including data information models outside the given scope). The Tobit model can be divided into a time series analysis Tobit model, cross-section Tobit model, and control panel Tobit model. However, this study has limitations in terms of data availability, and further research is needed to explore the topic in greater depth, including using more comprehensive data sets and more advanced modeling techniques. Future research can also examine the impact of specific policies on the green development of CBEC businesses, and explore the role of technology, innovation, and other factors in promoting sustainable development.

The standard Tobit model is shown below.

$$\begin{gathered} y_i^* = x_i^{'}\beta + u_i, i = 1, 2, \ldots, n \\ y_i = c, if\ y_i^* > 0 \end{gathered} \tag{2}$$

The error term of the $u_i\tilde{N}(0\sigma^2)$ model, which obeys a normal distribution with a mean σ^2 of 0 and a variance of $i = 12\ldots n$. The explanatory and explained variables can be observed when $\{x_i\}$ the explanatory variables and the $\{y_i^*\}$explained $y_i^* < 0$ variables are not observable at $\{y_i\}$ that time, and $y_i^* > 0$ only y_i the values y_i^* at that time, $x_i^{'}$ is $n \times k$ the ith row of the matrix X. If $\{x_i\}$ it has the property of being consistently bounded, then it also needs $\underset{n\to\infty}{\text{Lim}}\, n^{-1}X'X$ to be a positive definite matrix, and it β is σ^2 assumed that the parameter spaces of and are both positive definite. Then before applying the Tobit model, a distinction is made.

Matrices and vectors composed of positive samples of observations. Due to the specificity of the Tobit model, y_i^* whether the limit is 0 or otherwise, it will not have an essential effect on the whole model, and we y_i^* can denote the y_0 critical point by. However, y_0 if it varies with i, the model will be slightly different, and one of the explanatory $\{x_i\}$ and explained variables $\{y_i^*\}$ must be fixed before it can be estimated.

Extending the standard Tobit model to panel data, the model is defined as follows.

$$\begin{gathered} y_{it} = \max(0, x_{it}\beta + u_{it}), t = 1, 2, \ldots, T \\ u_{it}\big|X_{it} \sim N(0, \sigma^2) \end{gathered} \tag{3}$$

The panel Tobit has several characteristics: first, the model is x_{it}not strictly exogenous, and the association x_{it} between u_{it} and is not very strictly set, as well as being $t \neq s$ one of the factors taken into account. Thus, it x_{it} is possible to include variables that are influenced by feedback or $y_{i,t-1}$ to include them. Then, $\{u_{it} : t = 1, 2, \ldots, T\}$ the serial correlation is also allowed, i.e., the correlation between variables is manifested after the explanatory variables are controlled. That is, $D(y_{it}|x_{it})$ it is set out jointly by the x_{it} above equation and includes many factors, which can be variables of any condition (immediate constant variables, time dummy variables with time dummy variables or lagged dependent variables, interaction terms of time variables, etc.).

Table 1. Definition and depiction of variables.

Name of explanatory variables	Abbreviation	Indicator Description and Unit	Prognosis
Economic size	Ln (GP)	Gross regional product/total regional population (yuan/person)	Positive
	GR	Gross regional product GDP (%)	Positive
Industrial Structure	PI	Regional industrial output value/regional GDP (%)	Negative
Degree of opening to the outside world	DC	Regional actual utilization of foreign investment/ regional GDP (%)	Unknown
Environmental Control	SO2	Regional sulfur dioxide emissions/Regional exhaust emissions (%)	Negative

Results and Discussion

Variable Selection

In the manuscript, we will analyze the influencing factors of the green development efficiency of CBEC, take the green progression efficiency of CBEC as the explanatory variable (dependent variable) and each influencing factor as the explanatory variable (independent variable), analyze the degree of contribution of each affecting attribute to green progress efficacy of CBEC through random forest algorithm, and analyze the quantitative association between predictor attributes and output attributes through panel regression. There exist several attributes impacting the green progress efficiency of CBEC, and according to the existing studies, the influencing factors selected in this paper are the economic scale of CBEC, industrial structure, level of global openness, environmental control, and regional factors. The manuscript uses the data presented on the official website of a large CBEC enterprise in Beijing.

In summary, the definitions and descriptions of environmental efficiency explanatory variables are presented in Table 1 below.

After determining the affecting attributes of environmental efficacy, the random forest algorithm is used to investigate the contribution of each affecting factor to the technical efficiency of the environment and utilize the panel approach to quantitatively investigate the association between environmental efficacy and their affecting attributes. To further improve foreign trade and boost economic progress, the effect of green trade barriers and the opportunities brought by the advancement of e-commerce need to be analyzed Thus, the economic and trade structures should be adjusted, and the concept of green advancement should be established, which vigorously develops cross-border e-commerce.

Random Forest Approach to Investigate the Influencing Factors of Environmental Efficiency

The random forest algorithm, as a machine learning approach, is capable of handling data with varying magnitudes and naming levels by

Table 2. Relative effect of each influence factor on environmental efficiency calculated by the two methods.

		IncMSE	IncNodepurity
Economy size	GDP per capita	16.07254	0.218709
	GDP share	14.37875	0.201835
Industry structure		10.73885	0.142367
Degree of global openness		14.18971	0.173127
Environmental control		5.624456	0.055183

utilizing regression trees as its base learning method. Therefore, in this study, the influencing factors of eco-environmental efficiency are not normalized or standardized. Instead, we use the random forest algorithm to establish the functional correlation and analyze the corresponding impact of each influencing factor on eco-environmental protection efficiency.

The random forest algorithm employs two methods to estimate the harm of explanatory variables to eco-environmental efficiency. One method is based on the arbitrary transformation of the variables, while the other is based on the increase in the purity of connection points. By using these two methods, we can calculate the harm of each influencing attribute on eco-environmental efficiency. The random forest algorithm is implemented using the random forest package in R language, and the results are summarized in Table 2.

The random forest algorithm allows us to capture the complex relationships between multiple influencing factors and eco-environmental efficiency without the need for normalization or standardization. The results provide valuable insights into the relative importance of each factor in determining eco-environmental efficiency, which can be used to inform policy decisions and further research in this area.

The influence factors calculated by different criteria on the green progress efficiency of CBEC are different could be observed in Figures 4 and 5 and Table 2, and the criterion of random transformation is more suitable for the regression problem, and the calculation criterion of nodal purity is more suitable for the classification problem. In the manuscript, the green progress efficacy of CBEC is defined as the contact variable belonging to the regression problem, then the criterion of using random variables for analysis is suitable. The table depicts that among the factors affecting the green development efficiency of CBEC, the economic scale has the greatest influence on the green progress efficiency of CBEC. The degree of opening to the outside world has the second highest impact on the green progress efficiency of CBEC, accounting for 14.19%. Both industrial structure and environmental control have little influence on the green progress efficiency of CBEC, accounting for 10.74% and 5.62%, respectively.

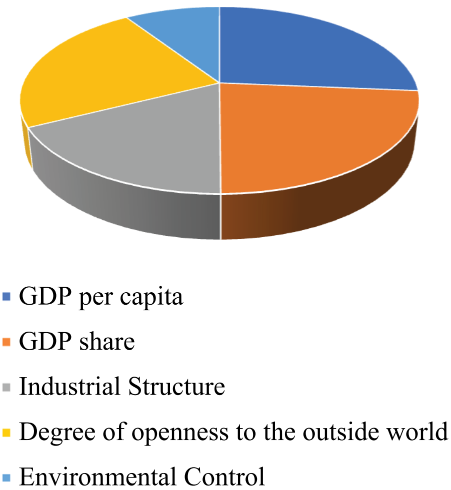

Figure 4. IncMSE comparison.

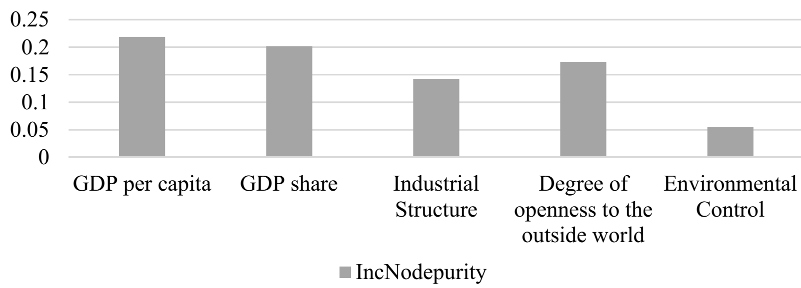

Figure 5. IncNodepurity comparison.

Panel Model Analysis of Environmental Efficiency Influencing Factors

To comprehensively examine the relationship between each influencing factor and eco-environmental efficiency, this study employs a panel regression model to analyze the data. Given that eco-environmental efficiency is a restricted variable with a value between 0 and 1, this paper utilizes a panel Tobit regression model to conduct the analysis. The regression equation is presented below, which allows us to explore the impact of each influencing factor on the eco-environmental efficiency of the CBEC industry.

$$\ln(EE_{it}) = \alpha + \beta_1 GR_{it} + \beta_2 \ln(GP_{it}) + \beta_3 PI_{it} + \beta_4 DC_{it} + \beta_5 SO_{2it} + \varepsilon_{it} \quad (4)$$

Where $i = 1, 2, \ldots, 32t = 12 \ldots 12$(2010 is year 1, 2011 is year 2, and so on), is the αconstant term, and β_i is the coefficient to be determined.

The description of each variable of this equation is as follows.

① $EE_{it}$is a proxy for the environmental efficiency value: the measure is the environmental technical efficiency value of area i at time t.

② GR_{it}represents the ratio of GDP of area i to the overall eco-GDP at time t.）

③ GP_{it}denotes the GDP per capita of region i at time t.

④ PI_{it}denotes the industrial structure, and denotes the ratio of industrial output to GDP of region i at time t.

⑤ DC_{it}denotes the level of regional openness i to global at time t. It is the ratio of utilized foreign investment to GDP.

⑥ SO_{2it}denotes the strength of environmental control of industry i at time t.

⑦ ε_{it}denotes the random error term of the equation.

⑧ C denotes the constant term to be determined for the equation.

This paper uses the software Stata12 for regression analysis, and the outcomes were presented in Table 3 and Figures 6 and 7.

In the manuscript, the test called Hausman was applied to test the model, and the outcomes indicate that the green progress efficiency of CBEC rejects the original hypothesis. This indicates that the green progress efficiency of CBEC fits the fixed-effects model (FE). According to the regression results, we can see that economic scale, industrial structure, the level of global openness,

Table 3. Tobit regression results of environmental efficiency influencing factors.

Regression results	Ecological	
Variables	FE	RE
Grit	0.0156	0.0193
	(0.0650)*	(0.0147)**
InGPit	0.0164	0.0124
	(0.0165)**	(0.0642)*
PIit	−0.0127	−0.0134
	(0.0057)***	(0.0925)*
DCit	0.0163	0.191
	(0.0213)**	(0.0395)**
SO2it	−0.0056	−0.138
	(0.0284)**	(0.0314)**
Region	32	Region 32
Observation	416	416
R2	0.6987	0.7112

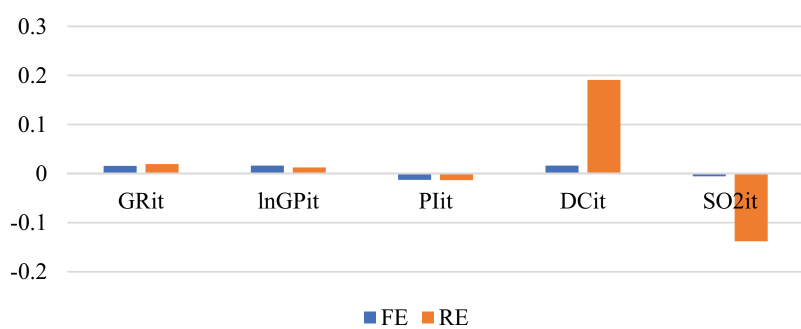

Figure 6. Comparison of regression coefficient results.

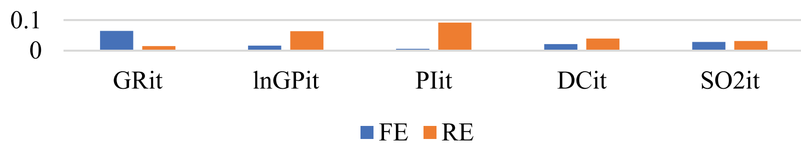

Figure 7. Comparison of significance levels of regression coefficients.

and environmental control all had substantial effects on the green progress efficiency of CBEC. Economic scale and level of global openness had substantial positive effects on the green progress efficiency of CBEC among them, while the industrial structure and environmental control had substantial negative impacts on the green development efficiency of CBEC.

Foreign trade is developing rapidly in this process, which has both opportunities and challenges, in which shortcomings mainly include the unbalanced structure of the product, restriction of green trade barriers, the influence of e-commerce development, lack of talent support, challenges brought by political and cultural differences and so on. To further improve foreign trade, and boost economic development, the need to analyze the influence of the green trade barrier and the opportunities brought by e-commerce development, adjust the economic structure, adjust the trade structure, set up the green development concept, vigorously develop CBEC, foster technical skills, strengthen cultural communication, the optimization of foreign economic policy, accelerate the conversion of the growth mode of foreign trade, To promote the development of foreign trade and maximize economic benefits.

The higher the percentage of industrial output value in GDP, the lower the environmental efficiency. This means that the greater the percentage of industrial production in the GDP of all regions, the more serious the environmental pollution to the environment, and the lower the environmental efficiency value of the region. Industrial production is a pollutant, and the discharge of chemical wastewater, organic waste gas, and waste is the main factor endangering environmental efficiency. The traditional industry is marked by "high input, low output, and high energy consumption," that is, low manufacturing efficiency, the low application efficacy of network resources, and high energy consumption generated by output. Therefore, it is necessary to reduce the proportion of industries in all industries, vigorously promote "low input, high output, and clean energy" industries such as high-tech and strategic new industries, adjust the industrial structure, improve production technology, and enhance the environmental efficacy of green development of CBEC. Expanding the level of opening-up has obvious active harm to environmental efficiency.

The level of opening to the outside world represents the degree of connection between a region and the outside world. It is the main indicator value that reflects the introduction of new technologies, new technologies, and the digestion and absorption of new common sense in the region. According to the traditional concept, European and American countries have adopted strict environmental control methods, resulting in the influx of high energy consumption and high energy consuming enterprises into Developing countries due to opening to the outside world, becoming "waste collection stations." However, the paper shows that improving the level of opening to the outside world can improve the level of environmental efficiency. One of the main factors is that the enhancement of the level of opening to the outside world gives companies more opportunities to introduce foreign excellent technology, which can improve production technology, enhance the implementation ratio of network resources, and then improve environmental efficiency. This is also practical.

Strengthening environmental manipulation has an operational impact on enhancing the environmental efficiency of cross-border logistics development trends. Reducing the percentage of sulfur dioxide in the environment can enhance the environmental efficacy value of the CBEC logistics development trend. Therefore, manipulating the company's sulfur dioxide emission, improving the production process, and strengthening the processing, treatment, and reuse of pollutants have a key harm to improving the environmental efficiency of the cross-border logistics development trend.

Conclusion

Conclusions of the Study

The manuscript investigates the influencing factors of green progress efficiency of CBEC using a random forest algorithm and panel Tobit model, and the primary inferences are as follows: economic scale, industrial structure, level of global openness, and environmental control are considered as influencing factors of green development efficacy of CBEC from the economic ranking, institutional level and geographical level. The results of the study show that economic scale, industrial structure, level of global openness, and environmental control all have significant effects on the efficiency of green progress of ecological CBEC. Among them, economic scale and global openness show substantial positive effects on the green progress efficiency of CBEC, i.e., increasing the GDP per capita and regional GDP has a positive contribution to the green progress efficiency of CBEC, and increasing the degree of global openness also contribute positively to the green progress efficiency of CBEC. In contrast, industrial structure and environmental control have significant negative effects on the green progress efficiency of CBEC, i.e., reducing the proportion of industry in the whole industry could enhance the green

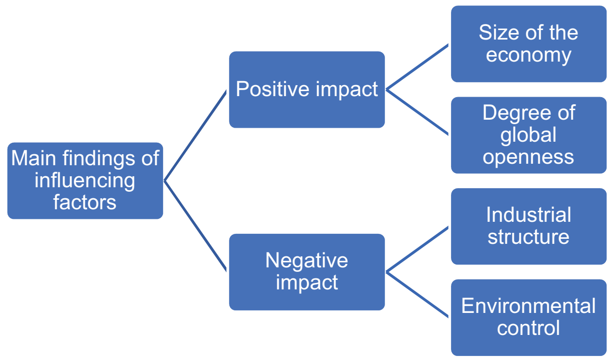

Figure 8. Main Conclusions of Influencing Factors.

progress efficiency of CBEC, and strengthening environmental control and reducing sulfur dioxide emission in the air can improve the green development efficiency of CBEC. Figure 8 presents it.

Policy Recommendations

Random forest algorithm and panel Tobit model are employed to practically analyze the attributes affecting environmental efficacy. The outcomes of the investigation suggest policies to establish green concepts and carry out green production regarding the CBEC field to promote the foreign trade's development and maximize economic benefits.

Develop a Green Economy and Improve Ecological Innovation Capacity

Attention should be directed to the progress of the green industry, the traditional concept should be changed, the progress prospect of the green economy should be analyzed, the concept of green progress should be established, the concept of protecting the ecological environment should be implemented in various industries, attention should be directed to protect ecology, energy saving initiatives should be developed, economic development should be realized. However, the restriction of CBEC green trade barriers should be eliminated.

The investment in scientific research should be increased. Funds should be allocated to promote enterprises' independent innovation, integrated innovation, absorption, digestion, and re-innovation, etc., to achieve breakthroughs in science and technology, and apply the most advanced technology in the world today to the real production of ecology to enhance the utilization rate of resources, and to be able to protect the environment while maintaining the high-speed progress of CBEC industry. Increase the investment in scientific research and focus on the introduction of advanced technologies and new industries at home and abroad. Second, we should strengthen the breakthrough of core technology. Make breakthroughs in the core and key technologies in the production of CBEC to shape unique production technologies of enterprises and create an industrial value chain with its characteristics. Carry out joint technical research across disciplines and fields, guide the concentration of elements, and strengthen the innovation capacity of enterprises, so that they could enhance the application ratio of resources and develop the green economy of cross-border e-commerce. Finally, increase cooperation with universities, governments, and research institutions to innovate cutting-edge technologies and realize the transformation of knowledge and technology. In recent years, ecological cooperation with major universities inside and outside the province has become increasingly rich, with research topics and projects covering all aspects of production. It can also be combined with universities to set up ecological research institutes to conduct research on ecological development issues and make policy recommendations suitable for their development. On this basis, we should strengthen the transformation of research results, apply them to actual production, improve the innovation capacity and transformation capacity of enterprises, and raise the application ratio of resources.

Conclusion: applying it to real manufacturing can improve the innovation and transformation ability of the company and enhance the application ratio of network resources.

As the green economy tends to develop, the innovation ability of industry will be improved, the application rate of ecological resources will be enhanced, and social resources will be saved, thus improving the environmental efficiency of ecology.

Adjust the Structure of Enterprises, Cooperate with High Technology and New Industries, and Cultivate Professional Talents

The study in Chapter 4 shows that the low efficiency of the green progress of CBEC generally stems from excessive industrialization. Therefore, adjusting the enterprise structure and actively cooperating with high-tech and emerging industries can improve the green development efficiency of CBEC. The government, in orbiting the governance and control of CBEC, should continuously improve the industry progress mechanism of CBEC, strictly implement the industry access conditions issued by the central government, reduce industries using a high amount of energy consumption, producing low output, and polluting the environment, eliminate industries with low production efficiency and high resource consumption, and vigorously develop high-tech industries and new industries with low input, high output, and low pollution.

Areas with more backward production capacity in the ecology should be guided by sustainable development, boost the upgrading of CBEC, encourage the combination of low energy consumption, high output, and low pollution industries, form a production value chain with an agglomeration of factors and resource saving, drive the progress of relevant industries and improve the resource utilization rate of CBEC in all aspects. Secondly, enhance the training speed of innovative talents and independent innovation to reinforce the industrial structure of CBEC. Talents are the cornerstone of enterprise development. We should strengthen the introduction of high-tech talents in the CBEC industry, cultivate professional talents, and encourage high-level outstanding talents to join the progress of the CBEC industry. Majors associated with the green progress of CBEC should be possibly set up in provincial universities and train professional talents to devote themselves to the construction of the green progress of CBEC. Finally, encourage responsible care and circular economy to guide the sustainable progress of the industry. Establish a scientific and standardized system to manage and implement environmental protection responsibilities into every CBEC enterprise's production, and guide the sustainable, thriving, and harmonious progress of the business. Improve production levels, promote the circular economy, change the development mode, and improve production efficiency.

Deepening Open Cooperation and Promoting Regional Knowledge and Technology Sharing

The research in the fourth chapter shows that strengthening and expanding opening-up is beneficial to improving the efficiency of the natural environment. Therefore, we need to increase and expand the level of opening up, promote the core concept of opening up and cooperation, and promote the sharing of professional knowledge and technology among regions and fields, to enhance the efficacy of the natural environment.

First, strengthen the communication and cooperation between regions. China and other regions show large regional differences, and there are also large differences between China and developed countries. Strengthening cooperation between regions is conducive to the sharing of knowledge, technology, and resources, reducing the differences between regions and promoting common development in learning from each region. Therefore, ecology should strengthen its ties with coastal areas, and learn from the development experience of overseas industrial chains. Different regions of CBEC should also reinforce cooperation and communication, and regions with low efficiency in green development of CBEC should reinforce learning, learn from each other's production experience, eliminate regional differences, and enhance the efficacy of green progress of CBEC. Second, encourage international cooperation and exchange in science and technology. Boost the level of global openness, strengthen scientific and technological exchanges and cooperation between countries, reinforce the exchanges and collaboration between the government, universities, and businesses and international outstanding cross-border e-commerce, vigorously absorb advanced foreign technology, and advanced management concepts, and attract outstanding foreign talents. Finally, reinforce the progress of transnational and cross-regional industries, increase import and export efforts, sell ecological products to developed countries, seek overseas investment and cooperation, and encourage the international progress of the industry.

Accelerate the progress trend of overseas industrial chains, increase the range of import and export trade, sell green ecological commodities to the markets of capitalist countries, seek overseas investment and cooperation, and encourage the progress trend of globalization of industrial chains.

Strengthening the level of global openness is conducive to enterprises absorbing and learning from advanced knowledge and technology at home and abroad, improving their production efficiency and resource utilization rate, and thus improving environmental efficiency.

Strengthening Environmental Control and Adhering to the Sustainable Development Strategy

The study in Chapter 4 shows that the impact of environmental control on the green progress efficiency of CBEC is negative, indicating that the greater the emission of sulfur dioxide and the worse the environmental quality, the lower the green progress efficacy of CBEC. Therefore, strengthening environmental control is beneficial to the improvement of green development efficiency of ecological CBEC.

First of all, the strict implementation of environmental control policies, adhering to sustainable development policies, and reducing the emission of pollutants is necessary. Strictly implement the concept of environmental protection in the production operation of CBEC enterprises, strengthen the learning and publicity of environmental protection knowledge, and strictly control the emission of pollutants in the production operation. We strictly follow national standards for production, purchase equipment with good production effects, enhance the application ratio of all resources, and decrease the emission of waste, waste gas, and wastewater. The waste after production is recycled and reprocessed to reduce the emission of various pollutants. Ecology of lakes, reservoirs, and other waters, should take advantage of resources, prioritize the progress of relevant industries, and in production should also pay special attention to protecting water resources. Second, there is an urgent need for cross-border electric companies to innovate environmental technology and boost the progress of energy-saving and environmental protection industries. Actively promote advanced environmental protection technology and products, innovative environmental protection technology, improve the level of pollution prevention and control, reduce the emission of pollutants in production, improve reuse technology, recycle and treat pollutants, reduce environmental pollution, and enhance the efficacy of green development of

CBEC. Finally, strengthen the cooperation of industries to enhance the quality of green progress.

Conclusion

It is indeed crucial to examine the green development of CBEC and improve its production efficiency while minimizing the negative impact on the environment. The present study focus on evaluating the environmental efficiency of CBEC and identifying the factors that affect its efficiency level. The use of the random forest algorithm and panel Tobit approach for investigating the influencing attributes of environmental efficiency is a valid method. The random forest algorithm can help in identifying the most important variables that affect CBEC's efficiency, while the panel Tobit approach can estimate the environmental efficiency of CBEC and the factors that affect it.

Overall, while our study provides important insights into the environmental efficiency of CBEC and the potential of AI to promote sustainable development, there is still much work to be done in this field. By addressing limitations and pursuing new avenues of research, we can continue to advance our understanding of CBEC and its role in promoting sustainability.

Disclosure Statement

No potential conflict of interest was reported by the author(s).

Funding

This investigation was supported by Zhuhai Science and Technology Program in Social Development "Research on the Construction of Industry-Education Integration Ecosystem in Zhuhai-Macau Cross-Border E-commerce" (No. ZH22036201210008PWC); Quality Projects of Zhuhai City Polytechnic "Research on the Reconstruction of Cross-border E-commerce Professional Curriculum System under the Background of Guangdong-Macao Industry-Education Integration" (No. JY20220111).

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