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Have Cross-Border E-Commerce Exports Promoted Regional Economic Growth? Evidence from China

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Abstract: The current study aims to discover the impact of cross-border e-commerce (CBEC) exports on regional economic growth in China. A benchmark regression via the fixed panel effect model was conducted based on Chinese provincial data from 2015 to 2020. The results demonstrated that CBEC exports significantly increased regional economic growth in China. The heterogeneity test also revealed CBEC exports have a significant positive impact in less developed regions rather than in more developed regions. Furthermore, the threshold effect test discovered that the technological input of manufacturing enterprises produced a non-linear significant impact on CBEC exports to elevate economic growth. When the proportion of technological input to GDP is less than the threshold of 0.031, the significant impact of CBEC exports on economic growth was larger; and then the impact became smaller and insignificant after the threshold. The findings suggested the Chinese government should vigorously develop CBEC export in terms of improvements in trade facilitation, CBEC talent training, and encouraging enterprises to explore different oversea markets. Simultaneously, attention should be paid to providing more policy support for the development of CBEC exports in less developed areas, and emphasis should be placed on guiding manufacturing enterprises to make rational use of Research and Development(R&D) funds. The empirical parts of this study are conducted by STATA 16 software.

Keywords: Cross-border e-commerce, exports, economic growth, Research and Development Intensity, Market environment quality, Technological developing level

JEL:B22, B27,O11

1. Introduction

After the 2008 U.S. subprime mortgage crisis, the global economy experienced significant fluctuations due to various factors, including the COVID-19 pandemic, the Sino-U.S. trade war, and the Russia-Ukraine conflict. Nevertheless, China's economy has maintained a relatively fast growth rate. In addition to the driving effect of the investment and consumption incentive policies introduced by the Chinese government, the growth of cross-border e-commerce (CBEC) exports may be one of the important factors promoting the counter-cyclical rise of China's economy. CBEC refers to an international business activity in which transaction entities belonging to different countries or regions complete commodity or service transactions through e-commerce platforms, complete capital flow through cross-border payment and settlement, and complete commodity distribution through cross-border logistic (Xin et al, 2019; Xiong et al., 2016 etc). From 2008 to 2023, the average annual growth rate of CBEC exports reached 22.65%.

In contrast to China's average annual export growth rate, which has not yet reached 6.5%, the recent economic growth trend in China may also be closely related to the driving effect of CBEC exports.

However, amidst the quick expansion of CBEC, there are also voices of skepticism questioning whether CBEC exports can genuinely contribute to China's economic growth not only from the economic society but also from the academic circle. These doubts can be summarized into two kinds: First, CBEC exports may make the overseas real economy struggle. CBEC exports can directly increase the overseas sales opportunities of product suppliers (Qi et al., 2020). Faced with competition from Chinese CBEC export products, overseas real economies, find it difficult to maintain their price advantage. Not only are they facing a dilemma of shrinking profits, but they may even go bankrupt. The bankruptcy of these physical stores may damage the overseas economy, which in turn affects the long-term sustainability of China's exports growth. Second, the low-price competition on CBEC platforms would also decrease CBEC export suppliers' profitability (Lang, 2013; Yu, et.al, 2022). The CBEC platforms offer diverse channels, with each channel being highly transparent for customers to effortlessly compare prices among different suppliers. Continuous pressure from customers to lower prices would significantly reduce suppliers' profits.

For Chinese government, when formulating economic policies, it is essential not only to clarify whether CBEC exports can truly promote economic growth but also to engage in deeper reflection on this issue. First, regarding the potential heterogeneity issues related to CBEC exports. Given the severe imbalance in China's regional economic development, a significant amount of production factors related to CBEC have been attracted to economically developed regions. However, whether CBEC exports have a greater impact on the economy of developed regions or underdeveloped regions directly affects the rational allocation of resources when the government formulates economic growth policies leveraging CBEC exports. Second, the potential nonlinear effects that may exist between CBEC exports and economic growth. Although, both endogenous and exogenous economic growth theories believe that technology can promote the improvement of production efficiency, reduce costs, and thereby promote economic growth (Solow, 1962; Paul Romer, 1996). However, there is an economic phenomenon in the society that many manufacturing enterprises, despite actively investing in technological innovation, still face the fate of declining development in the process of CBEC exports. So a question arises: Is it true that more technological investment in manufacturing is always better for regional economic growth? The answers to these questions will directly influence government departments in formulating differentiated policies to promote economic growth through CBEC exports.

Numerous studies have proven that exports can promote economic growth. However, there are very few papers that examine the role of CBEC exports in driving economic growth. Among the few studies on CBEC and economic growth, Zuo (2016) only focused on one province in China as the research objective, Ma and Fang (2021) empirically analyzed CBEC through proxy variables due to insufficient realistic data, Hang and Adjouro (2021) were limited to employing a time-series model with only 15 years of data, Zhong et al (2022) and Chen (2022) utilize data from e-commerce industrial parks as the proxy variables for CBEC transaction. While these studies all suggest that CBEC exports can promote economic growth, improper research methods or data processing may lead to incorrect results. Moreover, scarce research on the comprehensive impacting mechanisms of CBEC for economic growth is also another issue with the extant studies.

To conduct an in-depth study on the impact of CBEC exports on economic growth and fill in the research gap, this paper begins with a comprehensive review of the relevant literature and formulates theoretical hypotheses. In the third part, we establish a benchmark research model focusing on 31 Chinese provinces, a regional heterogeneity regression model, and a panel regression model with technological input in the manufacturing industry as the threshold variable, along with an explanation of the controlling variables. The fourth part presents the empirical analysis, while the fifth part summarizes the entire paper, conducts a countermeasure analysis, and highlights the research limitations and shortcomings.

2. Literature Review and Hypothesis Development

2.1 Literature Review

2.1.1 Theoretical Review

The essence of CBEC exports remains exports, albeit facilitated by the information technology approach of CBEC. Therefore, most mainstream international trade theories can be used to explain why CBEC exports can promote economic growth. Firstly, the theory of comparative advantage(Ricardo,1817). This theory posits that the foundation of international trade lies in the relative differences in production technologies among countries and the resulting differences in relative costs. Each country should, in accordance with the principle of "choosing the greater benefit when weighing two advantages, and the lesser disadvantage when weighing two disadvantages," concentrate on producing and exporting products with its "comparative advantage," while importing products with its "comparative disadvantage." CBEC exports enable enterprises to transcend geographical boundaries and search for markets and commodities with comparative advantages on a global scale. Through CBEC platforms, enterprises can more easily find suppliers or partners with lower costs and better quality, thereby reducing costs, improving efficiency, and ultimately promoting economic growth. Therefore, this paper takes the theory of comparative advantage as the basis for theoretical research. Secondly, the Heckscher-Ohlin (H-O) theory(Davis,1995): This theory posits that different factor endowments determine international trade patterns. A country will export goods produced with its relatively abundant factor-intensive inputs and import goods that consume a large amount of its relatively scarce factors. CBEC enables new production factors such as knowledge and information to be rapidly disseminated and shared globally. Countries that were originally scarce in new factors can now easily access new technologies and management experiences through the Internet, thereby changing their international trade patterns and distribution patterns and promoting economic growth. Some authors have attempted to use the theory of comparative advantage to explain the driving force of CBEC on economic growth. However, these analyses are usually limited to the market expansion role of CBEC, its low-cost nature. There is a lack of comprehensive discussion on the mechanism of the relationship between CBEC and economic growth.

2.1.2 Empirical Review

Research on CBEC export and economic growth can be traced back to the relationship between export and economic growth. Many scholars have empirically demonstrated the positive contribution of exports to economic growth based on the theory of comparative advantage. Jaunky (2011) explored the causal relationship between fish exports growth and economic growth in Small Island Developing States, finding a small but positive impact of fish export growth on economic growth. Jawaid (2014) studied the effect of trade openness on economic growth in Pakistan, finding a significant positive long-run relationship between exports and economic growth. Most recently, Mensah (2020) conducted a causality analysis on the export and economic growth nexus in Ghana, using time series econometric techniques to explore the long-run and short-run relationships between exports and economic growth. Although most studies indicate that exports can promote economic growth, there are also a few studies that do not support the conclusion that "exports are the engine of economic growth." For example, Xu and Lai(2001) found through modeling and analyzing data from 1980 to 1995 that the driving effect of China's export trade on economic growth was relatively small, and it had not yet become the "engine of economic growth." This suggests that at certain stages or under certain conditions, the growth of exports does not always significantly promote economic growth.

The impact of e-commerce on economic growth is also one of the relevant research areas in this paper. However, similar to the relationship between exports and economic growth, the conclusions of studies on the relationship between e-commerce and economic growth are also not uniform. Different scholars have argued and empirically demonstrated the positive impact of e-commerce on economic growth. Anvari & Norouzi (2016) believed the internet economy can contribute to economic growth by expanding consuming market. This study utilized panel data and applied Generalized Least Squares (GLS) regression from 2005 to 2013, revealing that e-commerce and R&D had a positive and significant impact on GDP per capita across 21 selected countries. Mohamed et al. (2022) used endogenous growth theory and a Generalized Linear Model (GLM) to estimate parameters. It tested for unit roots and examined cointegration with the Engle-Granger Method. Results show that internet usage positively impacts economic growth in Somalia. However, some empirical studies suggest that e-commerce may have a negative impact on economic growth. Chen (2011) identifiedc e-commerce as a form of technology. Employing a fuzzy mathematical evaluation method, the study concluded that the impact of e-commerce on economic growth follows a U-shaped trajectory, initially inhibiting and later promoting growth. Toska and Fetal (2023) examined the impact of e-commerce on economic growth in the Western Balkans using panel data techniques (pooled OLS, fixed effects, random effects, Hausman Taylor-IV) from 2008 to 2020. The study found that e-commerce did not foster economic growth in the region.

Although there is limited empirical literature directly studying the relationship between CBEC export and economic growth, some authors have attempted to examine the relationship between CBEC transactions and economic growth. Zuo (2016) employed the data from 2007 to 2014 and conducted a co-integration analysis on the association between CBEC and economic growth in the Guangdong province of China. The findings revealed a long-term equilibrium between CBEC and economic growth. Nonetheless, the research scope was only limited in Guangdong province and the results were not highly representative. Hang and Adjouro (2021) also employed the Autoregressive Distributed Lag model (ADLM) from 2005 to 2020 to examine the Chinese CBEC impact on economic growth. Specifically, CBEC positively impacted both short-term and long-term economic growth in China. Nevertheless, these findings might not be generalizable as only 15 years of data were utilized when time series models frequently require at least two decades of data (Box et al., 2015). Some scholars have also tried to use panel data for regression analysis. Ma et al. (2021) used panel data from 31 provinces in China from 2015 to 2018 and constructed proxy variables for CBEC value with the number of CBEC comprehensive pilot zones and CBEC exporters. Zhong et al. (2022) utilized the difference-in-difference (DID) method to investigate the impact of establishing CBEC comprehensive pilot zones on economic growth. The research literature currently available on the relationship between CBEC and economic growth almost universally supports the notion that they are positively correlated. However, due to the lack of provincial-level data, these provincial panel studies either use proxy variables in place of CBEC transaction volumes or rely on data from comprehensive CBEC pilot zones, which may lead to biased research outcomes. Some scholars have also conducted empirical research on the relationship between CBEC exports and overall exports. For instance, Yin and Choi (2023) employed a gravity model to analyze the impact of China's CBEC on its exports of goods and services to countries along the 'Belt and Road' route from 2000 to 2018. Their study revealed that CBEC had a more pronounced positive effect on trade in services compared to trade in goods. While this research is relevant to the broader theme, it does not directly elucidate the relationship between CBEC exports and economic growth. In contrast, Che et. al (2024) utilized monthly provincial-product-destination data from 2019 and 2020 and found that during the pandemic, CBEC promoted exports by facilitating the expansion of the existing intensive margin.These studies provide insights for the current research, but they still fail to directly reveal the relationship between CBEC exports and economic growth.

Considering the existing controversies among previous researchers regarding whether exports and e-commerce can promote economic growth, there are limitations in the current studies exploring the relationship between CBEC and economic growth, this study will contribute to the existing knowledge corpus in the following ways: (1) systematically exploring the theoretical mechanisms by which CBEC exports promote regional economic growth; (2) utilizing an extended Cobb-Douglas production function to construct an economic growth model incorporating CBEC exports; (3) possibly being the first to use provincial-level CBEC export panel data to conduct empirical analysis on the relationship between CBEC exports and economic growth; (4) possibly being the first to explore the regional heterogeneity of the impact of CBEC exports on economic growth; and (5) possibly being the first to explore the non-linear impact of manufacturing industry R&D intensity on the relationship between CBEC exports and economic growth.

2.2 Theoretical Hypothesis

Historically, economic growth theory has evolved through three stages: Classical Growth Theory, Neoclassical Growth Theory, and Endogenous Growth Theory. These theories emphasize the role of supply-side factors such as capital, land, technology, and labor in driving economic growth. In contrast, Keynesian demand theory explains the role of demand-side factors, such as market demand, investment, exports, and government spending, in stimulating economic growth. To explore the impact of CBEC exports on economic growth in depth, this paper particularly examines both supply and demand aspects.The impact of CBEC exports on the economy could be scrutinized from both supply and demand aspects. From the supply side: firstly, CBEC export can promote economic growth by cutting down the transactions cost. CBEC exports are a process in which inforamtion technology is applied in the whole process of doing business with oversea customers from business negotiation, signing contracts to customs clearance, logistics, and payments (Qi et al., 2020). The information technology could increase the return rate of all production factors and potentially alter the law of decreasing factor returns to increasing factor returns (Mohamed et al., 2022), which would significantly improve the efficiency of CBEC transactions with decreased costs. The reduction in costs will enhance the competitiveness of enterprises in oversea markets and lead to economic growth. Secondly, economic growth can be promoted by CBEC related investment. The corporations that quickly expanded through CBEC exports would attract more domestic and overseas investments, which would be channeled into the supply chains of CBEC export enterprises and lead to higher economic growth (Shabbir et al, 2021). Thirdly, economic growth can be promoted by the development of related supporting industries and innovative business forms. The theory of innovation-driven economic growth postulates that emerging industries and innovation are the primary drivers of economic growth (Schumpeter, 2000). Network technologies embedded in CBEC exports transformed traditional export methods and produced various innovative sales forms, such as live live streaming, short video, and social media sales. The technological innovation also resulted in different industries and CBEC platforms. Multiple service companies also emerged, such as website design companies, professional CBEC logistics companies, and CBEC financial firms. From the demand side: firstly, economic growth could be driven by oversea CBEC demand. The CBEC export is driven by consumption from foreign countries as CBEC exports could be effortlessly accessed by consumers via the Internet compared to traditional exports (Mou et al., 2019). Oversea consumption thereby stimulates economic growth. Secondly, driven by government purchase. In the process of CBEC export, the government is required to perform information upgrades and establish information facilities. The purchasing demand could also contribute to higher economic growth (Magdalena & Suhatman, 2020). Accordingly, the present study hypothesized that:

H1: The CBEC exports positively impact China's regional economic growth.

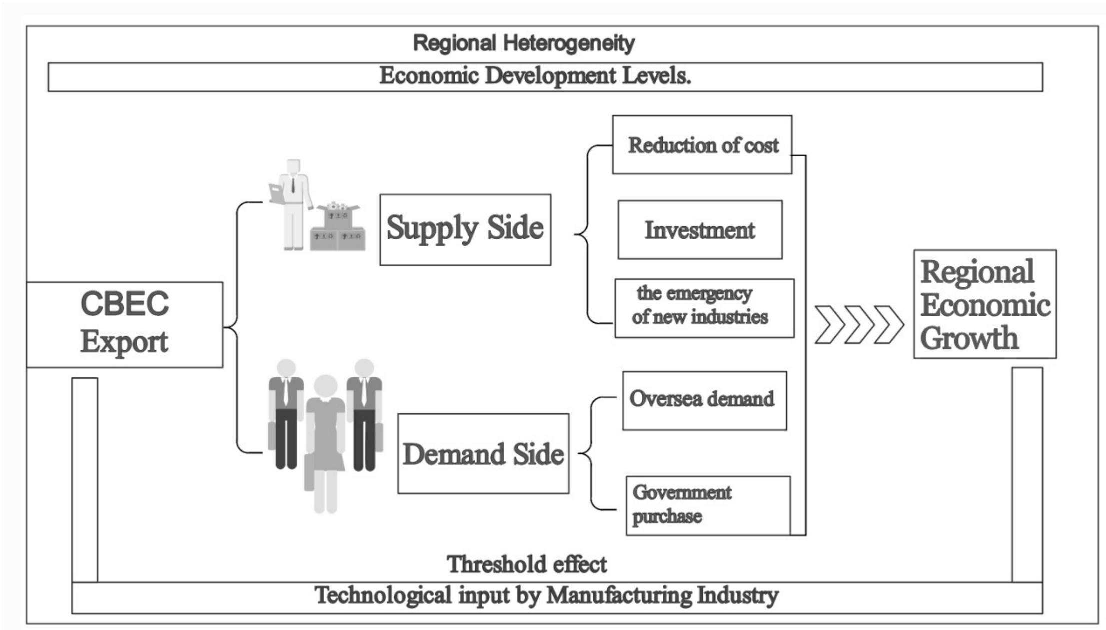
The economic convergence theory (Stefano, 2004) propounds that more economically underdeveloped regions are anticipated to achieve a similar standard as the developed regions to swiftly learn and adopt mature technologies and management experiences through ICT. Particularly, CBEC exports are an integral mechanism to promote economic growth in underdeveloped regions for higher learning opportunities. In addition, the New Geoeconomics (Florida, 2002) postulates that the information economy could reduce spatial barriers between regions while increasing the participation of more underdeveloped regions. The CBEC exports significantly lower the participation threshold of economically underdeveloped regions through market expansion, which provides a stronger economic growth momentum. Meanwhile, the relative comparative advantage theory (Ricardo,1817) posits that economically underdeveloped regions could attain relative comparative advantages in certain areas via CBEC emergence, namely more resources, skills, and products. The advantages could be thoroughly utilized and transformed into opportunities for economic growth to enhance the possibility of achieving a similar economic standard as developed regions. The second hypothesis was developed:

H2: The impact of CBEC exports on economic growth varies across regions with different economic developmental levels, wherein CBEC exports produce a more positive impact on underdeveloped regions than more developed regions.

China is a massive manufacturing country with exports accounting for above 90% of CBEC exports（Huang, 2021). An increase in the inner R&D input among Chinese manufacturing enterprises could encourage product innovation and technological improvement, which enables enterprises to produce more competitive products (Wu, 2020). The initial stage of technological inputs allows manufacturing enterprises to invest in technological innovation for a higher competitive technological advantage in the overseas market. Nonetheless, the advantage of acquiring a higher market share may decline gradually when more and more competitors adopt a similar technological level. Specifically, repetitive R&D input by manufacturing corporations may lead to wasted resources and diminishing technological effects where less original technological innovation and more imitative innovation exist, which would subsequently decrease the ability of CBEC exports to positively influence economic growth. Hence, this study posited that:

H3: There is a non-linear threshold effect between CBEC exports and economic growth. At the initial stage of R&D investment in the manufacturing industry, the promotional effect of CBEC exports on economic growth is significant. However, as the investment increases, the promotional effect of CBEC exports on economic growth become less.

Figure 1. The Impacting Mechanism of CBEC Exports on Regional Economic Growth



3. Methodology and Data

3.1. Methodology

3.1.1 Benchmark Model

The Cobb-Douglas production function is a mathematical model used in economics to describe the production process (Cobb & Douglas, 1928). This function describes the relationship between the production output and the production factors. Its basic form is:

$$Y=AK^{\alpha}L^{\beta}\mu \qquad \textbf{Model (1)}$$

In the equation, Y represents industrial output, A represents the comprehensive level of technology, L represents the number of labor inputs, K represents the capital input, α and β are the elasticity coefficients for capital input and labor input. Later, economist Robert Solow internalized the factor of technology and proposed an improved version of the Douglas production function.

$$Y=AK^{\alpha}L^{\beta}T^{\gamma} \qquad \textbf{Model (2)}$$

Where A represents total factor productivity, and T is an indicator of technological level. γ separately represent the elastic coefficient of technology. With the advancement of economic theory, supply-side factors such as human capital, and foreign investment, as well as demand-side factors such as export, exchange rate and institutional factors, have been recognized as important determinants of economic growth (Alfaro, 2010). This study endogenises CBEC exports with the aforementioned factors and further improves Cobb-Douglas production function. To facilitate an easier comparison of the effects of different variables on economic growth, this study takes the logarithm of most factors except for ratio variables and dummy variables to establish the empirical model of this study.

The specific model form is as follows:

$$\ln(PGDP_{it})=\alpha_0+\alpha_1\ln(CBEX_{it})+\alpha_2\ln(PKS_{it})+\alpha_{3ln}\ln(LAB_{it})+\alpha_4\ln(HUM_{it})+\alpha_5FDIL_{it}+\alpha_6EXR_{it}+\alpha_7\ln(INQ_{it})+\alpha_8\ln(TECIN_{it})+TRAW_{it}+COV_{it}+U_i+Z_t+\varepsilon_{it} \qquad \textbf{Model (3)}$$

Where PGDP represents economic growth, CBEX denotes Chinese CBEC exports, PKS signifies physical asset stock, LAB represents the number of labourers, HUM represents human capital stock, FDIL denotes foreign investment inflow, EXR refers to the RMB exchange rate, INQ signifies market institutional quality and TECIN represents government technological input. TRAW and COV are two dummy variables representing the US-China trade war and the COVID-19 pandemic respectively. t denotes statistic years from 2015 to 2020, U and Z respectively signify the provincial fixing and yearly fixing effects, and ε is the white noise.

3.1.2 Heterogeneity Analysis Model

The study made the heterogeneous regression based on Model (3) with two different samples to verify the impact heterogeneity of CBEC exports on economic growth with different regional economic developmental levels. The first sample was more developed Chinese provinces. The second sample was less developed Chinese provinces. The classification criteria for more developed and less derdeveloped regions are based on the per capita GDP of each province in 2020, with the top 15 provinces being classified as developed regions, and the rest 16 provinces as less derdeveloped regions.

3.1.3 Threshold Mechanism Model

This study developed a threshold variable model based on Model(3) to study the threshold effect of R&D density in the relationship between CBEC exports and economic growth:

$$\ln(PGDP_{it}) = \alpha_0+\alpha'1\ln(CBEX_{it})\, I(r_2 < MIRD_{it} < r_1)+\alpha''1\ln(CBEX_{it})I(MIRD_{it} < r_2)+\alpha'''\ln(CBEX_{it})I(MIRD_{it} > r_1)+\alpha_2\ln(PKS_{it})+\alpha_3\ln(LAB_{it})+\alpha_4\ln(HUM_{it}) + \alpha_5 FDIL_{it} +\alpha_6 EXR_{it}+\alpha_7\ln(INQ_{it}) +\alpha_8\ln(TECIN_{it})+TRAW_{it}+COV_{it} +U_i+Z_j+\varepsilon_{it} \quad \textbf{Model (4)}$$

Where MIRD refers to the R&D intensity of the manufacturing industry (threshold variable) and γ_1, γ_2 are the critical values of the two thresholds ($\gamma_1 < \gamma_2$). TECIN refers to the annual R&D expenditures by provincial governments, whereas MIRD indicates the ratio of annual internal R&D expenditure of manufacturing enterprises to Gross National Product. Therefore, TECIN and MIRD measure China's level of technological input from different scopes.

3.2. Data Description and Symbols

3.2.1 Dependent Variable

Economic Growth (PGDP)

The gross domestic product (GDP) refers to the total value of goods and services produced within a region during a specific period. The PGDP is per capita GDP, which is a key indicator to measure economic growth (Fan, 2020; Usman, 2021).

3.2.2 Primary Independent Variable

CBEC export (CBEX)

It refers to the provincial CBEC export value every year from 2015 to 2020 in China. Current data on CBEC exports in China can only be accessed at the national level, but not at the provincial level. This paper adopts a set of provincial CBEC export data proposed by Ping et. al (2024) as the primary explanatory variable dataset. This method combines the annual proportion of CBEC export sellers by province and the annual export value of each province as a proportion of the national export to estimate the CBEC export value of each province from 2015 to 2020. The specific estimation method for this dataset is as follows: firstly, the proportion of Chinese CBEC sellers in 10 key provinces in 2015, 2017, and 2018 could be obtained from the Chinese CBEX report(2015-2016, 2017, 2018) except for a very few provinces in certain years where data may be unavailable(Appendix Table A.1). Accordingly, the missing years in Hubei, Henan, and Hebei were filled with the proportionate equivalents of the visible years. Furthermore, the proportion of CBEC sellers in other provinces in 2015, 2017, and 2018 was extrapolated using the proportion of exports of each province in China total exports every year through the formula (1) to ensure that the total proportion of CBEC sellers in each province was 100% .Thirdly, the proportion data in 2016 could be estimated through the mean value approach based on the CBEC seller proportions in 2015 and 2017. The ratio-invariant method was subsequently employed to estimate the seller proportions in 2019 and 2020 as the proportion of CBEC sellers in each province was relatively stable annually. In this way all the CBEC seller's provincial proportions could be reasonably inferred (See Appendix Table A.2.). The total export value of CBEC sellers in all Chinese provinces from 2015 to 2020 was calculated via Formula (2). The estimation method of this provincial CBEC export value combines the two methods of the seller's distribution ratio and the export volume of each province to the national export amount. This method of estimating the export value of CBEC at the provincial level combines two approaches: the distribution proportion of sellers and the ratio of provincial export value to the national total export value(Yin & Choi, 2023). By integrating these methods, it maximizes the reasonable estimation of CBEC export values for each province.

The proportion of CBEC sellers of other provinces = (1 - Sum of the proportion of sellers in other known priority provinces) × (exports value in each province divided by the total exports value of the entire China in the same year)

Formula (1)

CBEC export value of every province = Total CBEC export value annually in China × distribution proportion of CBEC sellers in every province

Formula (2)

3.2.3 Controlling Variables

According to the previous research, this study choose Fixed Capital Stock(PKS),the Number of Labour(LAB), Foreign Direct Investment Inflow level (FDIL), the Stock of Human capital (HUM), Exchange Rate of the RMB (EXR), Market Institutional Quality (INQ), Government technological input (TECIN) as the controling variables. Among them, the international perpetual inventory technique was adopted to measure PKS through the formula(3), the ratio of FDI inflow to GDP was utilized to measure the national FDI level, the J-F lifetime income approach improved by Li and Tang(2015) is used to measure the HUM level, EXR refers to the real effective exchange rate, the Fan Total Marketisation Index (FTMI) was adopted to appraise INQ. This paper also specifically includes two dummy variables in its control variables: US-China Trade War (TRAW) and COVID-19 Pandemic (COV). Among all the variables, except for EXR, TCOV, and RAW, all are expected to have positive effects.

PKS = Fixed capital stock in the previous year × (1 - depreciation rate) + fixed asset formation in the current year + inventory increase **Formula (3)**

Where the depreciation rate is fixed at 10.96% (Shan, 2008).

3.2.4 Threshold Variable

Manufacturing Industry R&D Intensity (MIRD)

The current study employed Manufacturing Industry R&D Density (MIRD) as the threshold variable to test the non-linear relationship between CBEC export and economic growth. The ratio of inner R&D expenditures of manufacturing enterprises to the national GDP was employed to assess MIRD.

4. Empirical Findings and Discussion

4.1 Data Statistics and Correlation

4.1.1 Data Statistic Description

Table 1 depicts the descriptive statistics of all variables, including data units and sources. The PKS was deflated by the investing products price index in 2015 and PGDP, CBEX and HUM were deflated by the GDP inflation index in 2015 to eliminate the inflation impact. The sample size for all variables is 186. The standard deviation of PGDP is large. Thus, the economic developmental level of Chinese provinces was highly disparate. The large CBEX variance also indicated that the gap in provincial CBEX was relatively large.

Table 1. Statistic Descriptions of All Variables

Variable	Description	Unit	Mean	Std. Dev.	Min	Max	Data Source
PGDP	GDP per Capita	RMB Yuan	58838.5	27356.26	23908.32	173070.6	Chinese National Statistics Website
CBEX	CBEX Exports	Trillion RMB Yuan	2032.3	3229.856	9.54	17528.0	China Chinese Export Developmental Report, 2015-2016, 2017, 2018, Chinese National Statics Bureau
PKS	Physical Capital Stock	100 million RMB Yuan	39560.21	32361.955	2325.12	168828.5	Chinese National Statistics Website
LAB	The Number of	10 Thousand	2376.949	1627.857	181	7039	Chinese National Statistics

HUM	Labor Human Resource Stock	Persons Billion RMB Yuan	81931.37	60447.521	3010.279	310777.8	Website Center for Human Capital and Labor Market Research
FDIL	Foreign Direct Investment Level	Ratio	0.017	0.015	0	0.121	Chinese National Statistics Website
EXR	Exchange Rate	Ratio	95.5	2.36	93	100	The Website of the Bank of China
INQ	Market Environment Quality	Indexes	8.079	2.0	1.124	11.916	Wind Database
TECIN	Technological developing level	100 million yuan	154.1125	188.8788	4.81	1168.793	EPS Database
TRAW	US-China Trade War	NO	0.5	0.50	0	1	No
COV	Covid-19 epidemic	No	0.1667	0.37	0	1	No
MIRD	R&D Density Of Manufacturing Industry	Ratio	0.0168	0.012	0 .002	0 .06	EPS Database

4.1.2 Correlation Analysis

Table 2 portrays the matrix of correlation coefficients among the variables in the model. The correlation of most coefficients is in line with expectations, with a positive correlation observed between PGDP and CBEX. Furthermore, the correlation between all variables is less than 0.8. Since the correlation between a few variables is greater than 0.7, Variance Inflation Factor (VIF) test is conducted to further analyze this. Past scholars, such as Hair et al.(2009), stipulated the VIF value below 10 as the threshold to indicate no multicollinearity issue. The VIF value for every variable was revealed to not exceed 10, which also demonstrated no multicollinearity issue in all variables.

Table 2. Pairwise Correlations

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) PGDP	1.000								
(2) CBEX	0.517*	1.000							
	(0.000)								
(3) PKS	0.261*	0.583*	1.000						
	(0.000)	(0.000)							
(4) LAB	-0.068	0.550*	0.573*	1.000					
	(0.357)	(0.000)	(0.000)						
(5) HUM	0.422*	0.697*	0.793*	1.000					
	(0.000)	(0.000)	(0.000)						
(6) FDIL	0.449*	0.137	0.025	0.238*	1.000				
	(0.000)	(0.062)	(0.735)	(0.001)					
(7) EXR	- 0.032	- 0.026	- 0.238*	- 0.034	0.099	1.000			
	(0.668)	(0.728)	(0.001)	(0.644)	(0.181)				
(8) INQ	0.621*	0.634*	0.503*	0.695*	0.512*	- 0.033	1.000		
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.654)			
(9) TECIN	0.476*	0.688*	0.629*	0.528*	0.753*	0.261*	-0.080	0.654*	1.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.278)	(0.000)	

(10) MIRD	0.748*	0.501*	0.282*	0.484*	0.496*	- 0.017	0.700*	1.000			
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.822)	(0.000)				
(11)TRAW	0.073	0.118	0.480*	-0.012	0.103	-0.174*	-0.353*	0.114	0.150*	1.000	
	(0.325)	(0.110)	(0.000)	(0.867)	(0.162)	(0.017)	(0.000)	(0.122)	(0.041)		
(12)COV	0.171*	0.128	0.344*	-0.019	0.168*	-0.079	0.284*	0.090	0.078	0.447*	1.000
	(0.019)	(0.081)	(0.000)	(0.795)	(0.022)	(0.285)	(0.000)	(0.222)	(0.287)	(0.000)	

*Notes. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.*

4.2 Estimation for Model (3)

4.2.1 Benchmark Regression

Panel data are generally estimated with three types of regression models. They are mixed OLS, fixed effects (FE) and random effects (RE). The Hausmann test was employed to determine that Bidirectional Fixed Effects Model (Two-way FE) was appropriate for the estimation of Model (3). The robustness of the model was corroborated by adding the control variables individually. The estimated results are illustrated in Table (3).

Table 3. The Results of Estimation by Two-Way FE for Model (3)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	lnPGDP	lnPGDP	lnPGDP	lnPGDP	lnPGDP	lnPGDP	lnPGDP	lnPGDP	lnPGDP	lnPGDP
lnCBEX	0.0981***	0.0958***	0.151***	0.0682**	0.0644**	0.0644**	0.0668**	0.0583**	0.0583**	0.0583**
	(0.0332)	(0.0341)	(0.0472)	(0.0278)	(0.0292)	(0.0292)	(0.0297)	(0.0271)	(0.0271)	(0.0271)
lnLAB		-0.0703	-0.181	0.225	0.199	0.199	0.164	0.153	0.153	0.153
		(0.112)	(0.108)	(0.184)	(0.176)	(0.176)	(0.166)	(0.171)	(0.171)	(0.171)
lnPKS			0.553***	0.673***	0.667***	0.667***	0.644***	0.549***	0.549***	0.549***
			(0.120)	(0.170)	(0.174)	(0.174)	(0.168)	(0.167)	(0.167)	(0.167)
lnHUM				0.665***	0.690***	0.690***	0.696***	0.620***	0.620***	0.620***
				(0.0850)	(0.0876)	(0.0876)	(0.0852)	(0.0838)	(0.0838)	(0.0838)
FDIL					1.212	1.212	0.962	0.505	0.505	0.505
					(0.814)	(0.814)	(0.792)	(0.753)	(0.753)	(0.753)
EXR						0.369***	0.367***	0.321***	-0.00716	-0.185***
						(0.100)	(0.0967)	(0.0937)	(0.0165)	(0.0335)
lnINQ							0.181**	0.195**	0.195**	0.195**
							(0.0701)	(0.0818)	(0.0818)	(0.0818)
lnTECIN								0.103**	0.103**	0.103**
								(0.0409)	(0.0409)	(0.0409)
TRAW									-0.984***	-2.049***
									(0.320)	(0.401)
COV										0.533***
										(0.116)
Constant	10.20***	10.74***	6.103***	-4.726*	-4.753*	-41.69***	-41.43***	-35.41***	-2.616	15.15***
	(0.201)	(0.942)	(1.773)	(2.725)	(2.783)	(12.35)	(11.88)	(11.40)	(1.776)	(3.784)
Observations	186	186	186	186	186	186	186	186	186	186
R-squared	0.725	0.725	0.757	0.847	0.850	0.850	0.857	0.866	0.866	0.866
Number of ID	31	31	31	31	31	31	31	31	31	31

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3 depicts that the CBEX impact on China's regional economic growth consistently remains significant and positive regardless of whether employing only the primary explanatory variable or gradually adding multiple control variables. The InCBEX coefficient was 0.0583 when all variables were controlled, which postulated that a 1% increase in CBEX value would lead to a 0.0583% increase in economic growth. Hence, H1 was accepted. The research findings are also consistent with those of Zuo (2016) and Hang and Adjouro (2021). This indicates that CBEC exports can facilitate the creation of relative advantages for export enterprises by influencing both the supply and demand sides of the economy, ultimately contributing to economic growth. The signs of coefficients for all control variables are consistent with expectations except COV. One possible reason is that existing models have not considered the non-linear impact of inner technological input by the manufacturing industry. Subsequent text will provide further evidence for this judgement. The coefficient of lnLAB and FDIL aligns with expectations, but are not significant. For lnLAB, one possible reason is that economic growth is more influenced by the quality of human capital, rather than simply the increase in labor quantity in the information times (Maestas, 2023). For FDIL, the possible reason is that the inward direct investment might require more time to take effect (Belloumi, 2014).

4.2.2 Robustness and Endogenous Analysis

4.2.2.1 Robustness Test

This study employs two methods to conduct robustness tests. First of all, this study employed Total Gross Domestic Production (TGDP) as the dependent variable replacing PGDP. Table 4 demonstrates the InCBEX coefficient is positive and significant at the level of 5%. The result confirmed the robustness of the benchmark regression. Secondly, enlightened by Zhao and Yi (2022), this study uses the inverse transformation of the product of the distance between the capital cities and the nearest ports in each province and the logarithm of oil prices (nmms_lndistopr) as a substitute variable for the main explanatory variable in Model (3). The reason is that provinces farther from the nearest port typically have lower levels of CBEC exports, while those closer to the nearest port generally have higher levels. Because distance remains constant annually, multiplying it by oil prices imbues it with the meaning of CBEC export costs. Provinces closer to ports have lower CBEC export costs and higher levels of CBEC exports, while those farther have higher costs and lower levels of CBEC exports. Reversing the logarithm of the product of distance and oil price, if its coefficient is positive, indicates that CBEC exports significantly drive economic growth.The coefficient of nmms_lndistopr as shown in the column (2) of Table 4 is positive at 1% significant level. This confirms the robustness of the baseline regression results.

Table 4. Robustness Test for Model (3)

	(1)	(2)
VARIABLES	lnTGDP	lnPGDP
lnCBEX	0.0595**	
	(0.0263)	
nmms_lndistopr		235.6***
		(43.10)
lnLAB	0.152	0.135
	(0.172)	(0.173)
lnPKS	0.554***	0.487***
	(0.169)	(0.170)
lnHUM	0.619***	0.677***
	(0.0861)	(0.0808)
FDIL	0.524	0.767
	(0.736)	(0.646)
EXR	-0.186***	2.213***

	(0.0333)	(0.456)
lnINQ	0.196**	0.201**
	(0.0802)	(0.0902)
lnTECIN	0.102**	0.114**
	(0.0410)	(0.0416)
TRAW	-2.060***	21.95***
	(0.403)	(4.522)
COV	0.534***	-11.47***
	(0.115)	(2.265)
Constant	15.19***	-312.9***
	(3.782)	(61.80)
Observations	186	186
R-squared	0.868	0.865
Number of ID	31	31

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4.2.2.2 Endogenous test

CBEC exports may promote regional economic growth . On the other hand, regional economic growth can also promote a country's exports. Therefore, there may exist endogeneity issues of reverse causality in the benchmark regression. This study uses Two-Stage Least Squares (2SLS) Instrumental method with the lagged one period of CBEC exports (l.lnCBEX) as the tool variable to mitigate this issue. The first-stage test results show that this instrumental variable has a significant correlation with CBEC exports in the current period. Further, F test result shows that $F(1,144)$ is bigger than 10, suggesting that l.lnCBEX have passed the weak instrumental variable test. Therefore, it is suitable to be used as an instrumental variable. The regression results of the second stage show that the impact of CBEC exports on economic growth is positive at a significance level of 5%. The robustness of the benchmark regression result is further confirmed.

Table 5. 2SLS Instrumental Variable Regression Result

	(1)	(2)
	First Stage	Second Stage
VARIABLES	lnCBEX_	lnPGDP_
lnCBEX		0.0502**
		(0.0238)
L.lnCBEX	0.424***	
	(0.0670)	
lnLAB	-0.0259	-0.553***
	(0.157)	(0.0678)
lnPKS	-0.214	0.146***
	(0.196)	(0.0422)
lnHUM	1.118***	0.261***
	(0.102)	(0.0866)
FDIL	2.954	2.337
	(2.242)	(1.555)
EXR	0.0271	-0.0903**
	(0.0532)	(0.0362)

lnINQ	0.233	0.374***
	(0.196)	(0.117)
lnTECIN	-0.0230	0.0833**
	(0.0491)	(0.0338)
TRAW	0.150	-0.247***
	(0.203)	(0.0517)
COV	0.111	0.374***
	(0.177)	(0.142)
Constant	-9.513*	17.75***
	(5.010)	(3.592)
ID	Controlled	Controlled
Year	Controlled	Controlled
F(1,144)	1318.14	
Observations	155	155
R-squared	0.997	0.788

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4.3 Heterogeneity Analysis for Model(4)

Table 6 portrays the heterogeneity of the impact of CBEC exports on more developed regions and less developed regions. This study conducted a double fixed-effects regression on Model (3) for more developed regions and less developed regions and also performed a regression by replacing the dependent variable in Model (3) with ln(TGDP) for robustness test. As shown in columns (1) and (3) , regardless of whether lnPGDP or lnTGDP is used as the dependent variable, the coefficients of CBEC exports on economic growth in the more developed regions are not significant. However, as shown in Columns (2) and (4), CBEC exports can significantly promote economic growth in underdeveloped regions. This indicates that CBEC exports have a greater promotional effect on economic growth in underdeveloped regions compared to economically developed regions, which supports H2.This research finding is in line with the economic convergence theory proposed by Stefano in 2004. It posits that economically underdeveloped regions can achieve similar standards as developed regions by rapidly learning and adopting mature technologies and management experiences through information and communication technologies (ICT). Specifically, this involves technology transfer and diffusion, enabling underdeveloped regions to leverage the power of ICT to swiftly catch up with and converge with their more advanced counterparts.

Table 6. Heterogeneity Analysis for Model (3)

	(1)	(2)	(3)	(4)
	More developed regions	Less developed regions	More developed regions	Less developed regions
VARIABLES	lnPGDP	lnPGDP	lnTGDP	lnTGDP
lnCBEX	0.0252	0.0674**	0.0279	0.0696***
	(0.0388)	(0.0230)	(0.0384)	(0.0225)
lnLAB	0.0164	0.450	0.00844	0.452
	(0.202)	(0.328)	(0.201)	(0.324)
lnPKS	0.773**	0.373	0.775**	0.378
	(0.287)	(0.215)	(0.289)	(0.219)
lnHUM	0.632***	0.728***	0.623***	0.729***
	(0.0994)	(0.0871)	(0.100)	(0.0903)

FDIL	0.708	-1.658	0.655	-1.627
	(0.756)	(2.119)	(0.738)	(2.117)
EXR	-0.225***	-0.134***	-0.227***	-0.134***
	(0.0629)	(0.0348)	(0.0635)	(0.0333)
lnINQ	0.134	0.215*	0.155	0.221**
	(0.595)	(0.104)	(0.593)	(0.102)
lnTECIN	0.0940	0.0739	0.0968	0.0721
	(0.0729)	(0.0481)	(0.0726)	(0.0475)
TRAW	-2.609***	-1.499***	-2.625***	-1.508***
	(0.743)	(0.454)	(0.749)	(0.451)
COV	0.617***	0.382***	0.624***	0.381***
	(0.186)	(0.124)	(0.187)	(0.119)
Constant	18.02***	8.833*	18.28***	8.750*
	(5.213)	(4.576)	(5.245)	(4.507)
Observations	90	96	90	96
R-squared	0.840	0.906	0.841	0.910
Number of ID	15	16	15	16

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4.4 Threshold Effect Test for Model(5)

Table 7 reports the threshold effect test results with R&D Intensity of manufacturing industry as the single threshold for the national sample.Table 8 depicts that the threshold is 0.031 at the 95% confidence interval. Figure 2 illustrates the likelihood function plot, which reflects the construction process of threshold estimation and confidence intervals.The likelihood function plot displays a peak in the vicinity of 0.31, which further validates the reasonability of selecting 0.31 as the threshold value. Moreover, the plot indicates that there are no multiple significant peaks present. The convergence of CBEC exports on economic growth fulfilled the significance test under the single-threshold model, which suggested a non-linear relationship between CBEC exports and regional economic growth.

Table 7. Self-Sampling Tests for Threshold Effects

Threshold	RSS	MSE	Fstat	Prob	Crit10	Crit5	Crit1
Single	0.521	0.003	30.870	0.010	20.387	24.780	30.345
Double	0.455	0.003	26.170	0.373	57.074	74.062	105.275
Triple	0.415	0.002	17.140	0.483	41.801	51.761	84.336

Table 8. Estimated Threshold Value

Model	**Threshold**	**Lower**	**Upper**
Th-1	0.031	0.030	0.032

Notes. Threshold effect test (bootstrap = 300 300 300)

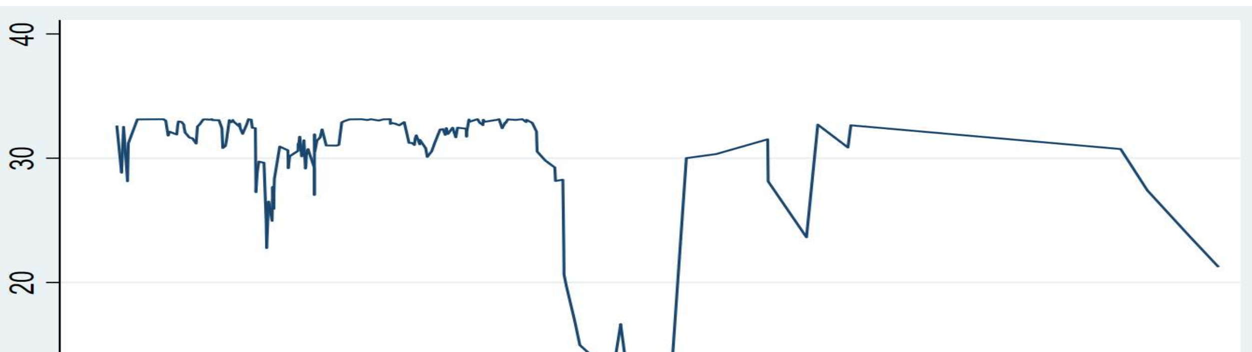


Figure 2. The Likelihood Function Plot

The column (1) in Table 9 demonstrates that the estimated coefficient is 0.062 when MIRD is below 0.031, which is significant at a 1% significance level. The result indicates that every 1% CBEC exports growth would lead to economic growth in China by 0.068%. The contribution of CBEC exports is insignificant when MIRD exceeded 0.031. The results of the threshold effect demonstrate that increasing investment in technology by China's manufacturing industry is not a case of "the more, the better." If technological investment is not directed towards effective innovation and instead relies on mere imitation innovation, it may lead to diminishing returns on technological investment. Therefore, H3 is accepted. According to the R&D investment intensity of each province in 2020, Beijing, Guangdong Province, Shanghai, and Tianjin showed above 0.031 R&D intensity value in R&D, whereas the other regions did not reach 0.031 in R&D intensity, as shown in Table 10. Table 10 illustrated the R&D Intensity Ranking of Manufacturing Industries by Chinese Province in 2020. For these provinces with relatively high R&D intensity except the four provinces mentioned above, particular attention should be paid to the rational utilization of enterprise research funding, enabling research investment to better facilitate the advancement of CBEC exports so as to ensure CBEC exports can continuously play the important role in regional economic growth.

This study specifically compares the threshold regression result with the two-way FE and OLS regression results of Model (3) as shown in Column (2) and Column (3) in Table (9). Based on the results of the three regressions, the impact of CBEC exports on economic growth is consistently positive. It is interesting that when the role of R&D intensity in manufacturing industry is added as a threshold, the coefficient of COV changes significantly from positive to negative, which obviously better reflects the reality of the Chinese economy. This once again highlights the importance of technological input by the manufacturing industry. Meanwhile, the coefficient of EXR changes significantly from negative to positive. The possible reason is that the threshold variable of technology plays a prominent role in reversing the economic growth pressure brought about by the appreciation of the Chinese currency. Technological advancements in manufacturing industries improve product quality, thereby helping manufacturing enterprises to maintain the high loyalty from oversea customers to Chinese goods even when goods prices rise due to exchange rate issues.

Table 9. The Threshold Effect Estimation with FE and OLS Regression as contrast

Variables	(1) Threshold Effect for Model (4)	(2) Two-way FE for Model (3)	(3) OLS for Model (3)
lnCBEX (MIRD＜0.031)	0.068**		

lnCBEX (MIRD＞0.031)	0.027		
lnCBEX		0.0583**	0.0695***
		(0.0271)	(0.0223)
lnLAB	-0.041	0.153	-0.558***
	(0.168)	(0.171)	(0.0672)
lnPKS	0.597***	0.549***	0.150***
	(0.164)	(0.167)	(0.0441)
lnHUM	0.625***	0.620***	0.255***
	(0.081)	(0.0838)	(0.0810)
FDIL	-0.871	0.505	2.757**
	(0.654)	(0.753)	(1.067)
EXR	0.109***	-0.185***	0.0131
	(0.029)	(0.0335)	(0.0109)
lnINQ	0.175***	0.195**	0.287***
	(0.063)	(0.0818)	(0.0900)
lnTECIN	0.089**	0.103**	0.0778**
	(0.039)	(0.0409)	(0.0322)
TRAW	-0.356***	-2.049***	-0.151***
	(0.069)	(0.401)	(0.0443)
COV	-0.360***	0.533***	0.00478
	(0.0127)	(0.116)	(0.0699)
CONS	-13.986	15.15***	8.120***
	(0.412)	(3.784)	(1.370)
Observation	186	186	186
ID	Controlled	Controlled	Not Controlled
Year	Controlled	Controlled	Not Controlled
R^2	0.8622	0.866	0.776
Prob > F	0.00	0.00	0.00

Table 10. The R&D Intensity Ranking of Manufacturing Industries by Chinese Province in 2020

Beijing	0.064444	Shandong	0.022999	Jiangxi	0.016765	Neimeng	0.009278
Shanghai	0.041748	Anhui	0.022833	Henan	0.016388	Guizhou	0.009071
Tianjin	0.034438	Liaoning	0.02186	Ningxia	0.015212	Guangxi	0.007818
Guangdong	0.031418	Sichuan	0.021714	Jilin	0.012956	Qinghai	0.007091
Jiangsu	0.029264	Hunan	0.02151	Heilongjiang	0.012641	Hainan	0.00662
Zhejiang	0.028785	Chongqing	0.021069	Gansu	0.01216	Xinjiang	0.004462
Shannxi	0.024151	Fujian	0.019188	Shanxi	0.011956	Tibet	0.002296
Hubei	0.023140	Hebei	0.017521	Yunnan	0.010031		

5. *Conclusion, Discussion, and Policy Suggestion*

5.1 Conclusion

The current study conducted a benchmark analysis through the bidirectional FE model based on innovatively derived provincial CBEX data from 2015 to 2020 in China. The results revealed that CBEC exports significantly increased Chinese regional economic growth. This study also conducted a robustness test by substituting the dependent variable and the main explanatory variable. Subsequently, a 2SLS Instrumental Variable Method was performed to corroborate the robustness of the benchmark regression. Moreover, the heterogeneous analysis demonstrated that CBEC exports can more significantly boost provincial economic growth in undeveloped areas of China compared to more developed areas. The threshold effect model also identified that the technological input by manufacturing industries played nonlinear regulatory roles in CBEC exports and economic growth. The CBEC exports contributed more to economic growth before the threshold while the positive effect was insignificant after the threshold. This conclusion not only further verifies the correctness of the theory of comparative advantage and the factor endowment theory, but also builds on previous research to extend these theories into the theory of CBEC exports.From a practical perspective, it has become more justifiable for government departments to further formulate policies to promote CBEC exports.

5.2 Policy Suggestion

Given that CBEC exports play a positive role in China's economic growth, it is recommended that all grade of Chinese governments accelerate the development of CBEC exports from the following aspects. Firstly, the governments should expedite the pace of trade facilitation reforms to facilitate CBEC exports. It is particularly important to emphasize the enhancement of the level of informatization nationwide and the establishment of overseas warehouses for cross-border exports. Secondly, the governments should broaden the channels for cultivating CBEC exports talents. Currently, the supply of talents for China's CBEC exports is far behind market demand. Thirdly, the governments should guide China's enterprises to actively explore newly emerging markets, including the 'Belt and Road' Initiative, RCEP, and African markets etc. Fourthly, the governments can actively facilitate connections between enterprises and markets through more international exchange activities. Based on the results of heterogeneity tests, the government should provide more support policies for the development of CBEC exports in less developed regions, including providing moderate financial subsidies, tax incentives, and reducing administrative restrictions etc. Given the threshold effect of inner technology input by the manufacturing industry, it is recommended that the government should encourage manufacturing enterprises in regions with insufficient R&D intensity to increase investment in research and development funds. For regions with high intensity of research and development input, the government should guide enterprises to effectively utilize R&D resources, encourage manufacturing enterprises to prioritize the development of originally-created products and ensure that enterprises receive higher returns on R&D investment further promoting regional economy growth.

5.3 Limitation and future direction of the study

This study use panel data to explore the relationship between CBEC exports and economic growth. Due to limitations in available data, this paper estimates CBEC export data from 2015 to 2020 by combining the distribution ratio of sellers with the proportion of traditional exports in each province's total exports. This method has a certain degree of scientific rigor, but compared with research based on genuinely accessible data, it also introduces certain research bias. As China's statistical system continues to improve, future studies can strive to obtain real CBEC data for analysis. Furthermore, this study is based solely on data from China, and future research on the relationship between CBEC exports and economic growth can be expanded to encompass more countries, larger regions, and longer time-frames, marking a promising direction for the field.

Conflicts of Interest

The authors declare no conflicts of interest.

Author Contributions

Conceptualization, G.P.; methodology, G. p.; software, G.P.; Validation, G.P.; 562 formal analysis, G. p. resources, G.P.; data curation, G.P.; writing—original draft preparation, G.P.; writing—review and editing, G.P.; supervision, H.Z.H. and ð L. C. All authors have read and agreed to the published version of the manuscript.

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Appendix A

Table A.1 The Original Data for CBEC Export Seller Ratios

	2015	2017	2018
Guangdong	24.7%	24.8%	21%
Zhejiang	16.5%	16.8%	17%
Jiangsu	12.4%	11.3%	13%
Beijing	5.2%	8.6%	5%
Shanghai	7.1%	6.5%	8%
Fujian	9.4%	5.4%	7%
Shandong	3.3%	3.6%	3%
Hubei	4.1%	No data	No data
Henan	No data	3.2%	No data
Hebei	No data	No data	2%

Data source： China's CBEC Export Development Report

Table A.2. Proportion of CBEC exports by the province to total national exports

	2015	2016	2017	2018	2019	2020
Guangdong	24.7%	24.75%	24.8%	21%	21%	21%
Zhejiang	16.5%	16.5%	16.8%	17%	17%	17%
Jiangsu	12.4%	11.85%	11.3%	13%	13%	13%
Beijing	5.2%	6.9%	8.6%	5%	5%	5%
Shanghai	7.1%	6.8%	6.5%	8%	8%	8%
Fujian	9.4%	7.2%	5.4%	7%	7%	7%
Shandong	3.3%	3.45%	3.6%	3%	3%	3%
Hubei	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%
Henan	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%
Hebei	2%	2%	2%	2%`	2%	2%

Other provinces	Calculated from **Formula(1)**	The average value of the data in 2015 and 2017	Calculated from **Formula(1)**	Calculated from **Formula(1)**	The same as in 2018	The same as in 2018
Total	100%	100%	100%	100%	100%	100%

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