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Cross-Border E-commerce and Economic Growth: Evidence from the "10+1" Free Trade Agreement

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Abstract: Cross-border e-commerce (CBEC), as a new driving force to economy, has been flourishing recently. Under the implementation of "10+1" Free Trade Agreement in 2010 and the Upgrade Protocol of "10+1" Free Trade Agreement in 2016, China and ASEAN countries has witnessed a prosperous bilateral CBEC transaction. As early as 2016, ASEAN has become China's 9th-largest trading partner in CBEC, and China's 3rd-largest CEBC export market. According to the customs statistical data from 2019 to 2023, China has maintained strong CBEC ties with ASEAN in B2B and petty B2C trade. And estimated bilateral CBEC volume appears an upward movement especially after the year of 2010 and 2016. While how this impressive CBEC trade benefiting from "10+1" FTA affects ASEAN's economic growth is still less been investigated. Our paper employs a Generalized DID method by examining the exogenous shocks from "10+1" Free Trade Agreement coming into force in 2016 to answer this question. By empirically analyzing the impact of CBEC on consumers, firms and labor, this study also comprehensively elucidate mechanisms through which CBEC influences macro-economic growth. We find that, first, CBEC reduces firms' procurement and inventory management cost and improves productivity through spillovers effect, especially for SMEs, to boost international trade. Second, CBEC by reducing information cost, expanding consumption choices and lowering goods' price for consumers fosters consumption. Third, increasing job opportunities and enhancing labor productivity brought by CBEC lead to a higher income, which promotes higher consumption. Consumption and trade boost economic growth. This paper provides theoretical evidence for further strengthening China-ASEAN economic cooperation and CBEC collaboration.

Keywords: Cross-Border E-commerce, International Trade, Economic Growth, China-ASEAN Free Trade Agreement

1. Introduction

The rapid development of Information and Communication Technology (ICT), especially the Internet, has reshaped the global economy and business model. The Internet has changed how business and consumers compare, buy, and sell both products and services, and how they search and manage information, deal with payments, and manage data. The Internet has also opened up completely new sectors in the economy by creating new products, new services, and new business models that were previously impossible [1]. These activities are now called the E-commerce. According to Vladimir Zwass [2], "Electronic commerce is sharing business information, maintaining business relationships and conducting business transactions by means of telecommunications networks."

Importantly, international trade has been facilitated by these developments which is because ICT reduces costs [1]. Finding the right supplier, specifying the product's requirements and quality, negotiating the price, arranging deliveries and marketing products are very costly which can be considered a substantial barrier to trade [3]. While ICT makes it possible for the e-commerce platforms' construction and application, which simplifies the deal process and eliminates physical proximity between buyer and seller. Hence, international trade in goods and services conducted via electronic means, referring as cross-border e-commerce (CBEC), has grown exponentially due to the reduction of barriers caused by travel, administration, communication and market search costs [3].

Recently, the development of CBEC has made remarkable achievements. The rapid progress of ICT, the exponential growth of global mobile phone users, the increasing recognition of overseas shopping of global consumers, the trade cooperation between governments by providing favorable policies, especially the signing of free trade agreements and the establishment of free trade zones [4], have facilitated CBEC transactions. According to eMarketer (2022), global retail e-commerce sales have increased from 1,300 billion dollars in 2014 to 6,000 billion dollars in 2022, with a yearly growth rate over 17.5%[1]. While CBEC has emerged as a significant component of e-commerce, it has performed impressively in the Asia-Pacific region. According to Avalara (2023), the Asia-Pacific region ranks No.2 in the total sales of CBEC among supply chain companies worldwide in 2023, following closely after Latin America and the Caribbean region, accounting for 21% in the global CBEC share[2]. Among these countries, China, as the leading figure in Asia-Pacific e-commerce landscape, possesses numerous well-known CBEC platforms such as Tmall Global, JD Worldwide, and etc., with total trade volume of China's CBEC firms increasing from 2.1 trillion yuan in 2012 to 15.7 trillion yuan in 2022 according to 100ec.cn[3]. Additionally, the development of e-commerce and CBEC in Southeast Asian countries has been into prosperity. According to Universal Postal Union (UPU) data[4], total international items including dispatch and receipt service in Association of Southeast Asian Nations (ASEAN)[5] grow rapidly from 4,523,578 in 2005 to 6,268,571 in 2021, and total international parcels including dispatch and receipt service grow from 1,422,382 in 2005 to 2,675,437 in 2020.

The rise of CBEC has also attracted the attention of scholars. There are three strands of literature making valuable reference to our paper. As an increasingly key composition of trade, many scholars focus on the CBEC and trade. Wang et al. [5] and Qin and Bryna [6], both study the case of China but obtain inconsistent results. The former finds that the development of international e-commerce significantly promotes the China's export [5]. The latter employs Person Correlation Coefficient and draws the conclusion that the impact of CBEC on international trade volume and exports was insignificant [6]. Yin and Choi stand for the former results using data of China's CBEC and export to Road & Belt countries, and find a positive effect between CEBC and trade [7]. Xing focuses on OECD countries and developing and least-developed countries, and employs the gravity model [1]. He finds that developing and least-developed countries embracing more application of e-commerce and the Internet, are more likely to benefit from South-to-North bilateral trade. Above all, there is still debate regarding the impact of CBEC on international trade, and limited attention paid to rapidly growing CBEC in Southeast Asia.

Another strand of literature has extensively used empirical methods to study the relationship between e-commerce or CBEC and economic growth in China [8, 9], in underdeveloped regions such as the Middle East [10] and etc., and in European countries [11, 12], and all these papers come into a consensus that e-commerce or CBEC exerts a positive and significant impact on economic growth. Among these, Zhong et al. is most closely related to our study, who use a Difference-in-Difference (DID) method exploring how CBEC comprehensive pilot zones influence economic growth in China [9]. Above all, though a large number of literature studies the relationship between CBEC and growth, and consistently concludes that e-commerce promotes economic growth, there are limited studies focusing on Southeast Asian region, particularly among the ASEAN countries. Despite the late start of e-commerce in ASEAN countries, they are essential components of the global emerging economies, and their contributions to global CBEC should not be underestimated. Moreover, very few studies evaluate the impact of multilateral CBEC cooperation on economic growth, especially in the case of China-ASEAN Free Trade Area (CAFTA). Though Zhong et al. [9] and Yin and Choi [7] explore CBEC promotion policy's economic effect, they pay attention to China but not the partners of China.

The last strand of literature emphasizes e-business' economic effect. First, for consumers, G. Ellison and S. F. Ellison [13] note that there's an increasing demand elasticity of commodities for competing sellers due to lower search costs brought by search engine on e-commerce platform. Retailers must face a directly fiercer competition with each other, with lower price and broader consumer choice benefiting the economy [14]. Second, for suppliers, e-commerce changes the way B2B transactions conducted, which reduces management costs and improves firms' productivity [14]. Third, for labor, Atrostic and Nguyen investigate e-business network in the US manufacturing firms [15], and Criscuolo and Waldron explore the online shopping in the United Kingdom [16], both studies find e-business had a positive impact on labor productivity. These papers tend to focus on the economic impact of ICT or e-business networks, such as the effect on consumer welfare, producer cost-benefit, and labor productivity. However, few studies have examined the role of CBEC. Prieger and Heil qualitatively explore the influence of e-commerce on GDP, monetary policy, and fiscal policy from a macroeconomic perspective, but ignore to provide empirical evidence to support these findings [14].

Above all, our paper's main work and potential contributions are as follows. On the one hand, it focuses on how bilateral CBEC between China and ASEAN affects ASEAN's economic growth through international trade. And we will employ a Generalized DID method by examining the exogenous shocks from "10+1" Free Trade Agreement coming into force. On the other hand, by examining the impact of CBEC on consumers, firms and labor, this study will comprehensively elucidate channels through which CBEC influences macro-economic growth, and provide empirical evidence to support these mechanisms.

The rest of the paper is organized as follows. Section 2 describes CBEC cooperation and bilateral CBEC development between China and ASEAN. Section 3 presents theoretical mechanisms, identification strategy and data. Section 4 provides empirical results and test the mechanisms. Section 5 concludes.

2. Background and Stylized Facts

2.1. Background of CBEC Cooperation Between China and ASEAN

China-ASEAN's relationship started from dialogue partnership in 1991 to the full establishment of the "10+1" Free Trade Agreement (FTA) in 2015. The China-ASEAN FTA negotiations began in 2002, which was formalized through the signing of *the Framework Agreement on Comprehensive Economic Cooperation (the Framework Agreement)*, and in 2004, the Trade in Goods (TIG) Agreement was signed and came into effect in 2005. In 2007, the Trade in Services (TIS) Agreement took effect, followed by the signing of the Investment Agreement in 2009, which came into effect in 2010. In 2010, China and the ASEAN-6 countries (Brunei, Indonesia, Malaysia, Philippines, Singapore and Thailand) fulfilled commitments to lower tariffs to 0, and in 2015, China fully established a free trade zone with the CLMV countries (Cambodia, Laos, Myanmar, and Vietnam). In 2015, *the Protocols to Amend the Framework Agreement on Comprehensive Economic Cooperation (the Upgrade Protocols)* covering negotiations and agreements on TIG, TIS and international investment, was signed and formally came into effect in 2016. In addition, extensive cooperation in areas such as finance, intellectual property protection, and energy has also been established. There's a need to recognize the goodwill and significant contributions made by China and ASEAN in promoting multilateral trade development and achieving comprehensive regional cooperation.

China has become ASEAN's largest trading partner since 2009. First, TIG between ASEAN and China has more than doubled since 2010, reaching USD 507.9 billion in 2019 (18% of ASEAN's total trade), and has nearly quadrupled since the ASEAN-China TIG Agreement came into effect in 2005. China's imports from ASEAN in 2019, which enjoyed preferential tariff rates, has increased by 9.6% year-on-year, accounting for 49% of China's total imports benefiting from preferential treatments. Second, TIS amounted to USD 65.7 billion in 2019. Third, Foreign Direct Investment (FDI) from China to ASEAN has increased by 185% from USD 3.6 billion in 2010 to USD 9.1 billion in 2019, accounting for 5.7% of total FDI flows to ASEAN. In 2019, China was the fourth largest source of FDI for ASEAN among its Dialogue Partners.[6]

Among all negotiations, the cooperation and efforts in CBEC made by the Chinese and ASEAN parties are worthy researching, which was first explicitly mentioned in *the Framework Agreement* in 2002. However, subsequent agreements on TIG, TIS, and investment did not claim cooperation in the field of e-commerce. It was not until 2015 that CBEC truly became important in the development and improvement of China-ASEAN FTA. *The Upgrade Protocol* detailed how multilateral e-commerce should be developed, with *Chapter 4 Article 7 Provision (3)* formally stating the need to create a favorable business environment for CBEC and promoting the development of e-commerce for small and medium-sized enterprises (SMEs) to enhance economic and trade cooperation (see Table 1).

Table 1. *CBEC Cooperation Articles in FTA.*

Year	Articles	Content
2002	Part II Article7 *in the Framework Agreement*	Measures to strengthen co-operation shall include, but shall not be limited to: promotion of electronic commerce.
2015	Chapter 4 Article7 Provision (3) in *the Upgrade* Protocols	1. The Parties recognize the economic growth and opportunities brought about by e-commerce, as well as the importance of promoting the application and development of e-commerce. 2.The Parties agree to share information, expertise, and engage in dialogue on e-commerce-related issues, including laws, regulations, rules, and standards, as well as best practices, to create an environment conducive to the development of e-commerce. 3. The Parties shall encourage the participation of the industry and the facilitation by government agencies to fully leverage e-commerce platforms in enhancing trade and investment relations among the Parties. 4. The Parties shall support e-commerce workshops and training programs, encourage capacity building cooperation, and enhance the ability of micro, small, and medium enterprises to access regional and international markets.

*Source: The the Framework Agreement on Comprehensive Economic Cooperation in 2002; the Protocols to Amend the Framework Agreement on Comprehensive Economic Cooperation between China and ASEAN and its Annexes in 2015.

Afterwards, during the 12th China-ASEAN Business and Investment Summit on September 2015, China Council for the Promotion of International Trade (CCPIT) and the ASEAN Chambers of Commerce and Industry (ACCI) signed the *Memorandum of Cooperation between China and ASEAN on Cross-border E-commerce Platforms*, initiating the construction of China-ASEAN CBEC platforms and actively promoting the multilateral cooperation mechanism in China-ASEAN Free Trade Area.[7] Since 2017, China has successively signed *Memoranda of Understanding on E-commerce Cooperation* with Vietnam, Cambodia, Singapore, Thailand, Laos, and Philippines, which provided a mechanism for dispute resolution.[8]

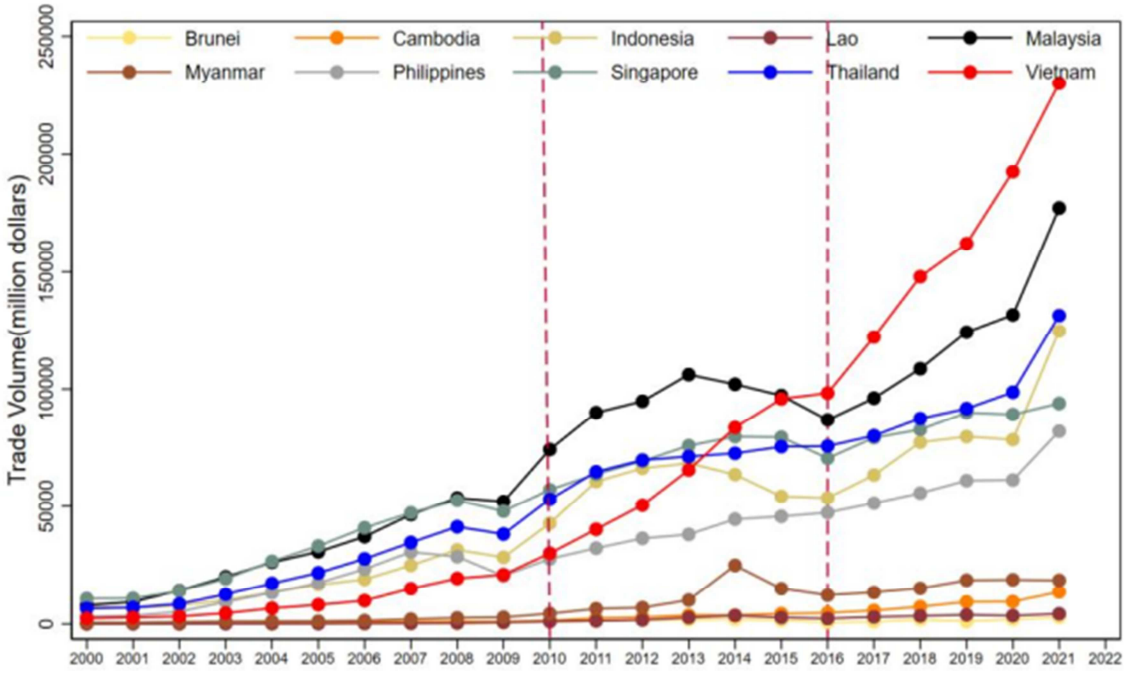
The formal consensus reached between both parties on CBEC cooperation in 2015 was officially implemented in 2016. Coupled with the continuous efforts by all parties thereafter, CBEC in China-ASEAN region has entered a rapidly growing period. As early as 2016, ASEAN has become China's ninth-largest trading partner in the field of CBEC, and it was China's third-largest export market for CBEC, surpassed only by the United States and the European Union[6].

2.2. Stylized Facts of Bilateral CEBC Between China and ASEAN

Government cooperation and favorable policies have indeed promoted the development of CBEC within CAFTA. According to the monthly statistical reports of the General Administration of Customs of China[9], the product code "98.05" representing personal CBEC products, is an important form of B2C CBEC. The product code "99.00" for simplified declaration of B2B CBEC is also compiled. Appendix table A1-A3 respectively presents the monthly import, export value of personal CBEC products, and export value of simplified declaration commodities for cross-border B2B trade between China and ASEAN countries.

Horizontally, B2C CBEC indicates that China imports more from Thailand, Singapore, Vietnam, and Indonesia through CBEC, while imports less from Brunei, Laos, and Myanmar. China also exports more to Singapore, Thailand, Indonesia, and Vietnam, but exports less to Brunei, Laos, and Myanmar. For B2B CBEC exports, China shows a closed relationship with Malaysia, Singapore, and Vietnam. Overall, China constructs stronger CBEC trading relationships with Singapore, Vietnam, Thailand, and Indonesia, while less link to Laos, Brunei, and Myanmar. Vertically, these tables show that China's B2C CBEC import from Malaysia, Singapore, and Thailand has been increasing over years. However, B2C CBEC export to Indonesia, Singapore, and Thailand has been decreasing annually, possibly due to the significant impact of the COVID-19 pandemic since 2020. B2B CBEC exports to Thailand and Vietnam are not affected by the pandemic and show a strong upward trend. In summary, China's CBEC connections with Singapore, Thailand, Vietnam, Malaysia and Indonesia are becoming increasingly close.

Due to the limitation of data available, we can only directly observe the last 3 years' movement of part of the CBEC. While as a form of electronic business, CBEC has become an integral part of cross-border trade. Figure 1 plots the bilateral trade volume (imports and exports) between ASEAN and China from 2000 to 2021. It can be observed that bilateral trade surged in 2010 and 2016, which respectively corresponded to the fully establishment of the China-ASEAN6 Free Trade Area and *the Upgrading Protocol*. It's worth noting that China's bilateral trade with Vietnam jumped from being the 6th largest partner in 2010 to the largest partner after 2016. This is closely related to the full implementation of CAFTA in Vietnam.



*Source: The National Bureau of Statistics of China.

Figure 1. *ASEAN-China Bilateral Trade Volume (in million dollars).*

The increasing trend in bilateral trade suggests an upward movement of CBEC. There's a doubt that this conclusion may not necessarily be applicable as CBEC is just one of the various components in international trade. Nonetheless, we confirm this conclusion using data from the General Administration of Customs of China in 2019-2021, and we calculate the correlation coefficients and test the significance of the bilateral CBEC scale and trade volume, as shown in Table 2. Row (2) column (1) and Row (4) column (3) respectively shows a significant positive correlation between CBEC export and total export, and between CBEC import and total import at a 5% level of significance. Rows (6) and (7) column (5) show that bilateral trade and CBEC scale are significantly positively correlated at a 5% level of significance. These results indicate a strong positive correlation and consolidate the common trend between CBEC transactions and international trade within CAFTA.

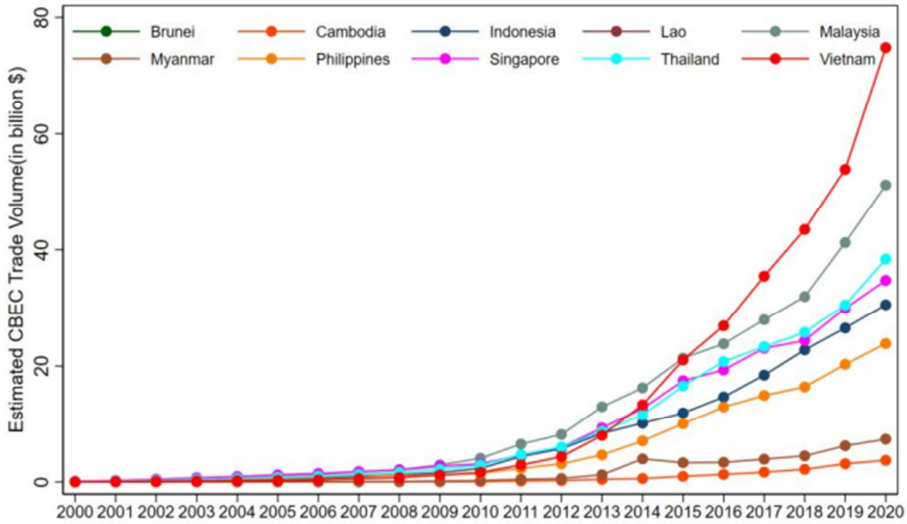
Table 2. *Correlation Coefficients of International Trade and CBEC Transaction.*

		(1)	(2)	(3)	(4)	(5)	(6)	(7)
		export	**CBEC export (9805)**	**import**	**CBEC import (9805)**	**Trade Volume**	**CBEC Transaction**	**CBEC Volume (9805)**
(1)	export	1						
(2)	CBEC export (9805)	0.32* (0.09)	1					
(3)	import	0.90*** (0.00)	0.32* (0.09)	1				
(4)	CBEC import (9805)	0.35* (0.06)	0.51*** (0.00)	0.38** (0.04)	1			
(5)	Trade Volume	0.98*** (0.00)	0.33* (0.08)	0.97*** (0.00)	0.37** (0.04)	1		
(6)	CBEC Transaction	0.43** (0.02)	0.50*** (0.01)	0.42** (0.02)	0.79*** (0.00)	0.44** (0.02)	1	
(7)	CBEC Volume (9805)	0.38** (0.04)	0.76*** (0.00)	0.41** (0.03)	0.95*** (0.00)	0.41** (0.03)	0.78*** (0.00)	1

*Note: The values in parentheses are p-values. The coefficients with *, **, *** represent a 10%, 5% and 1% significant level. The calculations are based on data from 2019-2021. The variable export, import refers to bilateral exports and imports between China and ASEAN. CBEC export (9805) and CBEC import (9805) refers to the export and import volume of products in code 9805 (i.e., personal CBEC products). Trade Volume is the sum of bilateral exports and imports. CBEC Transaction encompasses the export and import of products under code 9805, and the export of the Simplified declaration CBEC B2B category (code 9900). CBEC Volume (9805) includes only the import and export of product coded 9805.

Besides, for facilitating further research, we calculate a weight using China's aggregate trade scale and bilateral trade with ASEAN countries, and estimate the bilateral scale of CBEC. Details can be found in Appendix B1. Figure 2 plots the estimated bilateral CBEC volume, which shows an upward movement in CBEC especially after the year of 2010 and 2016 for both countries. Among ASEAN countries, Vietnam, Malaysia, Thailand, Singapore and Indonesia are top 5 CBEC partners with China, which is conformity with the direct evidence in Tables A1-A3. This further validates the reasonableness of the estimated bilateral CBEC scale.

Above all, under the promotion of CAFTA and CBEC cooperation articles, along with the extensive application and high-speed advancement of ICT, CBEC between China and ASEAN has flourished since 2016.



Source: Calculated and complied by authors.

Figure 2. *Estimated Bilateral CBEC Volume (in billion dollars).*

3. Methodology

3.1. Theoretical Mechanisms

CBEC has the potential to impact economic growth through various channels. Previous studies mainly focused on the economic effects of e-commerce, but hardly thoroughly considered specific impacts of CBEC. The distinctive feature of CBEC is its ability to connect global commodities and service markets through the internet, which breaks geographical limits. Both producers and buyers benefit from a wider range of procurement and consumption choices, and are exposed to a huge market. This optimizes resource allocation and is beneficial to all parties.

For firms, on the one hand, CBEC provides convenience for businesses to enhance management efficiency. Producers can optimize their procurement processes and inventory management through CBEC. By adopting CBEC, cost savings directly result from making it easier to find suitable suppliers and prices worldwide, freeing labor from time-consuming traditional procurement methods [17], automating parts of the procurement process, and providing greater control over expenditure strategies through e-commerce [18]. Moreover, CBEC helps businesses accurately predict and plan inventory requirements by providing real-time access to global market information. Companies can manage their supply chains flexibly based on demand variations in different regions and markets, avoiding inventory overstock or stock-outs. This optimizes the global value chain of businesses, reduce management costs, and thus increase profits. On the other hand, CBEC improves productivity of firms. For the scenario of China and ASEAN, CBEC could promote technology spillovers by application of ICT and trade which enhances firms' productivity in LDCs (Least-Developed Countries). Also, CBEC platforms lower the threshold and provide more direct opportunities for SMEs, facilitating their entry into the global market. Firms' efficiency gains from CBEC make it possible to enter global market and trade [19], which finally positively exerts on the economic growth.

For consumers, CBEC by reducing information cost [13] and expanding product choices [20] enhances their welfare. CBEC platforms, including Alibaba, JD, Amazon, eBay and etc., apply search engine and big data analysis, which allow buyers to search proper service and goods described in key words, enable them to disseminate and access product information, and make it easier to find better products and services through an electronic way [21]. Furthermore, consumers can not only obtain information about domestic products but also easily access products from overseas markets through CBEC. The market structure tends to be more competitive, and the price elasticity of demand for products increases, leading to price reductions. Better match with products and lower prices greatly fosters consumption.

Besides direct effects, CBEC also indirectly affects economic growth through the labor market. On the one hand, it creates employment opportunities, especially for high-skilled workers. The rise of CBEC requires the support of new technologies and marketing methods, which fosters the emergence of new job opportunities in fields such as information-related goods and services, entertainment, software, and digital products [3]. Examples include e-commerce platform development, application software development, social media advertising, and influencer marketing. On the other hand, it disrupts employment, particularly for low-skilled workers [22]. E-commerce's essence lies in using ICT for marketing and other business transactions. In this process, simple and routine jobs such as intermediaries and sales personnel in physical retail stores are replaced with self-service electronic systems. Examples include self-checkout, automated order management, automatic package tracking, and unmanned electronic retail systems. CBEC has a dual effect of both creative destruction on employment, with employment creation effect predominating in China-ASEAN (see Appendix A2 Figure A1).

Besides employment expansion, there's a positive impact of e-commerce on labor productivity. E-commerce system reduces coordination costs between different work processes, helps companies refine and decompose tasks, and enhances the degree of specialization, thereby improving labor productivity [22, 14]. The additional channel for increasing the per capita output of workers through CBEC is that the development of e-commerce requires companies to equip their workforce with ICT capital. The complementarity between ICT capital and high-skilled labor enhances production efficiency [3]. Stable employment and efficient labor productivity bring income growth for workers, and higher income promotes higher consumption.

International trade and consumption are important indicators for measuring economic growth. In national economic accounting, an increase in either of these factors contributes to GDP growth. Therefore, it is undeniable that CBEC plays a positive role in promoting economic growth overall.

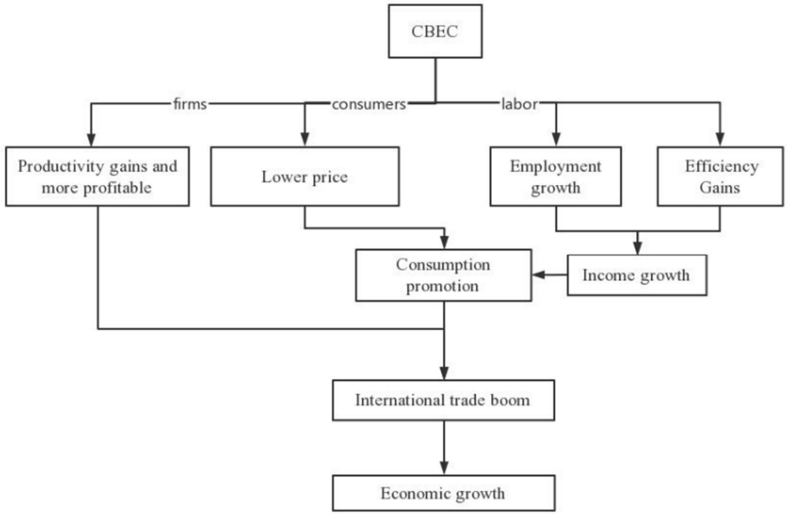


Figure 3. *Mechanisms of CBEC and Economic Growth.*

3.2. Identification Strategy

3.2.1. Empirical Method

In order to rigorously demonstrate the causal relationship between China-ASEAN bilateral CBEC and economic growth, we utilize generalized DID method which bases on the CBEC promotion articles coming into force in 2016. The empirical model is represented by equation (1).

$$Y_{ct} = \alpha_0 + \beta IDI_c \times Post_{t=2016} + \gamma X_{ct} + \lambda_c + \lambda_t + \varepsilon_{ct} \quad (1)$$

where, Y represents GDP per capita, bilateral trade volume, consumption per capita, employment rate, and output per worker of country *c* in year *t*. X represents a series of indicators that may affect the country's economic growth, including infrastructure and countries' advancement of technology. The constant term is α_0. And ε_{ct} represents the error term. λ indicates year and country fixed effect adsorbing factors that vary over time and across countries.

The interaction term of interest $IDI_c \times Post_{t=2016}$ indicates that the treatment group comprises countries with higher levels of ICT development, while the control group comprises countries with lower levels of ICT development. The reason why using ICT development index (IDI) to group the treatment and the control is that ICT serves as the foundation for CBEC. If country *c* experiences a lower ICT development level (i.e., IDI), with fewer users of the internet, electronic payments, and e-commerce platforms, the potential impact of CBEC on the economy may be tiny. On the contrary, if country *c* extensively applies ICT to production and daily consumption before the agreement took effect in 2016, then once barriers to CBEC are removed, these countries can quickly adopt CBEC to optimize consumption and global supply chain management, thereby promoting robust growth of international trade at a faster pace. While *the Upgrade Protocol* of the "10+1" agreement, which specifically promotes the development of bilateral CBEC, came into effect in 2016. Therefore, $Post_{t=2016}$ suggests the practice of the agreement in 2016, taking the value of 1 for the years after 2016 and a value of 0 for the years before 2016.

In equation (1), we are interested in the coefficient β, which represents the difference in economic growth between countries with high levels of IDI and other countries after *the* Upgrade *Protocol* coming into effect in 2016. If the coefficient β is statistically significantly positive, it indicates that countries with better ICT application and development perform better in growth compared to those with lower levels of IDI after the implementation of CBEC promotion articles in 2016. This suggests that the CBEC positively promotes rapid growth. On the other hand, if the coefficients $\beta < 0$, or is not statistically significant, it cannot be drawn to the conclusion we expected.

3.2.2. Data and Descriptive Statistics

The statistical description of all required data and variables is presented in Table 3. First, following the principle of minimizing estimation bias by using a larger sample size, we collect data from the year 2000 onwards. So far, for ASEAN countries, the data of the year 2020 is the latest annual compilation by the ASEAN Statistical Bureau. Therefore, this study chooses the period from 2000 to 2020 as the research window (see Table 3, variable *year*).

Furthermore, this study collects data of ASEAN countries from *World Bank*, such as population and labor force. As infrastructure development and technological level are also important factors influencing economic growth, proxy variables are considered in the reduced form, such as access to clean water, transportation development, and internet accessibility for residents. Proxy variables such as *Annual Freshwater withdraw (billion cubic meters)*, *Air transport passenger carrier,* and *Mobile cellular subscribers* are collected from open data of *World Bank*. Additionally, technology advancement is proxied by the number of patent applications, including *resident* and *non-residents patent.*

Moreover, economic growth encompasses various aspects. Based on the mechanisms outlined above, we select the following indicators as the dependent variables, representing important aspects of economic growth: *bilateral trade volume* between China and ASEAN countries (sourced from *China's National Bureau* of Statistics); *per capita GDP* of ASEAN countries (sourced from the *ASEAN Statistics Bureau*); *final consumption expenditures*(sourced from *World Bank*); *employment rate* and *labor productivity* of ASEAN countries (sourced from the *International Labor Organization*).

Finally, the core explanatory variable is the interaction term $IDI_c \times Post_{t=2016}$. IDI_c [10] from the report of ITU (International Telecommunication Union) stands for ICT application intensity of country *c*, with indicator IDI ranging from 0 to 10. The larger the IDI, the higher the level of ICT development. We calculate an average IDI level before 2016 to represent the country's readiness for CBEC. And the variable $post_{t=2016}$ serves as an indicator for the *Upgrade Protocol*'s in practice.

Table 3. *Descriptive Statistics.*

Variable	Obs	Mean	Std. Dev.	Min	Max
year	210	2010	6.07	2000	2020
Population (million people)	210	59.811	70.128	0.334	271.858
labor force (million people)	210	29.168	34.016	0.151	136.202
Dependent Variables					
bilateral Trade value (billion$)	210	31.392	36.932	0.041	192.29
bilateral export value billion$)	210	16.563	20.277	0.013	113.816
bilateral import value (billion$)	210	14.829	17.967	0.006	78.474
GDP per capita (thousand$)	209	12.137	21.517	0.245	154.935

Variable	Obs	Mean	Std. Dev.	Min	Max
final consumption per capita (thousand$)	197	5.198	6.972	0.253	30.106
employment rate (%)	210	65.121	5.543	53.37	76.888
labor productivity (thousand$)	210	21.024	29.663	0.649	100.329
Independent Variables					
IDI intensity (2010-2015)	210	3.953	1.642	1.903	7.652
Post	210	0.238	0.427	0	1
$IDI_c \times Post_{t=2016}$	210	0.941	1.868	0	7.652
Control Variables					
annual Freshwater withdraw (billion cubic meters)	186	45.697	58.059	0.092	222.635
air transport passenger carrier	208	19.321	23.549	0.125	115.2
mobile cellular subscribers	210	49.499	78.995	0.013	435.2
patent - nonresident	172	3820.866	3095.248	4	12409
patent - resident	146	600.253	525.975	1	3093

4. Empirical Results and Robustness Checks

4.1. Empirical Results

Table 4 presents the regression results for equation (1) excluding control variables. β is the coefficient of $IDI_c \times Post_{t=2016}$. Column (1) presents the direct nexus between CBEC and growth. Without controlling other factors, the coefficient of the core explanatory variable is significantly positive. The result indicates that CBEC promotes per capita GDP growth, and the magnitude of β suggests after 2016, for every 1 unit increase in a country's ICT development level, per capita GDP increases by 5173 US dollars.

Column (2) - (4) respectively show the results of the total bilateral trade volume between China and ASEAN countries, the bilateral export volume and the bilateral import volume as outcome variables, with international trade as the key mediating variable between CBEC and growth. $\beta > 0$ and statistical significance suggest that after 2016, the countries of higher level in IDI experienced more rapid international trade booms. In column (2), for every 1 unit increase in IDI after the *Upgrade Protocol* coming into effect in 2016, the bilateral trade between China and ASEAN countries increases by 4.879 billion dollars on average. Based on the regression results of trade, it can be concluded that CBEC does indeed promote international trade growth, which will finally benefit the statistically economic growth.

Stimulus consumption is the key economic effect of CBEC for consumers, and also an indirectly important channel between labor market and growth. Table 4 Column (5) shows that CBEC increases final consumption expenditure, for 1 unit increase in IDI intensity after 2016 following 1271 dollars increase in consumption per capita. As to labor market, column (6)-(7) show that CBEC positively contributes to employment rates and worker productivity. For every 1 unit increase in IDI, the employment rate increases by 0.9%, and output per worker increases by 1615 dollars on average. These confirm that CBEC increases employment opportunities and enhances worker efficiency to increase individual income, ultimately promoting economic growth.

Table 4. *Impact of CBEC on Economic Growth.*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	GDP per capita	bilateral trade	bilateral export	bilateral import	final consumption	Employment rate	output per worker
$IDI_c \times Post_{t=2016}$	5.173***	4.879*	2.648*	2.231*	1.271***	0.901***	1.615***
	(3.54)	(2.52)	(2.45)	(2.35)	(7.430)	(4.02)	(4.59)
Constant term	7.292***	26.80***	14.07***	12.73***	3.978***	64.27***	19.50***
	(4.29)	(11.79)	(11.12)	(11.46)	(19.910)	(245.00)	(47.27)
Year Fixed Effect	Y	Y	Y	Y	Y	Y	Y
Country Fixed Effect	Y	Y	Y	Y	Y	Y	Y
Adjusted R^2	0.5420	0.7182	0.7102	0.7153	0.9475	0.8332	0.9856
Obs.	209	210	210	210	197	210	210

*Note: t statistics in parentheses. The coefficients with *** are significant at the 1% confidence level; with ** are significant at the 5% confidence level; and with * are significant at the 10% confidence level, likewise.

The results in Table 5 show that taking other factors into consideration, though there is a loss of sample size, the coefficients of the interaction terms remain significantly positive, indicating the robustness of the benchmark's conclusion that CBEC between China and ASEAN promotes economic growth. However, comparing column (1) in Table 4 to column (1) in Table 5, the magnitude of CBEC's effect on per capita GDP growth decreases when considering infrastructure development and national technological advancement. For every 1 unit increase in ICT development level, per capita GDP increases by 1149 dollars. In addition, comparing to columns (2) in Table 4, CBEC's economic effect on average final consumption expenditure is halved. Column (3)-(4) in Table 5 show that CBEC's impact on employment and worker productivity remains robust.

It is worth mentioned that infrastructure development

overall has a positive influence on promoting per capita GDP growth, final consumption and labor productivity. Technological advancement, especially residents' patents application, has an important influence on ASEAN's economic growth and employment stability, which are conformity with economic intuition.

Table 5. *Impact of CBEC on Economic Growth with Control Variable.*

	(1)	(2)	(3)	(4)
	GDP per capita	**final consumption**	**Employment rate**	**output per worker**
$IDI_c \times Post_{t=2016}$	1.149**	0.504**	0.794***	1.413***
	(2.32)	(2.14)	(3.68)	(3.59)
Labor force	-0.932***	-0.432***	0.470***	-0.665***
	(-4.35)	(-4.72)	(5.05)	(-3.92)
Annual Freshwater withdraws	0.202***	0.094***	-0.0676**	0.126***
	(3.41)	(3.65)	(-2.62)	(2.68)
Air transport passenger carrier	-0.061	-0.028	-0.018	-0.064*
	(-1.32)	(-1.36)	(-0.88)	(-1.76)
Mobile cellular subscribers	-0.027	-0.014*	-0.014	-0.009
	(-1.37)	(-1.67)	(-1.56)	(-0.57)
Patent - nonresident	0.0008**	0.000*	0.0002	0.0007**
	(1.99)	(1.73)	(0.99)	(2.18)
Patent - resident	0.0054***	0.002***	0.0014**	0.0035***
	(4.14)	(4.56)	(2.39)	(3.41)
Constant term	29.89***	15.334***	49.81***	36.82***
	(4.40)	(5.23)	(16.85)	(6.83)
Year Fixed Effect	Y	Y	Y	Y
Country Fixed Effect	Y	Y	Y	Y
Adjusted R^2	0.964	0.9685	0.931	0.992
Obs.	133	131	133	133

4.2. Robustness Checks

4.2.1. Concurrent Events

The identification strategy relies on the DID model and utilized the Articles on the promotion of bilateral CBEC development in the 2016 *Upgrade Protocol* as an exogenous shock. It has studied the role of CBEC in economic growth and the mechanisms. Actually, the *Upgrade Protocol* coming into force in 2016 was aiming to contribute to the reduction of tariffs, expansion of multilateral market access, facilitation of trade, liberalization of services trade, and protection of investment, further enhance bilateral economic cooperation and openness. These undoubtedly exerted a positive impact on trade and economic growth. Our identification may be contaminated by concurrent favorable cooperation.

To identify the pure effect of CBEC, we would like to observe how CBEC affect economic growth directly by using absolute CBEC scale. Due to the difficulty in obtaining statistical data, the scale of China-ASEAN bilateral CBEC is estimated (as shown in Appendix B1) and the results are plotted in Figure 2. Using the estimated scale of bilateral CBEC, we study the absolute impact of CBEC on economic growth in ASEAN countries. The regression model is equation (2).

$$Y_{ct} = \delta_0 + \theta CBEC_{ct} + \sigma X_{ct} + \lambda_c + \lambda_t + \mu_{ct} \qquad (2)$$

Table 6 presents the regression results of equation (2). Our focus is on the coefficient of the core explanatory variable *CBEC*. In column (2)-(4), we can conclude that CBEC has a significant positive impact on consumption, employment and labor productivity, while its effect on per capita GDP growth is not statistically significant (see column (1)). Additionally, control variables are included for robustness and results are shown in Appendix Table B2, where the coefficients of *CBEC* are no longer statistically significant, which is possibly due to the loss in sample size. Despite less-than-ideal significance, coefficients are still positive. This indicates a robust conclusion that China-ASEAN CBEC promotes economic growth in ASEAN countries.

Table 6. *Bilateral CBEC Volume.*

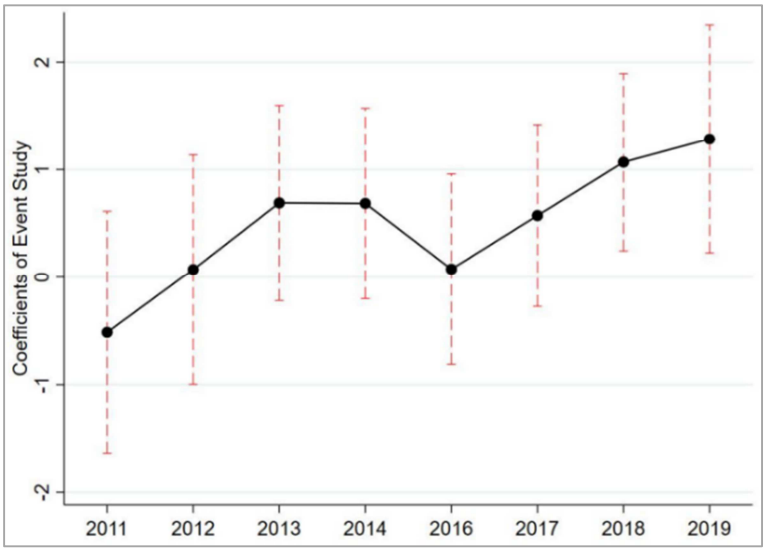
	(1)	(2)	(3)	(4)
	GDP per capita	**final consumption**	**employment rate**	**output per worker**
CBEC Trade Value	0.199	0.0497**	0.127***	0.168***
	(0.159)	(2.42)	(0.023)	(0.037)
Constant term	10.92***	4.875***	64.345***	19.996***
	(1.423)	(26.24)	(0.206)	(0.336)
Year Fixed Effect	Y	Y	Y	Y
Country Fixed Effect	Y	Y	Y	Y
Adjusted R^2	0.584	0.932	0.867	0.988
Obs.	209	197	210	210

Background above has mentioned that the FTA between China and ASEAN countries had different timelines for implementation. The FTA between China and ASEAN6 came into effect in 2010, while between China and CLMV countries, the date was delayed to 2015 for full implementation. This could lead to bilateral trade being impacted by FTA at different times, thereby affecting economic growth. To accurately identify the positive effect of CBEC Articles on growth, we construct a dummy variable D_{ct} to absorb the economic effects brought by the full implementation of the FTA. For ASEAN6 countries after 2010, and for CLMV countries after 2015, let $D_{ct} = 1$, and $D_{ct} = 0$ for other situations.

The regression model is set on the basis of Equation (1) with the inclusion of D_{ct}, and the results are shown in Table 7. These results indicate, after controlling the effect of the full implementation of the FTA on economic growth, coefficients β remain consistent with the benchmark in terms of magnitude and significance. This demonstrates a robust promoting effect of CBEC on economic growth.

Table 7. *Robustness Check.*

	(1)	(2)	(3)	(4)
	GDP per capita	**final consumption**	**employment rate**	**output per worker**
$IDI_c \times Post_{t=2016}$	1.541***	0.656***	0.937***	1.653***
	(3.06)	(2.83)	(4.23)	(4.08)
Labor force	-0.907***	-0.427***	0.479***	-0.650***
	(-4.36)	(-4.86)	(5.24)	(-3.89)
Annual Freshwater withdraws	0.169***	0.080***	-0.079***	0.105**
	(2.87)	(3.21)	(-3.08)	(2.23)
Air transport passenger carrier	-0.096**	-0.046**	-0.031	-0.086**
	(-2.07)	(-2.24)	(-1.49)	(-2.29)
Mobile cellular subscribers	-0.012	-0.006	-0.008	0.001
	(-0.57)	(-0.78)	(-0.88)	(0.04)
Patent - nonresident	0.001**	0.0003*	0.0001	0.001**
	(2.05)	(1.84)	(1.01)	(2.21)
Patent - resident	0.005***	0.002***	0.001**	0.003***
	(3.87)	(4.29)	(2.12)	(3.16)
D_{ct}	4.509***	2.073***	1.641**	2.752**
	(2.65)	(3.00)	(2.19)	(2.01)
Constant term	28.03***	14.69***	49.14***	35.69***
	(4.23)	(5.2)	(16.85)	(6.69)
Year Fixed Effect	Y	Y	Y	Y
Country Fixed Effect	Y	Y	Y	Y
Adjusted R^2	0.966	0.971	0.934	0.993
Obs.	133	131	133	133



Note: The dashed line represents the 95% confidence interval.

Figure 4. *The Dynamic Effect of CBEC on Growth.*

4.2.2. Common Trend

The validity of DID strategy relies on the assumption of parallel trends. The treatment and control groups must have comparable trends before the policy being into force. To

assure the robustness of our conclusions, we employ the event study approach to estimate the dynamic effect of CBEC on economic growth. The model is specified as equation (3), where we replace $Post_{t=2016}$ with a series of year dummy variables.

$$Y_{ct} = \alpha_0 + \delta_t IDI_c \times \sum_{t=1}^{9} year_t + \gamma X_{ct} + \lambda_c + \lambda_t + \varepsilon_{ct} \quad (3)$$

To highlight the impact of the CBEC promotion articles in 2016, taking into account the influence of the 2008 financial crisis on East Asia and the outbreak of the COVID-19 pandemic at the end of 2020 in China, we constrain the research period from 2011 to 2019, using 2015 as the baseline year. We estimate the dynamic effect of CBEC on growth. Coefficients of interest are estimated and plotted in Figure 4.

The coefficients indicate that before 2016, the promotion effect of CBEC on economic growth was not statistically different from 0, which suggests that the DID model satisfies the parallel trends assumption. In comparison to the baseline year 2015, the impact of CBEC on promoting economic growth dose not manifest immediately in 2016 but exhibits a lagged effect. It is not until 2018 that the promotion effect of CBEC on economic growth becomes statistically significant.

5. Conclusions

With the popularity of the internet and continuous advancements in information and communication technology, CBEC has become an integral part of the global economy that cannot be ignored. With major e-commerce platforms such as Alibaba and JD.com, China not only holds significant influence in the domestic market but also plays a crucial role in cross-border trade. The CBEC market in China surpassed $2 trillion in 2021, demonstrating its enormous potential for growth. Besides China, leveraging the widespread use of internet applications and smartphones, ASEAN countries have actively improved infrastructure such as logistics and customs clearance, facilitating the convenience and efficiency of e-commerce and cross-border transactions.

While the longstanding friendly diplomatic relations between China and ASEAN have further promoted comprehensive economic cooperation, with a focus on the development of CBEC in *the Upgrade Protocols of "10+1" agreements* in 2016. This paper investigates the stylized facts of bilateral CBEC development and analyzes whether CBEC exerts a positive impact on economic growth, especially on ASEAN countries, and the mechanisms between them.

The economic cooperation process from the China-ASEAN dialogue relationship in 1991 to the comprehensive implementation of the China-ASEAN Free Trade Agreement in 2015 outlines a long-standing and stable economic partnership among 11 countries, which provides a friendly business climate for CBEC. According to the report from CCPIT, ASEAN has become China's 9th-largest trading partner in CBEC, and China's 3rd-largest CEBC export market in 2016. According to the customs statistical data from 2019 to 2023, China has maintained strong CBEC ties with ASEAN in B2B and petty B2C trade. And estimated bilateral CBEC volume appears an upward movement especially after the year of 2010 and 2016.

Particularly, we review the Articles related to the development and cooperation of CBEC in *the Protocols to Amend the Framework Agreement on Comprehensive Economic* Cooperation *(the Upgrade Protocols)* within CATFA. And utilizing *the Upgrade Protocol* that officially took effect in 2016 aiming to promote CBEC development, we establish a generalized Difference-in-Differences method to study the causal relationship between bilateral CBEC development and economic growth in ASEAN, and testify the potential mechanisms.

Our results imply that bilateral CBEC within CAFTA positively affects economic growth, which is mainly through the international trade. For firms, CBEC reduces their procurement and inventory management cost through the internet and automated e-business system, and improves productivity through trade spillovers effect, especially for SMEs to boost international trade. For consumers, CBEC reduces information cost and search cost, and expands product choices overseas, which causes a more competitive market and higher price elasticity of demand. Lower price for consumers fosters consumption. For labor, CBEC creates more job opportunities directly and enhances labor productivity by equipping labor with ICT capital, which leads to a higher income, and promotes higher consumption. Cross-border consumption boosts international trade and finally exerts a positive significance on growth.

This paper supplements the insufficient empirical research about the ASEAN region, provides solid theoretical evidence for the deepening cooperation between China and ASEAN, and consolidates the confidence to enhance the development of CBEC, thereby promoting shared prosperity of both parties.

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Author Contributions

Conceptualization, Suri Ho and Yao Shen; Methodology, Suri Ho and Can Yi; Literature search and review, Suri Ho; Data collection and analysis, Can Yi and Yao Shen; Writing - Original Draft Preparation, Can Yi and Suri Ho; Writing - Review & Editing, Yao Shen and Can Yi; Supervision, Yao Shen; Project Administration, Yao Shen; Funding Acquisition, Yao Shen.

Conflicts of Interest

The authors declare no conflicts of interest.

Appendix

Appendix I. Sylizes Facts of CBEC Development

(1). Bilateral CBEC between China-ASEAN

Table A1. *Personal CBEC Product - Import (in dollars).*

Date	Brunei	Cambodia	Indonesia	Lao	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam
201901		8697	29430	665	137689	2593	6508	392506	790463	79405
201902		5054	54013	351	50048	965	7009	241724	249421	67799
201903	3442	9194	30898	3057	79656	1138	9263	393151	572060	86083
201904	7236	6830	40071	60	81229	1201	13139	452106	549916	85196
201905	2010	9680	69692	218	99853	2240	12272	533809	913432	107552
201906	2665	7489	121657	492	99022	3916	12937	499349	1867364	89440
201907	3363	7471	126364	422	116309	841	22093	470353	677073	89967
201908	1355	7820	97760	485	167099	912	20297	680807	841624	107121
201909	2068	7787	94450	4557	208837	1937	16801	859379	679503	311606
201910	964	9030	48525	1885	193655	2465	13902	691441	602062	127435
201911	2505	12803	37011	664	258151	3822	14747	559449	897337	169001
201912	630	23771	44296	1171	149260	11975	21466	441218	859523	269002
202001	1023	9359	21301	3994	485034	9669	13452	869281	573792	164259
202002	1424	6256	58133	886	179805	2770	12370	474467	700934	68102
202003	523	8103	36271	2132	152840	865	18004	1076106	1314984	118537
202004	137	7575	33126	6871	295322	829	10984	1147328	806517	88643
202005	17	3913	16240	630	82884	633	5136	580870	936576	55513
202006	1834	12282	115215	547	347151	1686	25369	1707544	1908986	156618
202007	827	13578	143422	714	504687	896	30302	1627911	2205961	99932
202008	8812	11500	43901	2216	574852	768	26576	1574770	2245641	112413
202009	6661	15060	49334	1672	531858	1650	28716	1653161	2083107	172780
202010	288	19647	63391	2193	510441	1554	34350	1423197	2045863	245284
202011	1021	25534	79264	1153	763379	4006	46856	2133963	3521054	287757
202012	324	29932	88661	488	1203706	10501	51412	2110893	3419009	355382
202101	39	17270	64522	869	1281890	6786	36284	1825513	2330265	288036
202102	89	17819	58000	140	654129	12146	34675	1396077	1367415	331993
202103	251	21003	78616	1544	1037918	29195	125215	1707618	1888613	819650
202104	7991	17170	88915	1110	691526	48160	49773	2161017	2381458	626996
202105	1317	17545	235075	1096	512388	46060	333901	1892627	5223249	502298
202106	1556	38790	310111	5140	581497	53055	203387	1974288	3239502	279994
202107	271	25842	267452	13978	470444	55822	53025	1510777	3604444	281976
202108	169	39297	172244	23368	480954	60277	61342	2304611	3478866	325626
202109	27	55854	121391	57119	586667	51750	53165	2281109	3194484	383451
202110	0	37472	122578	197289	431062	47013	112843	1259240	2013175	326217
202111	148	70631	204747	9201	569853	73214	70712	1791035	4360138	629202
202112	30	69423	226229	8243	653299	59496	96461	1503009	4994360	633784
202201	94	41730	209355	4985	632152	38453	67483	3591152	5577383	442103
202202		23500	158497	3626	528436	25465	76143	1679852	2590817	346412
202203		16228	112036	2463	485837	15760	53439	1291906	3226496	294848
202204	45	13105	138061	2885	647229	33208	30788	1560074	2423812	274866
202205	64	17825	113849	1946	428730	26634	34757	1095632	1132544	157195
202206	12	19115	198367	4915	579842	31351	25298	1430682	2254727	147879
202207		10249	119876	3862	392377	19762	27696	1466044	2530839	163452
202208		12028	136403	6084	839083	14909	28600	1587105	3144160	227218
202209		21625	93790	4411	643571	13266	59773	1455803	2316950	163945
202210		26944	105073	3586	645952	11654	47540	2010900	2137554	138199
202211		23139	86987	7190	716889	17875	59820	1828977	3109193	226667
202212	68	20660	99824	4287	486111	8915	49308	1186267	2640533	233265
202301	25	11532	154901	89159	617590	13826	27058	1256807	4393208	145366
202302		12620	78211	9290	477752	9515	22454	1050691	2530874	181244
202303	51	10703	61185	5290	467218	8297	24738	927916	1941604	209999
202304	241	26979	63002	11879	435598	7311	23417	768471	1777682	202000
202305		16382	58261	17307	415147	4834	16719	843584	2343104	185949
202306	350	31907	74144	12592	341802	5801	21396	844086	2207008	316819

Source: General Administration of Customs of China

Table A2. *Personal CBEC Product - Export (in dollars).*

date	Brunei	Cambodia	Indonesia	Lao	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam
201901	109974	114575	882374	11829	474176	29896	263696	1481966	1272500	207349
201902	79302	94147	612720	7671	301402	25604	180535	1050501	1033173	146011
201903	106954	132141	843433	11827	458801	34064	264848	1413126	1249217	234879
201904	95449	107837	802355	12375	447205	31629	248728	1388113	1075639	208457
201905	68840	110105	682899	10238	372409	30300	207621	1213815	976482	188460
201906	67308	126832	659588	9810	344097	35401	212381	1150086	1047418	188073
201907	74961	138028	772767	16308	359619	37863	227589	1201615	1097367	184780
201908	64513	138694	720118	16255	342016	40423	221547	1134331	1047340	178608
201909	59134	129506	767921	9547	345307	42208	240551	1111168	1054306	180316
201910	70270	140022	959225	10501	436286	49382	320878	1328811	1174341	194133
201911	97001	156433	1111815	13630	456385	65769	375905	1650133	1490649	265744
201912	91415	148580	1013166	13857	359664	64602	325344	1576617	1303658	271308
202001	69170	122972	589650	11990	336208	41626	325066	1195606	1028485	157155
202002	37101	93387	375880	8408	234604	28119	221292	922122	860566	116148
202003	30157	142706	593410	26779	718181	37768	448632	1539060	1353282	192959
202004	1227	22800	302182	4831	333269	3293	50919	828437	403416	98323
202005	0	2227	197634	537	312686	15125	4536	972404	527971	97736
202006	51	3575	144911	1013	255832	13521	33219	583847	434672	77886
202007	20	760	66635	102	282484	16996	28745	1013858	532937	93741
202008	34	101	67503	14	774489	103269	38097	1644155	1828204	100990
202009	230	18155	229192	893	259032	20998	114551	859728	532743	122798
202010	708	26574	233447	712	301591	21848	168310	961189	582969	148686
202011		29166	194911	3904	263262	25953	149237	832041	524692	122915
202012	22	24991	216534	1068	275682	28576	191652	859850	560943	138368
202101		30217	254160	986	276819	22804	206844	872372	525974	145161
202102		28622	242545	1974	290236	20553	188314	867743	508092	143921
202103		18718	172391	338	203644	5205	113237	553351	342926	92508
202104		26811	273305	1232	276967	3613	189832	817100	530915	157044
202105		41511	217590	2555	272836	4236	177059	749854	444484	134494
202106		112184	319807	1493	398019	11612	202839	990137	574395	209678
202107		89895	230556	1315	243552	7826	176302	700103	381095	113903
202108	16	82166	254062	624	233030	8222	156659	666040	390562	117330
202109	65	73698	225491	531	243694	11459	143806	659821	389470	107259
202110		60599	233616	334	209896	6666	134260	550450	326182	94356
202111		51364	211440	309	190442	7438	122882	571621	348627	108412
202112	0	51206	221397	719	201815	9827	134726	585977	445044	134578
202201	0	43533	216475	625	204402	8682	134023	558785	412076	142018
202202		38361	213665	1120	219681	8651	130179	560794	375895	130415
202203		34122	145257	466	106603	6069	100411	358402	306202	89477
202204	4475	40446	183388	965	120182	5636	109385	401077	333382	114515
202205	8770	26624	135332	219	93610	4266	90912	315139	267345	87444
202206	2048	27592	131716	164	99976	5176	83944	298846	268865	88290
202207		26831	129283	480	111900	4408	85632	310675	277745	91346
202208		26769	142312	411	108446	4841	91096	335186	263169	82890
202209		28896	148897	328	133036	3951	106514	346219	249513	87627
202210		24215	157526	202	108507	2872	84893	310872	242840	71910
202211		26496	149278	172	88392	3517	72322	280573	211858	67420
202212		31387	170349	198	115420	3261	74470	350401	251845	79474
202301		35113	183839	102	122653	2948	85273	355317	248146	90925
202302		24691	155103	992	118813	2333	73024	295158	199044	61267
202303		32412	180951	654	105897	2567	85589	375028	297539	88168
202304		35077	170898	702	79680	4005	117340	393973	306601	108256
202305		32475	203607	388	114514	3087	84765	413142	276367	85947
202306	16	28011	151881	269	94945	3412	71566	314302	273164	67774

Source: General Administration of Customs of China

Table A3. *B2B CBEC Simplified Declaration Goods- Export (in dollars).*

date	Brunei	Cambodia	Indonesia	Lao	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam
202007			29412		3965874		339369	31239903	488463	415715
202008			379594		10218737		7991403	44224714	652661	3201885
202009		6046	1553548		26461561	13803	14023521	15392089	729969	5880801
202010		15247	865548		9210522		655006	15793174	36706	1930513
202011		72	967814		9107864		1298951	17034892	47236	1802272
202012			228876		1748279		1125034	4926411	6313598	2397642

date	Brunei	Cambodia	Indonesia	Lao	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam
202101		225	133144		1869145		439219	3113505	1674516	3806793
202102		1662	457310		2054980		245579	4184814	10260650	7870885
202103		1280	555895		3613180		165135	5863109	814198	7848235
202104			2205158		4686946		6050756	7995130	2176202	2626322
202105	168		1581531		2878647		7052435	10946689	29200379	1421990
202106		2452	2002217		5846299		886835	15752483	8358057	6976815
202107	63	2225	5073006		5527290		7368411	19964940	5999726	3233271
202108		1413	1896272		7309783		186855	19574436	1581722	4503230
202109		1084	1223050		2705443	1341	402954	16266386	1479212	2824650
202110			831602		3652870		329870	5450430	1137599	2347202
202111	201550	561526	3671040		3683389		368496	7355833	1632019	1744249
202112	444723	369102	4131556		3707176		442002	12954208	6183297	372949
202201	828893	820946	4539068	650380	2072473		465256	38001501	17976731	17642869
202202	467066	555638	5104305		3723683		354618	12799330	7266021	15545646
202203	91495	316111	5842065		1666032		225627	1866640	4388886	6830262
202204	114520	147789	1098716		4921131	31202	1613477	7896233	7534426	9655618
202205	126892	147999	1076010		4793871	3322	1795154	7033542	3622174	2912023
202206	106653	92418	874591		3399726	373	1223449	1947550	5199774	15445332
202207	3298	89172	821827		576383	2779	942551	10525932	4144826	13015455
202208	1556	44335	1505448	3848022	2988349	960	839520	5418421	10324274	30657688
202209	136762	99028	5412448		3658266		1878643	4906501	21085151	33672828
202210	63026	70289	4125638	43	4146715		1686429	7697455	17022471	30408572
202211	50309	253159	5540493	7	4498115		3505556	5074958	12094965	27771047
202212	26518	2457707	2440344		3614834		4026806	3209021	11549064	40016347
202301	65869	2007081	1042056		3399909		2929683	1228496	10313253	42017175
202302	123883	290990	1633641		3060063		2968116	1992025	8769444	61896965
202303	176006	2688590	1710149		2887059		3572165	10583582	18470699	77759984
202304	72490	1746586	1128871		2373130	606	8444992	4402637	7820063	43071436
202305	626995	666604	1377765		1360555	2849	2414557	63246777	3298188	12894197
202306	9163	2347197	335852		418101		1004966	27605674	5456915	37035692

Source: General Administration of Customs of China

(2). Employment Creation and Destruction in Industry of Information and Communication in ASEAN and China

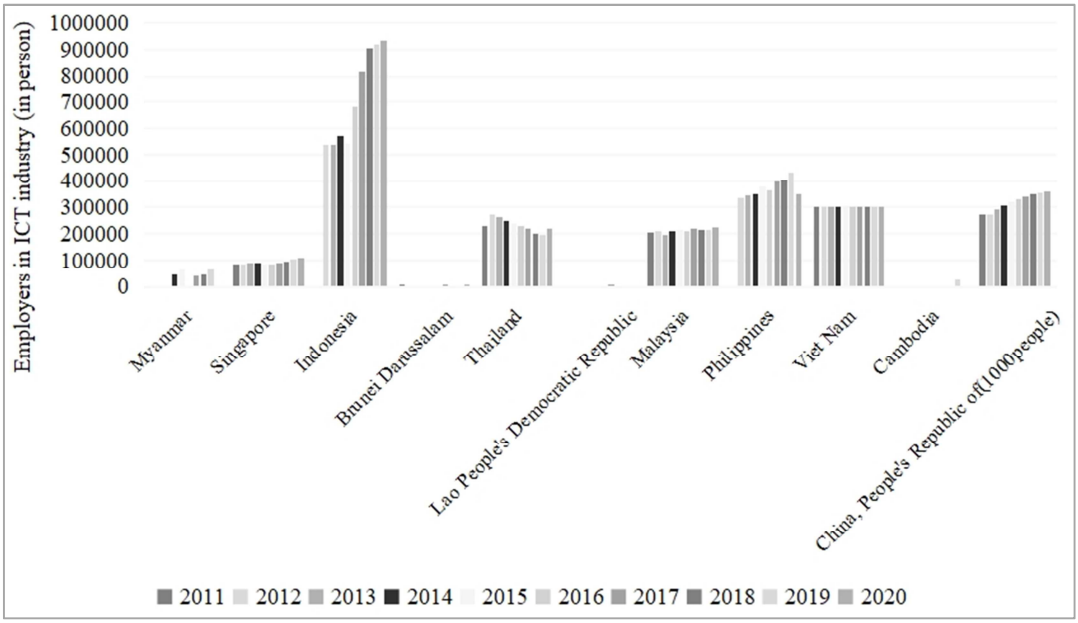

Figure A1. *Numbers of Employers in the Industry of Information and Communication (in person).*

Source: ASIAN Development Bank

*Note: In order to enhance the visual clarity of the graph, the data for China is presented in units of "thousand people", while for other countries, it is presented in units of "per person".

The overall development of e-commerce between China and ASEAN has contributed to increased employment as the evidence shown in Figure A1, which depicts the employment in the Information and Communication (IC) industry, as

reported by the Asian Development Bank.

The employment creation effect among China and ASEAN dominates. Bars displays the employment in the IC among ASEAN countries and China from 2011 to 2020. China's IC employment are significantly higher than those of ASEAN countries, reflecting the enormous domestic demand for e-commerce. Additionally, Indonesia performs exceptionally well within ASEAN, ranking first in IC employment. The IC employment for China, Indonesia, Philippines, Vietnam, Thailand, Malaysia, and Singapore have steadily increased year by year, with other countries lagging behind. Overall, this graph illustrates that in the current context of e-commerce driving ICT development, it has also created numerous job positions and employment opportunities, promoting domestic labor force employment.

Appendix II. Evidence of CBEC Development

(1). Estimated Bilateral CBEC Volume

Due to the limitation of accessing to bilateral CBEC data, using bilateral trade volume we calculate a weight to estimate the CBEC volume between China and ASEAN. First, estimating the scale of bilateral CBEC requires indicators of trade value and CBEC value of China. The data on the scale of China's trade (i.e., imports and exports value) and China-ASEAN bilateral trade from 2000 to 2020, are sourced from the statistics of the National Bureau of Statistics of China. Additionally, the data on China's CBEC value is sourced from Wangjingshe (100ec.cn), which provides comprehensive services in the field of digital economy and relevant statistical indicators.

Next, we approximate the scale of China-ASEAN CBEC by using the weight of bilateral trade volume between China and ASEAN countries. The specific calculation formula is as follows:

$$CBEC\_Trade_{ct} = \frac{Trade_{ct}}{Trade_t} \times CBEC_t \quad \text{(B1)}$$

$$CBEC\_Import_{ct} = \frac{Import_{ct}}{Import_t} \times CBEC\_Import_t \quad \text{(B2)}$$

$$CBEC\_Export_{ct} = \frac{Export_{ct}}{Export_t} \times CBEC\_Export_t \quad \text{(B3)}$$

Where the subscript c represents ASEAN countries and t represents the year. The left-hand side of equations (1)-(3) represents the bilateral CBEC value between China and ASEAN country c annually, China's CBEC imports from country c annually, and China's CBEC exports to country c annually respectively.

The first term on the right hand represents the weight of bilateral trade, where the denominators $Trade_t$, $Import_t$ and $Export_t$ represent China's total trade, imports and exports in year t. The numerators $Trade_{ct}$, $Import_{ct}$ and $Export_{ct}$ represent China's bilateral trade, imports, and exports with country c in year t. The second term on the right-hand, $CBEC_t$, $CBEC\_Import_t$ and $CBEC\_Export_t$ respectively, represent China's CBEC scale, CBEC import, and CBEC export in year t. The basic idea behind the indicator is that if there is a frequent trade interaction between country c and China, the CBEC scale will also be proportionally larger, and if there is limited trade interaction between country c and China, the CBEC scale will be smaller.

The results of three indicators grouped by country are shown in Table B1. Based on the total scale of bilateral CBEC, the countries that have the closest CBEC connection to China's are Vietnam, Malaysia, Thailand, and Singapore, while the countries with the least CBEC interaction are Brunei, Laos, Cambodia, and Myanmar. Among them, Vietnam has the closest connection to China in terms of CBEC imports and exports.

Table B1. *Summary statistics of Estimated Bilateral CBEC Value in 2000-2020 (in billion dollars).*

Indicators	Obs.	Mean	SD	Min	Max
Brunei					
CBEC export value	21	0.156	0.196	0	0.687
CBEC import value	21	0.025	0.064	0	0.29
CBEC trade value	21	0.162	0.207	0.001	0.756
Cambodia					
CBEC export value	21	0.861	1.289	0.004	4.373
CBEC import value	21	0.051	0.090	0	0.294
CBEC trade value	21	0.704	1.098	0.003	3.718
Indonesia					
CBEC export value	21	6.353	7.504	0.074	22.252
CBEC import value	21	1.43	2.188	0	7.365
CBEC trade value	21	7.717	9.575	0.095	30.54
Lao					
CBEC export value	21	0.227	0.286	0.001	0.821
CBEC import value	21	0.083	0.130	0	0.41
CBEC trade value	21	0.341	0.463	0.001	1.393

Table B1. *Continued.*

Indicators	Obs.	Mean	SD	Min	Max
Malaysia					
CBEC export value	21	7.598	9.153	0.062	30.57
CBEC import value	21	2.947	4.411	0.001	14.771
CBEC trade value	21	12.238	15.124	0.102	51.174

Indicators	Obs.	Mean	SD	Min	Max
Myanmar					
CBEC export value	21	1.591	2.110	0.012	6.813
CBEC import value	21	0.264	0.402	0	1.247
CBEC trade value	21	1.702	2.319	0.008	7.354
Philippines					
CBEC export value	21	5.176	7.036	0.035	22.741
CBEC import value	21	0.92	1.272	0	3.799
CBEC trade value	21	5.858	7.451	0.04	23.828
Singapore					
CBEC export value	21	8.429	9.555	0.139	31.29
CBEC import value	21	1.493	2.139	0.001	6.213
CBEC trade value	21	9.339	10.966	0.138	34.737
Thailand					
CBEC export value	21	6.652	8.321	0.054	27.428
CBEC import value	21	2.022	2.950	0	9.459
CBEC trade value	21	9.405	11.712	0.084	38.399
Vietnam					
CBEC export value	21	12.349	17.729	0.037	61.799
CBEC import value	21	2.442	4.389	0	15.419
CBEC trade value	21	13.788	21.329	0.031	74.845

(2). Robustness Checks of CBEC Volume

Table B2. *Bilateral CBEC Volume.*

	(1)	(2)	(3)	(4)
	GDP per capita	final consumption	Employment rate	output per worker
CBEC Trade Value	0.059	0.0322	0.011	0.072
	(0.071)	(1.11)	(0.032)	(0.058)
Labor force	-1.126***	-0.536***	0.370***	-0.903***
	(0.227)	(-5.78)	(0.103)	(.186)
Annual Freshwater withdraws	0.246***	0.121***	-0.05	0.179***
	(0.067)	(4.42)	(0.03)	(0.055)
Air transport passenger carrier	-0.087	-0.048**	-0.026	-0.096**
	(0.053)	(-2.17)	(0.024)	(0.043)
Mobile cellular subscribers	-0.027	-0.013	-0.015	-0.009
	(0.021)	(-1.54)	(0.009)	(0.017)
Patent - nonresident	0.001**	0.0003*	0	0.001**
	(0.00)	(1.82)	(0.00)	(0.00)
Patent - resident	0.006***	0.00262***	0.002***	0.004***
	(0.001)	(4.96)	(0.001)	(0.001)
Constant term	35.519***	18.29***	52.985***	43.725***
	(6.922)	(6.37)	(3.139)	(5.664)
Year Fixed Effect	Y	Y	Y	Y
Country Fixed Effect	Y	Y	Y	Y
Adjusted R^2	0.972	0.967	0.943	0.994
Obs.	133	131	133	133

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4 Due to the availability of CBEC data, we utilize "international items" as a proxy variable for physical transactions in CBEC. As goods under B2C CBEC need to be delivered, and a significant portion of them are transported through the postal system, there is a very close relationship between the two. Postal and parcel data are considered by UNCTAD as effective indicators for measuring physical delivery in CBEC.

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http://www.customs.gov.cn//customs/302249/zfxxgk/2799825/302274/tjzd/4243241/index.html

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