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**Master's Thesis of International Commerce**

# **Impact of COVID-19 and Digital Trade on Exports: An Empirical Analysis into South Korea**

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# **Impact of COVID-19 and Digital Trade on Exports: An Empirical Analysis into South Korea**

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# Abstract

The introduction of digital trade, and the steep increase in its use, has colossally changed the paradigm of the economic system. Digital trade has brought about the need to bring large reforms to the currently existing trade system. As such, this paper utilizes the definition of digital trade as the transaction of trade through cross border e-commerce paper, and seeks to provide an overview of the CBEC and total export structure of South Korea by country and by sector. It then analyses the relationship between CBEC and COVID-19 on their effects on total exports by country and by product classification. The results show that the interaction term of COVID-19 stringency levels and CBEC was significant in explaining for the changes in total exports. It also showed that the effect of COVID-19 was much weaker than the effects of CBEC on total exports, as can be seen when even strong COVID-19 stringency levels led to high total exports with high levels of CBEC. By controlling for country-level characteristics and time, this analysis found large differences to be stemming from country-level differences as well as time-invariant factors. Furthermore, upon consideration of the product level differences, the relationship between CBEC exports and COVID-19 stringency levels seem to be coming mostly from Chemicals, Minerals and Fuels, Textile and Clothing, Garments, Shoes and Hats, Electromechanical instruments and vehicles products. By grouping countries according to income classifications, Upper Middle Income countries showed the highest significance. Hence, in conclusion, this paper raises several policy implications on the government and businesses. Firstly, policy makers and the government should focus on improving CBEC infrastructure for the products that are holding up total exports. Furthermore, more businesses should continue to build upon their digital services in order to engage more with CBEC exports.

**Keyword :** Cross Border E-Commerce, South Korea, Exports, Digital Trade, COVID-19

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# Chapter 1. Introduction

The digitalisation of the economy has not only facilitated existing activities, but has also created new systems and activities that have replaced older flows within the economy. Trade, in particular, has transformed colossally so that its structure now seems completely different in nature to the bartering system many millennia ago. Digital trade has rapidly increased in many countries as small and large businesses attempted to recover from the drastic effects of the recent pandemic, COVID-19 (Peters 2022, 2) (Tudor 2022, 3). It seems that digital trade had given them a much more efficient and easier method of selling their products while refraining from in-person interactions (Lopez-Gonzalez et al. 2020, 3-4). Since the online network reaches globally, such practices have also allowed many businesses to sell their products abroad.

The introduction of digital trade, and the steep increase in its use, has colossally changed the paradigm of the economic system. Digital trade has brought about the need to bring large reforms to the currently existing trade system. Many academics have analysed the necessary reforms and changes needed to welcome the new phase of digital trade (Collins 2021, 649-666), (Burri and Polanco 2020, 187-220), and the WTO has also actively announced the need to reform its system to effectively control digital trade. Yet as much as there is acknowledgement of the potential of digital trade, there is still insufficient amount of analysis into its actual impact on the economy. Its effect should be analysed fully in order for institutions to be able to control it effectively, and for businesses to use it to its best use.

The definition, or the boundaries, of digital trade still remains a field to be discussed. As much as digitalization has impenetrated most areas of life, it is unclear to which extent digitalization must be involved to consider a trade “digitalised”. The OECD defines it as “digitally-enabled transactions of trade in goods and services that can either be digitally or physically delivered, and that involve consumers, firms, and governments”. Most commonly,

we are able to see digitalization of trade through the servicification of GVC and production, the implementation of AI in production, and e-commerce. Of these three, e-commerce has the most direct impact on a country's exports, and is also the newly rising method of digital trade. In this sense, the term digital trade we see nowadays is heavily attributed to trade through e-commerce – that is, cross border e-commerce (CBEC). In this paper, the following definition that many existing literature use for simplicity is adopted: that digital trade is the transaction of trade through cross border e-commerce. (Kim and Lee 2017, 129-145). Hence, this paper seeks to delve deeper into the impacts of cross border e-commerce in South Korea.

This paper seeks to provide important implications on Korea and its businesses to choose their strategies effectively. As much as COVID-19 and CBEC has affected the structure of Korea's export system, an in-depth study of their impacts on Korea's total exports should provide significant insight into its newly forming structure. This study will aim to provide an essential and fundamental basis to all future studies on how to optimally control CBEC in South Korea. Without the knowledge of the actual CBEC export structure of Korea, it is difficult to come up with effective strategies and policies to enhance the country's exports through CBEC, or to protect the domestic producers that export in the upcoming future.

As such, this paper will analyse the effect of CBEC exports on total exports with the following hypotheses: (1) there is a positive correlation between CBEC exports and total exports and (2) CBEC exports mitigate the negative effects of COVID-19 on export growth.

First, the paper seeks to present an overview of the cross border e-commerce export structure of South Korea by going through available data on Korea Customs Service. The overview will show a potential relationship between CBEC and total trade which coincides with the beginning of COVID-19. Having grasped the general picture of Korea's CBEC export structure, extensive literature review will show different research undertaken surrounding the topic of cross border e-commerce and exports. Then, it will examine the impact of CBEC on total exports during COVID-19 in Korea to fully uncover the

relationship between CBEC and total exports of South Korea. The results will pose implications on the actual impacts of CBEC exports on total exports of South Korea.

## 1.1. Overview of Korea' s CBEC

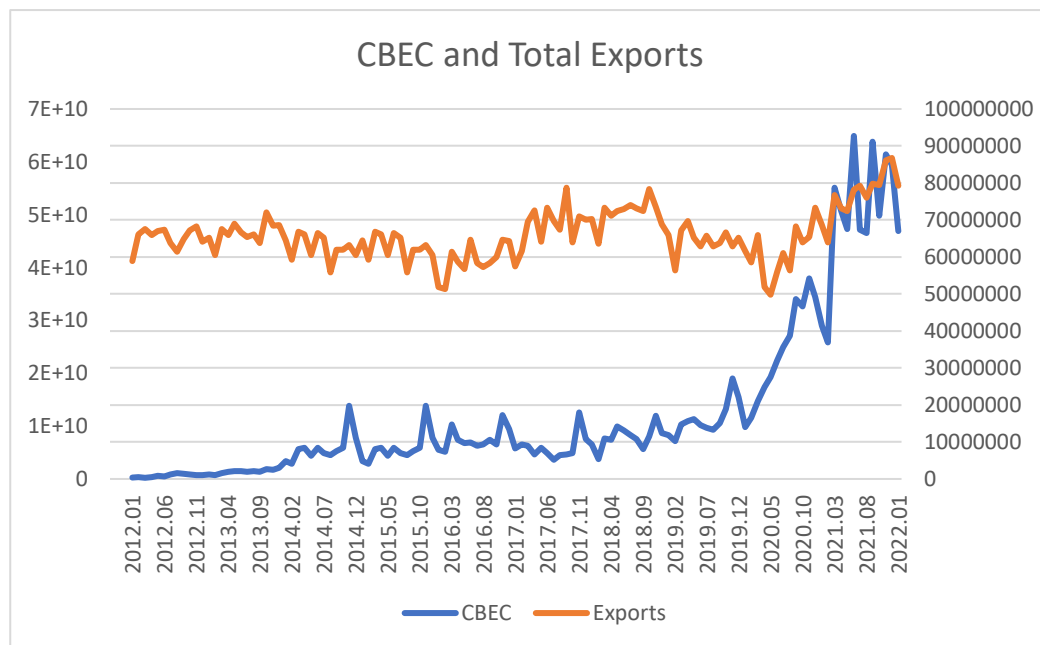
Korean CBEC data is currently available to the public through two main sources of data – Korea Customs Service (KCS) and Korean Statistical Information Service (KOSIS). The two institutions have different mechanisms of gathering CBEC data, and hence have relatively different data. To briefly explain their differences, KCS gathers its data from export declarations each exporter has to make when exporting one's products, while KOSIS gathers its data from a set of approximately 1,100 businesses through interviews. Although some have argued that the data collected by KCS omits many cases of CBEC because export declarations are not mandatory for products under the price of FOB 2 million won, the amount is considered as small or insignificant. This is because export declarations provide many advantages to the exporter such as refund on VAT, or to receive confirmation of one's export performance. Furthermore, the process has recently been facilitated for exporters to declare their exports when shipping them out abroad. Not only is the amount of omission small, but KCS may also include products that are re-exported or processed in other countries. Hence, in practice, KCS data is expected to have relatively accurate results, especially for recent time periods. Hence, this paper will use KCS data as its CBEC data source.

Figure 1 shows that during the decade 2012 to 2022, the levels of CBEC and total exports had been relatively parallel to each other until January 2020. Since then, CBEC levels have risen exponentially. In fact, South Korea had one of the highest shares of online sales in total retail sales in 2020 and 2021 at 28% (UNCTAD 2021). This well reflects the effect of COVID-19 on the behavior of consumers, as well as the impact of this change in



behavior on the businesses themselves. The steep increase in CBEC levels overlaps well with the beginning of COVID-19 – CBEC levels rose steeply almost immediately after the first case had been reported in January 20<sup>th</sup>. In May 2020, Korean exports plunged due to the immediate effects of global lockdowns and political tensions between borders of different countries. Yet despite the obstacles and restrictions to trade caused by COVID-19, CBEC levels increased drastically – to almost four times in less than a year. During the difficult times of the pandemic, CBEC export levels have risen from 14 million dollars to 92 million dollars. Following this steep increase in CBEC export levels, total exports have also recovered from the plunge in May 2020. Hence, it is difficult to forego the impact CBEC exports may have had on facilitating the recovery of Korean exports, keeping in mind that the proportion of CBEC exports in total exports have also increased drastically.

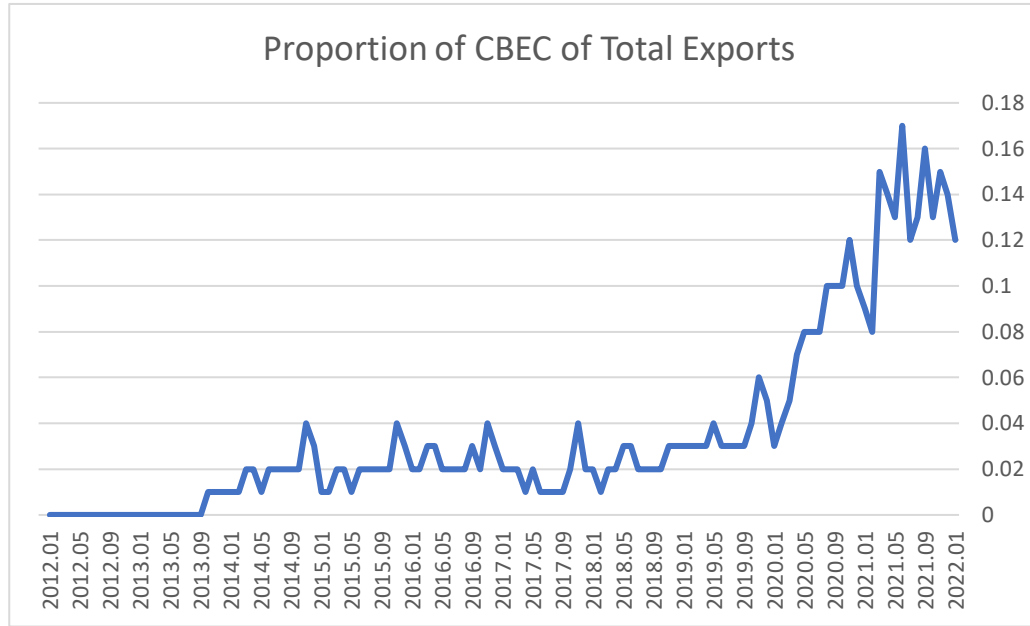
**Figure 1. CBEC and Total Exports**



Data Source: Korea Customs Service, Author's calculations

Figure 2 depicts the steep rise in the proportion of CBEC in total exports from the beginning of 2020. Hence, this emphasizes the need to research deeper into the relationship between CBEC and total exports in order to capture the full picture of Korea's export structure.

**Figure 2. Proportion of CBEC from Total Exports**



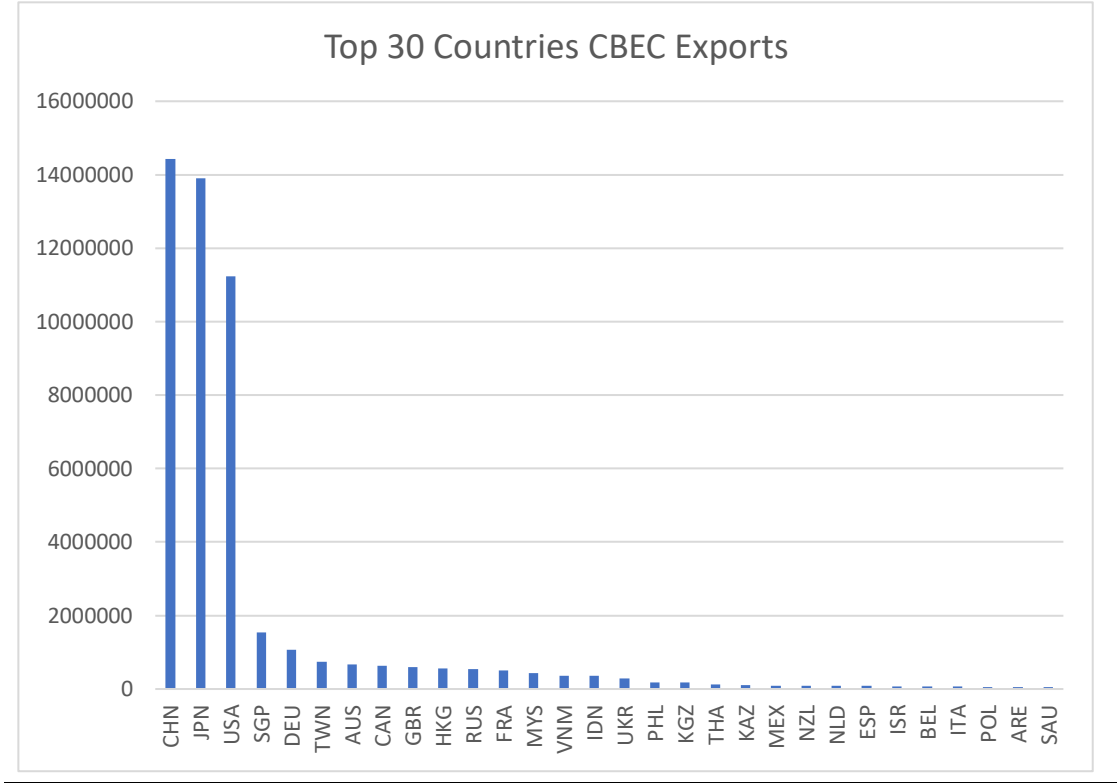
Data Source: Korea Customs Service, Author's calculations

## 1.2. Overview by Country

To observe whether the increase comes from particular countries, this section provides a brief overview of where the CBEC exports are focused on. Some countries tend to be taking large proportions of Korea's CBEC exports. Of the total value of exports through e-commerce from Korea between January 2019 to January 2022, China was shown as importing the highest value of imports with 14.4 million dollars per month. This is followed by Japan with an average of 13.9 million dollars per month, and the US with 11.2 million dollars per month. The top 30 countries are shown in Figure 3. Grouping the top 30 countries

by their region, half of the top countries were based in Asia (with two Middle East countries), 11 countries based in Europe, and two countries in North America or Oceania. Considering that most amount of exports head towards China, Japan, and the US, the role of distance seems to be playing less of a significant role in determining the flow of CBEC exports. This may indicate that CBEC is facilitating trade across regions regardless of geographical distance, which has been corroborated by recent research into the topic of the “death of distance” in the gravity model.

**Figure 3. Top 30 Countries CBEC Exports**



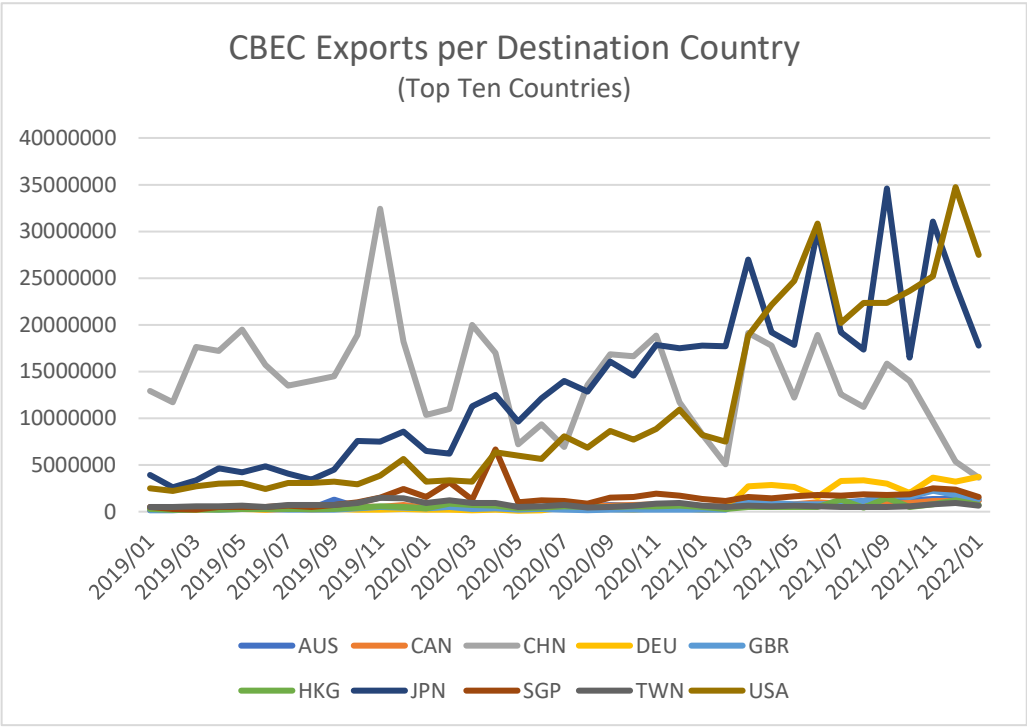
Data Source: Korea Customs Service, Author's calculations

It is also observable through Figure 4 that the top ten destination countries of Korean CBEC exports show a similar pattern during the respective time period of January 2019 to January 2022. Figure 4 shows the flow of exports per top ten destination countries during the time period of January 2019 to January 2022. The US and Japan both show

similar patterns in that both exports increase much more rapidly from the beginning of 2020.

Figure 5 shows the export flow to the rest of the top ten countries, as their levels are difficult to observe in the previous one.

**Figure 4. CBEC Exports per Destination Country**

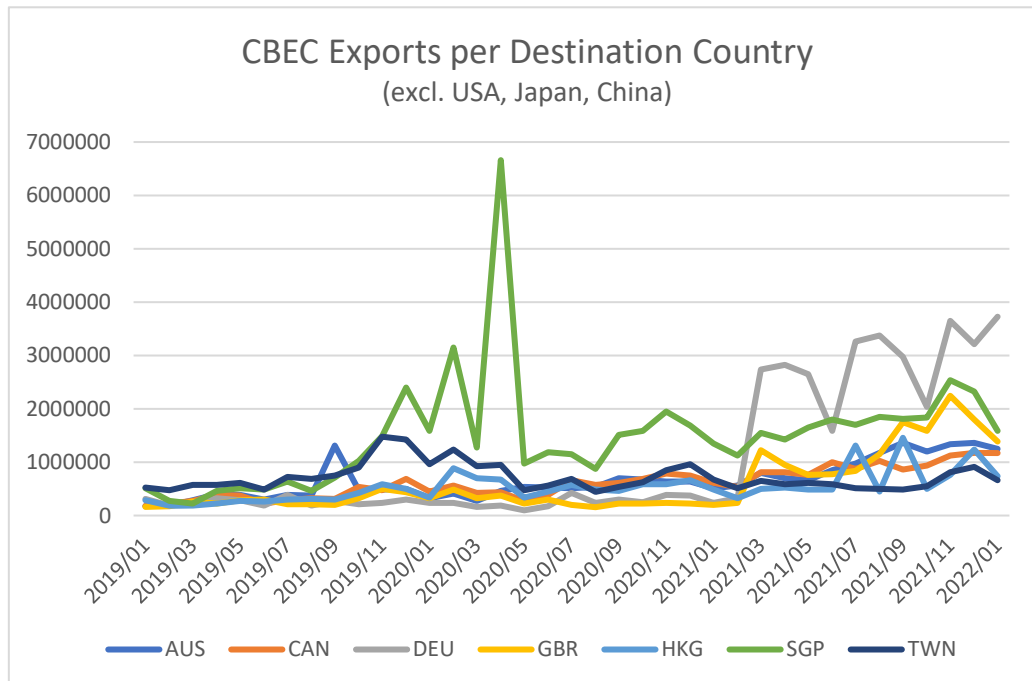


Data Source: Korea Customs Service, Author's calculations

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**Figure 5. CBEC Exports per Destination Country**

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Data Source: Korea Customs Service, Author's calculations

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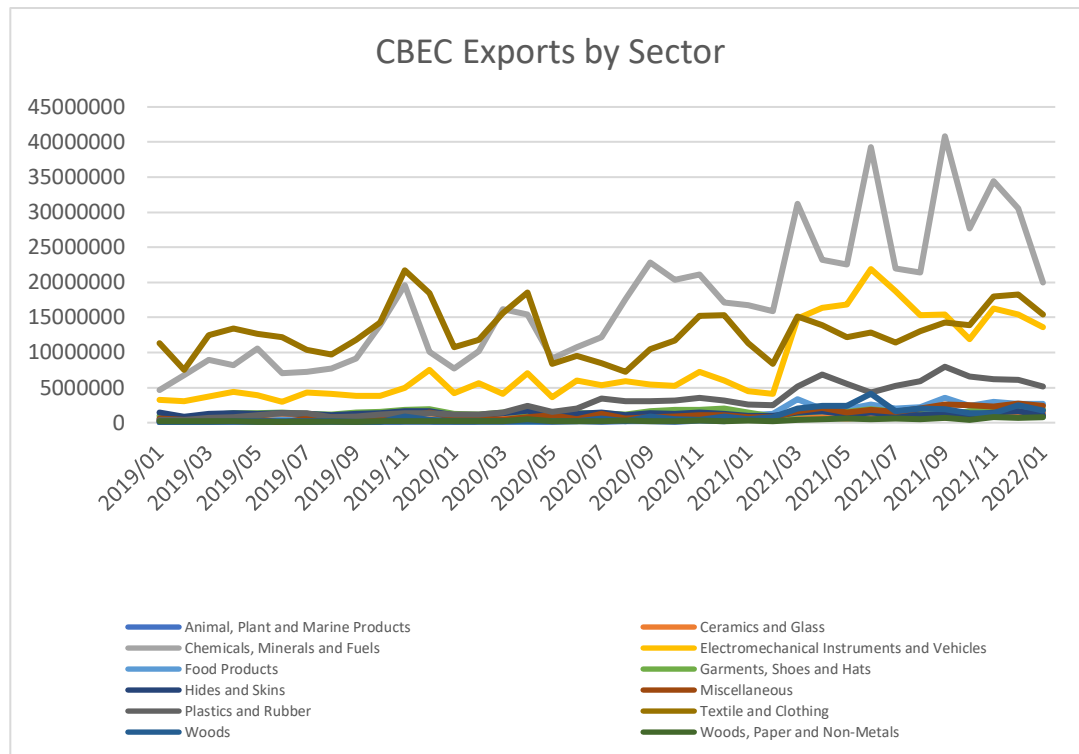
All countries show a similar pattern as Japan and the US. The only two that show different trends are Chinese Taipei and China. Although the total exports to the two have been increasing over the same time period, CBEC exports remained relatively stagnant. This may indicate that some country-level characteristics, or bilateral relationship between the destination countries and South Korea may play a significant role in determining the flow of exports. This emphasizes the need to take into account the different factors that affect different countries differently. In order to observe the relationship between CBEC and total exports in detail, a more intricate study is needed that can endorse the differences that lie across countries. The purpose of this study is highlighted as in-depth quantitative analysis is needed to do so.

### 1.3. Overview by Sector

This section refers to the 16 product classifications defined by the World Custom Organizations (WCO) sector classification, with some slight adjustments to match the Korean HS 2-digit product nomenclature system. The classifications are readjusted to 12 product classifications according to the 97 HS 2-digit product codes specified by the Korea Customs Service in order to show the flows of CBEC exports by sector.

Most sectors seem to be affected by the beginning of COVID-19 as most show rapid increases at the beginning of 2020. The highest amount of sales in dollars stem from chemicals, minerals and fuels, reaching \$40 million in 2021. This sector seems to be dominated by the amount of cosmetics sold through CBEC from Korea. Interestingly, textile products do not show a large change pre-COVID-19 and post-COVID-19. Its levels have been relatively stable during the period.

**Figure 6. CBEC Exports by Sector**



Data Source: Korea Customs Service, Author's calculations

On the other hand, the amount of electromechanical instruments and vehicles increased rapidly in February 2021, exceeding the amount of textiles exported. This sector includes one of the top CBEC exports from South Korea, Solid State Drive (SSD). SSDs are semi-conductor storage devices of computers, also including batteries of all kinds. Though it aligns well with the beginning of COVID-19, it is difficult to state whether the increase in this sector has been due to the very fact of being traded through CBEC, or whether it has been due to other technological advances in the creation of batteries and semi-conductor devices. Next in line comes plastics and rubber sector, aligning well with the beginning of COVID-19. Although the exports of this sector through CBEC have been rising, its growth rate rises almost twofold in May 2020, when the actual effects on COVID-19 started to impact exports from Korea. Other sectors have shown similar flows, such as other household accessories, woods, paper and non-metals. On the other hand, the rest of the sectors showed

little to no change pre-pandemic and post-pandemic. Perhaps the overall effects from CBEC flows are coming from particular sectors only, and this emphasizes the need to look into sectoral differences when determining the effect of CBEC on total exports.

As such, this paper will look into the existing literature surrounding the topic of CBEC and total exports during COVID-19 to possibly analyse the current flows of CBEC and total exports. It will then seek to provide more in-depth analysis of Korea's CBEC export structure through an empirical analysis by presenting the relationship between CBEC, COVID-19, and total exports.



## Chapter 2. Literature Review

### 2.1. CBEC in South Korea

The study into the CBEC structure of Korea has actually begun even before the 21<sup>st</sup> century, as academics emphasized upon the major changes in WTO and OECD discussions with the introduction of e-commerce. Although the sizes of internet shopping were minimal and CBEC was only at its infant stage, academics reinforced the need for exporting businesses to implement the necessary infrastructure and communication technology to not fall behind the global trend of e-commerce (Lee and Seo 1998, 303-318). Furthermore, even in its earlier stages, its impact on exporters was reinforced as CBEC led firms to undergo marketing online, which in turn enhanced productivity by facilitating the share of information of the global market (Lee 1999, 131-156). Since there was little infrastructure and technology to support large-scale movement towards CBEC, research generally focused on how to improve the existing infrastructure and technology of businesses to adopt CBEC effectively. Some emphasized the importance of trust within the partnership with international logistic bodies (Cho and Koo 2001, 93-114). Yoon, Ha, and Kim performed a survey-based analysis into a region in Korea, Busan, to organize the main problems businesses faced when adopting CBEC (Yun et al. 2003, 267-289).

As CBEC growth began to accelerate in the early 2010s with enhanced infrastructure, the trading system seemed unfit for CBEC trade, and different small and large obstacles and problems made CBEC activities inconvenient and at times, unfair. As such, numerous studies have focused on the improvement and reforms that should be brought to national policies to support the transforming structure of trade through caused by the introduction of digital trade through e-commerce. The role of the government to support the growth of CBEC through effective policies was frequently established (Lee K. 2017, 79-114), with some arguing in support of relaxing the domestic restrictions on exporters of

CBEC (Park S. 2015, 127-161) (Park J. 2019, 66-76). As the repercussions of the WTO reform in response to the effective control of digital trade, many have also analysed the necessary transformations in domestic and international law needed to both control and promote CBEC from and to South Korea (Kwon 2021, 72-78). Kim T. and Kim S. underwent quantitative analysis into the cost structures of a major Korean e-commerce platform and a global platform to establish the conclusion that there needs to be changes to the government and associated organisations to increase effective infrastructure that may decrease the costs of logistics for exporters (Kim T. and Kim S. 2020). The importance of a strong supply chain through seamless logistics is also emphasized globally (Chen 2022, 9). Ahn lists out important policies set out by the government such as Ministry of Trade Industry and Energy, Korea Customs Service, and Ministry of Science, ICT and Future Planning, as well as legal regulations related to CBEC to discuss changes needed to each policy and regulation to effectively promote CBEC (Ahn 2017, 3-21). Park compares domestic CBEC growth to the global market to raise implications on the need for the government to promote research and development of Korean firms to implement the necessary technology for more companies to export using CBEC (Park 2019, 66-76). Furthermore, with the increase in such problems, many academics also argued in favour of implementing a dispute settlement system in Korea to solve disputes related to e-commerce, just as such pre-existing arbitration institutions in the US and China that act as the middle ground for sellers and buyers (Kim G. 2017, 3-24). Such system seems highly necessary especially with the amplification of e-commerce into cross border e-commerce, much because customers and sellers are located in different countries where information of each other is not readily available.

From the late 2010s, there has been an increase in the amount of quantitative research into CBEC structure of South Korea following the global trend. The positive effect of CBEC on firm productivity and performance has been widely discussed (Lee K. 2017, 79-114), with CBEC exports having stronger positive effects than CBEC imports (Lee G. and Whang

U. 2022, 25-43) (Kim C. and Jeong K. 2021, 1-14). Lee and Whang, for instance, conducted an empirical analysis on how CBEC has affected firm performance using enterprise surveys, concluding that CBEC and firm performance have a positive correlation, especially with firms that export through CBEC (Lee G. and Whang U. 2022, 25-43). They also pointed out that since Korean CBEC exporters need to be supported more by suitable policies and regulations, the Korean government needs to build improved CBEC trading systems with other countries in order to establish a safe and effective trading environment for CBEC exporters of Korea.

Many academics have hence also focused on the bilateral CBEC trade analysis between Korea and major destination countries to look into its structure. Some analysed into the FTAs with the major countries Korean CBEC exporters export to, such as China, in order to pose implications on policy makers and the government to suggest alterations to the countries' legal terms (Kwon H. 2010, 71-96; Ho I. 2019, 27-49). Others have conducted empirical analysis into the effects of Korea's main economic indicators (GDP and exchange rate) on CBEC exports to China, concluding that CBEC exports were indeed positively correlated to the economic indicators, especially in the long term (Cai and Kim H. 2020, 3-20).

Most recently, more empirical research into Korea's CBEC export structure have been conducted since digital trade started taking a more concrete shape across the world. Some attempted to analyse the factors that influence the CBEC of South Korea, as do Lee and Kim in their paper of analysing how the geographical distance or broadband subscription affect CBEC (Lee and Kim 2021, 1-18). With the beginning of the pandemic, more literature focused on how CBEC has affected Korea's exports during COVID-19 (Cho J. et al. 2020, 137-147). They briefly explain the increasing trend of e-commerce in both service and manufacturing sectors, and raise regulatory implications to narrow down the digital gap between Korean companies and foreign companies by loosening policies on digital trade,

strengthening e-commerce chapters in bilateral FTAs, and providing a strong basis for digital development.

Yet there is little empirical analysis based on official data and many analyse the policies and the infrastructure surrounding CBEC to suggest the directions policy makers should take regarding the development of digital trade in South Korea. The research in Korea, as explored above, do not focus on the direct effect of CBEC export on the total exports in Korea. Since COVID-19 has accelerated the transformation of how global buyers are exposed to different products, an analysis of this is needed to be able to understand how this change is occurring. Though this aspect lacks in Korea, many academics have undergone similar research in relation to that of other countries.

## 2.2. CBEC and Exports

E-commerce has provided many benefits to the exporters that use CBEC in comparison to those that do not. In general, there are two main ways e-commerce can affect total exports. Most directly, e-commerce can affect exports by facilitating the process of distributing electronic services. It acts as an effective method of reaching out to customers regardless of their location. Such increases in efficiency and decreases in the costs of communication and delivering services digitally can provide great advantages to exporting firms or individuals (Kastratovic and Bjelic 2022, 502-526).

Indirectly, E-commerce can create spillover effects that can multiply its beneficial effects on total exports. Essentially, companies or individuals may learn from the new market on foreign customers or invest more on survival in the midst of the highly competitive market of e-commerce. Such shifts in strategies may lead the exporter to grow, as more consumer feedback occurs through CBEC (Mou et al. 2019, 749-777). Some even state that these internal spillover effects may actually have more effects than the direct effects (Tiessen et al. 2001, 211-233) Others focus on the importance of marketing strategies

which are enhanced by e-commerce, which in turn allow exporters using e-commerce to grow (Gregory et al. 2007, 30-57).

It is widely known that CBEC provides various benefits to the country and to businesses. When analysed by different regions in China, the differences in CBEC infrastructure per region seem to contribute to their differences in economic growth, hence confirming that CBEC development accelerates economic growth (Zhong et al. 2022, 15-17). Although Zhong, Wang, and Ge focus on regions within China, this seems to be a global phenomenon (Bekkers et al. 2020, under “Chapter 1”). Foreign studies have begun empirical analysis earlier than South Korea to find out the actual CBEC export structure of respective countries. Though e-commerce export data is limited in many countries, some studies still strive on uncovering the actual structure by using an indicator of how developed e-commerce is in a country, instead of the official CBEC export data (Hayakawa et al. 2021).

Others conducted empirical research into the effect of CBEC on exports. This began with the famous quote “the death of distance” using the gravity model (Cairncross 1997, 157). Lendle used data from the platform eBay to show that distance mattered less with digital trade than offline trade. The gravity model is most frequently used by most academics to look into the relationship between CBEC and exports (Ding et al. 2020, 1-10). Yin and Choi also used the gravity model to analyse the impact of CBEC on the effect of China’s Belt and Road Initiative on Chinese exports, concluding that CBEC has more impact on services than on goods (Yin and Choi 2021, under “Discussion on the findings”). Ma et al. in particular analysed the role of CBEC on China’s imports, supporting the analysis by Lendle et al. that distance matters less with CBEC.

With this in mind, this paper seeks to fill in the existing gap in the literature in Korea surrounding CBEC and exports. It will analyse how CBEC exports affect Korean total exports during COVID-19, and strives to provide important implications on businesses and policy makers as a basis to all activities and studies related to CBEC.

## Chapter 3. CBEC and Korean Exports during COVID-19

As seen briefly in the literature review, many academics have already conducted various analyses into the effects of CBEC on a country's trade. This paper will provide an in-depth analysis into the structure of Korea's CBEC and its relationship to total exports. It will especially focus on analysing the role of CBEC on mitigating the effect of COVID-19 on Korean exports with the previously mentioned hypotheses. (1) There is a positive correlation between CBEC exports and total exports and (2) CBEC exports mitigates the effect of COVID-19 on export growth.

The previously presented overview of Korea's CBEC structure and a comparison to the total exports have indeed shown favourable results in accordance with the hypotheses. However, this alone cannot prove that Korea's CBEC system has had the hypothesized effect on its total exports. Hence, this chapter will analyse into whether the effects are indeed coming from CBEC and COVID-19 through empirical analysis.

As shown through the literature review, very limited amount of empirical research into the relationship between total exports and CBEC exports is available surrounding Korea. On top of this, few take into account both CBEC and COVID-19 together in their empirical analyses. This paper will take inspiration of the methods used by foreign researchers who analysed the effect of CBEC exports on the role of COVID-19 on exports in China, yet by modifying their methodology to suit the data available for Korea.

This analysis will enlighten on possibly one of the most important takeaways from the effect of COVID-19 – the digital transformation, and raise implications on the need to develop digital trade in Korea further to be ready for the new economic structure awaiting at the end of the COVID-19 crisis. As empirical analysis using the official CBEC data on Korea is rare, this paper may contribute to the future studies that focus on other implications or CBEC trade on Korea's economy.

### 3.1. Data Selection and Variables

This paper will conduct analysis with the following variables, also shown below in Table 1. The log of total exports  $EXP_{ict}$  is the dependent variable representing Harmonized System 2-digit code products that are exported from South Korea. Although higher digit products would be favoured so that more information on the products that are being traded could be uncovered, only HS 2-digit code products were provided by the Korea Customs Service as monthly data.

One of the main independent variables is  $CBEC_{it}$ , which represents the value of each commodity product exported through CBEC. Korea Customs Service provides CBEC trade data through HS 4, 6, and 8-digit code products. Hence, the traded volume data of HS 4-digit code products were collected, converted into 2-digit code products by summing the export volume of all 4 digit code products in the respective 2-digit code classifications. Both variables,  $EXP_{ict}$  and  $CBEC_{it}$ , have been logged after adding 1 to the original values so that values of zero would not eliminated.

$COVID_{ct}$  is another independent variable essential to this paper. It represents the extent to which exports have been influenced by COVID-19. An indicator created by the Oxford Coronavirus Government Response Tracker is used as data to represent the stringency of each government of the respective destination country. Further explanation is provided later in the paper.

The analysis will also include the major variables generally included in a standard gravity model to analyse their effects on total exports.  $GDP_{ct}$  represents the logged GDP per capita of the destination countries.  $Dist_c$  represents the logged geographical distance between the capital of Korea and the respective destination country.  $Lang_c$  represents whether Korea and the destination country share a common language.  $Fta_c$  is a dummy variable on whether the destination country is in an FTA with Korea or not.  $Col_c$  shows whether Korea and the destination country have been in a colonial relationship, and last but not least,  $contig_c$  shows

whether the Korea and the destination country share boundaries with each other or not. The two variables,  $lang_c$  and  $contig_c$  have been dropped because no country shared a language nor border with Korea.

**Table 1. Variables and Descriptions**

Variables	Description	Source
$EXP_{it}$	logged total exports from Korea	Korea Customs Service
$CBEC_{it}$	logged digital exports of each product	Korea Customs Service
$COVID_{ct}$	logged destination country COVID-19 stringency levels	Oxford Coronavirus Government Response Tracker (OxCGRT)
$GDP_{ct}$	logged GDP per capita of destination country	IMF World Economic Outlook
$Dist_c$	logged geographical distance between the capitals	Centre d'Etudes Prospectives et d'Informations Internationales (CEPII)
$lang_c$	dummy of shared language	Centre d'Etudes Prospectives et d'Informations Internationales (CEPII)
$col_c$	colony relationship	Centre d'Etudes Prospectives et d'Informations Internationales (CEPII)
$contig_c$	shared boundaries	Centre d'Etudes Prospectives et d'Informations Internationales (CEPII)
$ftac$	dummy of fta	Ministry of Trade, Industry and Energy

**Table 2. Descriptive Statistics**

Variables	Obs	Mean	St Dev	Min	Max
Total Exports	306,514	5718762	7.88E+07	0	6.84E+09
CBEC Exports	306,514	5854.841	153696.5	0	2.37E+07
$COVID_{kr}$	306,514	27.98005	27.30804	0	75.93
$COVID_{des}$	306,514	33.54097	31.68505	0	100
$GDP_{cap}$	306,514	21764.11	24658.82	0	234317.1
$Dist_{cap}$	306,514	8445.212	4022.419	0	19629.5
Colony	306,514	0.0115916	0.1070388	0	1
FTA	306,514	0.5004633	0.5000006	0	1

Source: Author's Calculations

Both total exports and CBEC exports are calculated in USD. On average, 0.015% of total exports are traded through e-commerce. Though on the surface the potential effect on total exports seem small, this paper will present its more complex influence on total exports through the mitigation of the effect of COVID-19.

### 3.2. Analytical Basis

Hu et al. have conducted research of similar purpose to this paper, yet focused on China. This paper did not adopt the exact methodology used by Hu et al. due to the differences in data availability between Korea and China. One of the main difference lies in the  $CBEC_{it}$



variable. In China, since CBEC data is not readily available, Hu et al. adopted a method widely used in China to classify exports as digital – namely referring to the Import List published by the Ministry of Finance of China in 2016 to identify the products that are traded through CBEC. The Korean government has not released any kind of trade list for CBEC, but its institutions such as the Korea Customs Service and the Korean Statistical Information Service provide in-detail information on the exact traded amounts of HS 4-digit products. Here, the data from Korea Customs Service has been used for the reasons mentioned in Chapter 2, along with the fact that Korean Statistical Information Service does not provide its data on a monthly basis.

There are existing criticisms on the data available by Korea Customs Service. The two institutions provide relatively similar data on the imports into Korea – yet the differences lie in their data on the exports from Korea in differences in the methods each institution uses to collect data. However, the limitations of the data provided by the Korea Customs Service are expected to be minimized since this paper uses both the CBEC data and the total exports data from the same source – Korea Customs Service. Although the volumes of respective data might differ from other sources, using the data from the same source should provide similar results since they both have been collected using the same method. And since CBEC values will be represented as proportion of the total exports, the variable will relatively be similar to the data used by the Korean Statistical Information Service.

Returning to the issue at hand, Hu et al. used the Difference in Difference method to analyse the effect of CBEC on the total exports with the external shock of COVID-19. Since no official data on CBEC statistics is available in China, Hu et al. could only create CBEC data by counting the number of products under the HS 2-digits code that are traded through CBEC platforms. Classifying the products into digitally traded and non-digitally traded was necessary in order to differentiate between the control and treatment group needed for a Difference in Difference analysis. However, in the case of Korea there is no need to go through the process of aligning exported products with the CBEC products through the

Import list. Instead, the volume of CBEC exports can simply be calculated as the log of the exports of each product that is exported through CBEC, available by the Korea Customs Service. Hence, this paper showcases the results of regression analyses based on this CBEC variable as provided by the Korea Customs Service.

A second yet essential difference in the methodology lies within the COVID-19 variable. Since Hu et al. use the Difference-in-Difference analysis, it regards the pandemic as the external shock that influenced all countries similarly to how it influenced China, the main country in question. This essentially points toward the fact that the authors are assuming that COVID-19 has affected all countries similarly after the beginning of the pandemic. However, in reality, the flow and effect of COVID-19 is inconsistent along the time period, nor is it the same across countries even during the same period. Most of the impacts of the pandemic on the economy were caused through the policy responses of the government, such as border closure, lockdowns, or school closures. To look into these, an indicator created by the Oxford Coronavirus Government Response Tracker is used as data to represent the stringency of each government of the respective destination country. Since trade is affected by the countries on both sides of the transaction, South Korea and the destination country in this paper, stringency levels in this analysis have to reflect both the levels of Korea and that of the destination country as well. To reflect both stringency levels, the average is taken between South Korea's stringency levels at the specific time period and the destination country's stringency levels at the same time period. This this may show how COVID-19 measures have affected the exports from Korea to the destination country, this paper will be able to show a more accurate account of the impact of the pandemic on exports than it would have been able to by simply assuming the pandemic to have had an effect immediately after the first case of COVID-19 had been reported.

### 3.3. Analytical Method

The gravity model has been expanded to incorporate the effects of cross-border e-commerce (CBEC) and COVID-19 stringency levels on bilateral exports from Korea to destination countries. The study uses data from January 2019 to January 2022, capturing the period from before the first COVID-19 case in South Korea (January 2020) to the present. The model includes CBEC and COVID-19 variables, in addition to the conventional gravity model variables such as economic size, geographical distance, and trade agreements.

There are several methods for estimating a gravity model, such as Two-stage Least Squares (2SLS), VAR model (Qiao, Qi, 2018), Poisson Pseudo Maximum Likelihood (PPML) regression and Difference in Difference (D-in-D). The paper by Hu et al., 2022 uses the D-in-D model to effectively show the impact of CBEC and COVID-19 on Chinese exports. Some use the 2SLS methodology in order to include an instrumental variable (IV), which allows controlling for endogeneity. Recently, the PPML methodology has been used in the research using the gravity model, given its advantages on issues on overdispersion, excess zeros in observations, as well as handling heteroskedasticity. It requires that the dependent variable is of count data, i.e. quantity of each product exported. In the case of this study, the use of a linear model is preferred over other methods due to several reasons, including the ease of interpretation of the coefficients, the absence of assumptions about the distribution of the dependent variable, and the availability of total export data as only continuous trade data in terms of dollars. Since the value of each product traded vary largely, taking the value of trade flows may better capture the economic value of the trade flows.

The following log-log equation will be first used:

$$EXP_{ict} = a + b_1CBEC_{ict} + b_2COVID_{ct} + b_3GDP_{ct} + b_4dist_c + b_5col_c + b_6FTA_c + e_{ict}, \quad (1)$$

where  $i$  represents all Harmonized System two-digit codes from 01 to 97,  $c$  represents 185 destination countries, and  $t$  represents the monthly time period from January 2019 to January 2022. Bilateral exports data, monthly CBEC data, and monthly COVID-19 stringency indices have been logged after adding 1 to the values in order to avoid values with 0 dropping out. The results will show an analysis of how CBEC and COVID-19 are affecting total exports from Korea.

Furthermore, the interaction term  $\text{CBEC}_{ict} * \text{COVID}_{ct}$  will be included to show the effect of COVID-19 is different for the different values of CBEC. The interaction of these variables will capture the potential impact CBEC has on the relationship between COVID-19 and exports.

$$\text{EXP}_{ict} = a + b_1 \text{CBEC}_{ict} + b_2 \text{COVID}_{ct} + b_3 \text{CBEC}_{ict} * \text{COVID}_{ct} + b_4 \text{GDP}_{ct} + b_5 \text{dist}_c + b_6 \text{col}_c + b_7 \text{FTA}_c + e_{ict}, \quad (2)$$

Thirdly, the following regression will take the country-level differences through country fixed effects in order to remove any effects the country-specific variables may have on the effect of CBEC and COVID-19 on exports. The following equation is used:

$$\text{EXP}_{ict} = a + b_1 \text{CBEC}_{ict} + b_2 \text{COVID}_{ct} + b_3 \text{CBEC}_{ict} * \text{COVID}_{ct} + b_4 \text{GDP}_{ct} + \gamma_c + e_{ict}, \quad (3)$$

,where  $\gamma_{ct}$  captures the time-invariant differences between countries.

Not only should the country-specific factors be taken into account, but the differences that may arise due to time flows. Hence, the following equation includes a time fixed effect:

$$\text{EXP}_{ict} = a + b_1 \text{CBEC}_{ict} + b_2 \text{COVID}_{ct} + b_3 \text{CBEC}_{ict} * \text{COVID}_{ct} + b_4 \text{GDP}_{ct} + b_5 \text{dist}_c + b_6 \text{col}_c + b_7 \text{FTA}_c + \varphi_t + e_{ict}, \quad (4)$$

Last but not least, the following equation controls for both time and country fixed effects.

$$\text{EXP}_{ict} = a + b_1\text{CBEC}_{ict} + b_2\text{COVID}_{ct} + b_3\text{CBEC}_{ict}*\text{COVID}_{ct} + b_4\text{GDP}_{ct} + b_5\text{dist}_c + b_6\text{col}_c + b_7\text{FTA}_c + \gamma_{ct} + \varphi_t + \epsilon_{ict}, \quad (5)$$

Using these baseline regression models, further regression analysis will be conducted to show the differences in the effect of CBEC on COVID-19 and total exports across sectors and regions. As we have seen above in the CBEC overview, it is expected to see differences in the various sectors and countries. More detailed descriptions will be provided later in the paper.

As such, this paper will research into the effect of CBEC exports on the impact of COVID-19 on Korean total exports. It aims to provide a comprehensive analysis into the digital trade export structure of South Korea, while referring to its effect on total exports as well as taking into account the impact of COVID-19.

### 3.4. Results and Analysis

<b>Table 3.</b> Estimation Results					
	(1) lnexp	(2) lnexp	(3) lnexp	(4) lnexp	(5) lnexp
lnbec	0.646*** (0.00395)	0.636*** (0.00573)	0.0124** (0.00405)	0.678*** (0.00575)	0.0107** (0.00410)
lnCovidkr	-0.0505*** (0.00495)	-0.0549*** (0.00533)	-0.0376*** (0.00259)	-0.142*** (0.0220)	-0.0415*** (0.0107)
lnGDP	-0.229*** (0.00783)	-0.229*** (0.00783)	1.081*** (0.0565)	-0.0589*** (0.00707)	0.780*** (0.0691)
lnDist	-0.325*** (0.00924)	-0.325*** (0.00924)			
col	2.475*** (0.0939)	2.473*** (0.0939)			
fta	0.877*** (0.0222)	0.877*** (0.0222)			
covidkr#cbec		0.00429* (0.00191)	0.00315*** (0.000927)	0.00713*** (0.00193)	0.00329*** (0.000930)
Time FE	NO	NO	NO	YES	YES
Country FE	NO	NO	YES	NO	YES
_cons	12.65*** (0.113)	12.66*** (0.113)	-1.211* (0.521)	8.851*** (0.0880)	1.601* (0.639)
N	306514	306514	306514	306514	306514
R-sq	0.106	0.106	0.002	0.096	0.005

Standard errors in parentheses  
 \* p<0.05, \*\* p<0.01, \*\*\* p<0.001

Source: Author's Derivations from Dataset

The first column (1) in Table 3 presents the results of a simple OLS estimation on the effect of CBEC levels, COVID-19 stringency levels, and other country-level characteristics on total exports from Korea. The coefficients show results similar to what has been proven in existing literature. GDP per capita of the destination country has a positive impact on total exports, while distance seems to be negatively correlated with total exports, meaning that the further away the destination country is, the less exports have been provided to the respective country. This is well aligned with the results provided by many literature, including the theory known as the “death of distance” by Cairncross (Cairncross, 1977). The variable for colonization is positive and significant, meaning that the countries that have had a colonial relationship with South Korea tend to have higher values of export transactions. Whether a country has free trade agreements was shown to have a positive and significant impact on the total volume of total exports, essentially meaning that countries with FTA tend to have more exports from Korea than those that do not.

On the whole, this shows that column (1) is a good reflection of currently existing literature on the flow of total exports. Now, as this paper has emphasized above, this analysis will focus on the impact of CBEC and COVID-19 on total exports. The coefficient for CBEC is shown to be positive and significant, corroborating the first hypothesis of this paper that CBEC increases total exports. It also shows that CBEC and traditional exports do not have a substitutional relationship, but a rather complementary one. An increase in CBEC further boosts traditional exports, as can be seen by the higher increase in total exports, which includes CBEC and traditional exports. This may indicate that CBEC plays a vital role in boosting total exports, and that more exporters and policy makers should focus on building upon the crucial influence CBEC has on Korea’s exports.

Furthermore, COVID-19 stringency levels of the exporter country, South Korea, is significant and a 1% increase in the levels of stringency policies leads to a 0.05% decrease in total exports. This is well aligned with the results provided by many literature, including the theory known as the “death of distance” by Cairncross (Cairncross, 1977).

The second column (2) is a simple OLS regression model, but with an interaction term included as the independent variable. The variables for COVID-19 stringency and volume of CBEC have been interacted to show the effect of CBEC on the impact of COVID-19 stringency policies on total exports. The inclusion of the interaction term provides more information on the relationship between the three factors at interest. Results showed that the inclusion of the interaction variable has provided more statistical significance to the regression. The interaction variable seems to have a positive and significant coefficient of 0.004. This shows that effect of CBEC on total exports will increase as COVID-19 stringency levels increase, and vice versa.

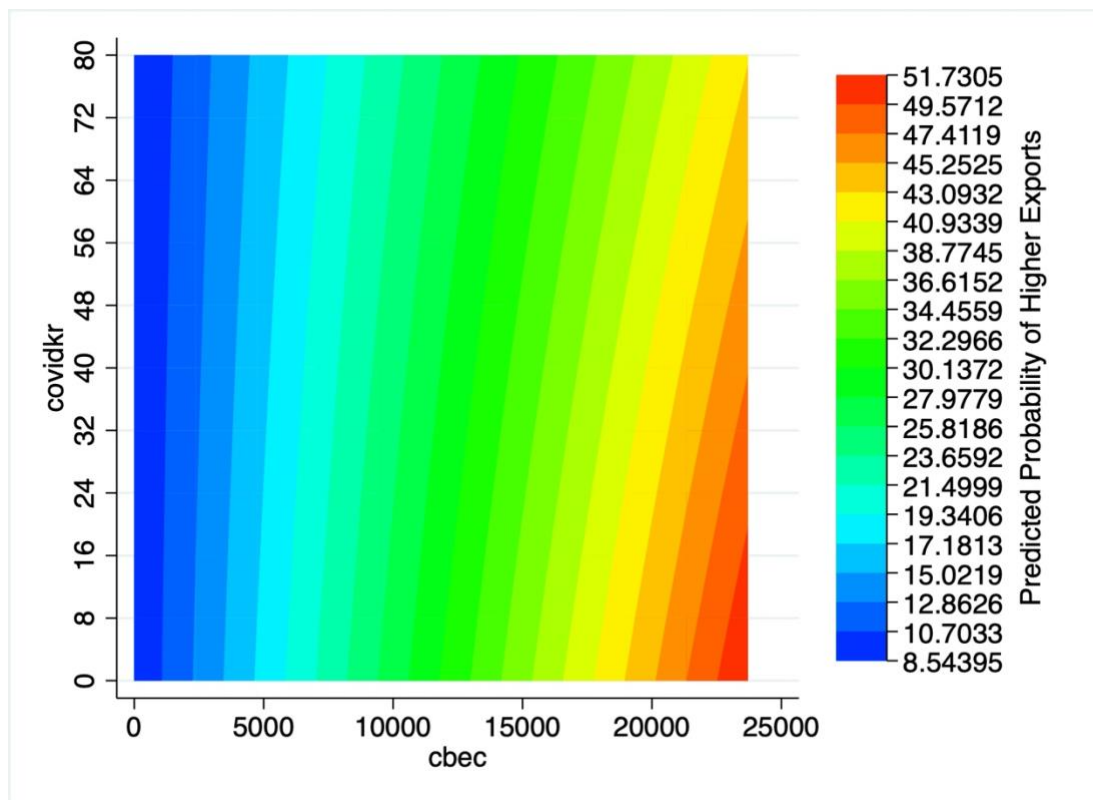
Whereas without the interaction variable the variable for government stringency levels was insignificant, the new interaction provides significance to the overall model. Hence, it can be deduced that there is an interaction occurring between the two variables that may potentially be able to explain for the effects on total exports. To illustrate the actual effect of the interaction term, a contour graph is used as shown in Figure 7.



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**Figure 7.** Contour Plot of CBEC and COVID-19 Stringency Levels

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Source: Author's Derivations from Dataset

In essence, Figure 7 shows that at higher levels of CBEC and lower levels of COVID-19, there exist the highest levels of total exports. CBEC levels seems to be the determining factor of high total exports. Even at low COVID-19 stringency levels, if there are low levels of CBEC exports, there are low levels of total exports. Furthermore, during high levels of COVID-19 stringency levels, if there are high levels of CBEC exports, total export levels are higher. Hence, overall, the negative effects of high COVID-19 stringency policies such as lockdown, border closures, and decreased travelling seem to be complemented by the high levels of CBEC exports. Total exports at high levels of CBEC exports seem to decrease with the high levels of stringency policies, but on the whole seem to keep exports high despite the extreme consequences of COVID-19 policies.

The third (3), fourth (4) and fifth (5) columns in Table 3 are fixed effects models, controlling for country-level characteristics. As mentioned above, since this paper uses panel

data, the Hausman test has been used to avoid endogeneity and to evaluate which analytical model would suit the analysis best. All tests suggested strong evidence that the fixed effects model is better than the random effects in terms of consistency and efficiency, essentially rejecting the null hypothesis with a P-value less than 0.05, and hence, all models have been analysed using the fixed effect model in order to minimize potential omitted variable bias.

Column (3) is a fixed effect model controlling for country-level differences that may affect the relationship between CBEC, COVID-19, and total exports. The results show that the coefficients for the interaction variable, as well as the independent variables CBEC and COVID-19 vary with and without the fixed effect of the country variable. The interaction variable turns more significant, and this may indicate that the country fixed effect has had added significance to the model. Yet the coefficient decreases slightly, which shows the need to look deeper into country-level differences, and that the actual relationship between these variables and exports may be different. To look into the differences in effects of CBEC and COVID-19 on exports by region, further analysis will be conducted later in Section 4.6.

The fourth column (4) is a fixed effects model with the monthly date as the fixed effect. Controlling for factors that may have influenced all countries equally over time, such as political conflicts, or worldwide impacts, have distinctly increased the significance of the interaction variable. This may indicate that the interaction between CBEC and COVID-19 has a higher effect on total exports when controlling for external influences.

The last column (5) combines both time and country fixed effects. The coefficient for the interaction variable remains significant and positive, with higher COVID-19 stringency levels leading to higher effects of CBEC exports.

### 3.5. Robustness Checks

Additional tests to keep the robustness of the model have been undergone. The model was tested for autocorrelation since it uses monthly data from a span of almost three years using the Wooldridge test. Since the p-value is higher than the significance level (0.1525), there is not enough evidence to reject the null hypothesis that there is no first-order autocorrelation. Hence, no strong signs of autocorrelation are shown.

To test for heteroskedasticity, the modified Wald Test has been conducted. The null hypothesis that there is no heteroskedasticity was rejected with the P-value of 0.000. Since there was no indication of autocorrelation, all four regression analyses were repeated by only controlling for potential heteroskedasticity (Hoechle, 2007). The comparison of the two results shows that there are no large differences in the estimates. The results of the robustness checks in Table 4 are much in line with the benchmark results.

<b>Table 4. Robust Estimation Results</b>					
	(1) lnexp	(2) lnexp	(3) lnexp	(4) lnexp	(5) lnexp
lnbec	0.646*** (0.00286)	0.636*** (0.00406)	0.0124** (0.00379)	0.678*** (0.00402)	0.0107** (0.00385)
lnCovidkr	-0.0505*** (0.00495)	-0.0549*** (0.00551)	-0.0376*** (0.00352)	-0.142*** (0.0222)	-0.0415*** (0.0114)
lngdp	-0.229*** (0.00784)	-0.229*** (0.00784)	1.081*** (0.0796)	-0.0589*** (0.00716)	0.780*** (0.101)
lnDist	-0.325*** (0.0100)	-0.325*** (0.0100)			
col	2.475*** (0.0731)	2.473*** (0.0732)			
fta	0.877*** (0.0223)	0.877*** (0.0223)			
lnCovid#lnbec		0.00429** (0.00131)	0.00315*** (0.000656)	0.00713*** (0.00132)	0.00329*** (0.000652)
Time FE	NO	NO	NO	YES	YES
Country FE	NO	NO	YES	NO	YES
_cons	12.65*** (0.116)	12.66*** (0.116)	-1.211 (0.734)	8.851*** (0.0883)	1.601 (0.933)
N	306514	306514	306514	306514	306514
R-sq	0.106	0.106	0.002	0.096	0.005
Standard errors in parentheses					
* p<0.05, ** p<0.01, *** p<0.001					
Source: Author's Derivations from Dataset					

### 3.6. Analysis by Product

**Table 5.** Descriptive Statistics of Product Classifications

Product Classifications	Freq.	Percent	Cum.
Animal, Plant and Marine Products	31,419	10.32	10.32
Ceramics and Glass	13,511	4.44	14.76
Chemicals, Minerals and Fuels	50,956	16.74	31.5
Electromechanical instruments and vehicles	37,164	12.21	43.71
Food Products	29,880	9.82	53.53
Garments, Shoes and Hats	11,301	3.71	57.24
Hides and Skins	7,152	2.35	59.59
Miscellaneous	16,321	5.36	64.95
Plastics and Rubber	11,463	3.77	68.71
Textile and Clothing	43,678	14.35	83.06
Woods	16,890	5.55	88.61
Woods, paper and non-metals	34,664	11.39	100
Total	304,399	100	

Source: Author's Derivations from Dataset

During January 2019 to January 2022, the most frequently traded products were chemicals, minerals and fuels, which are mostly comprised of cosmetic products. These are followed by textile and clothing, which are both corroborated by the recent boom in Korean fashion items due to the proliferation of Korean culture. Furthermore, electromechanical instruments and vehicles, rank as 3<sup>rd</sup> highest products which are exported from Korea. These include SSDs (Solid State Drive), reflecting the recent steep increase in the performance of K-semiconductors. These product classifications were created to observe the differences in the effects of CBEC and COVID-19 on total exports that may exist.

Referring to Table 6, all variables showed similar results and coefficients. Among the product classifications, the products that were the most traded showed significance. This is most likely due to the lack of data on the other products during the whole time period. For

the four product classifications Chemicals, Minerals and Fuels, Textile and Clothing, Garments, Shoes and Hats, Electromechanical instruments and vehicles, the interaction term of COVID-19 and CBEC show stronger positive coefficients. As such, higher CBEC levels are associated with higher COVID-19 stringency levels, which leads to higher exports of Chemicals, Minerals and Fuels, Textile and Clothing, Garments, Shoes and Hats, and Electromechanical instruments and vehicles. It can be deduced that these top sectors are where the increase of CBEC may have the largest impact on increasing total exports during COVID-19.

**Table 6.** Estimation Results by Product Classification

	Animal, Plant and Marine Products	Food Products	Chemicals, Minerals and Fuels	Plastics and Rubber	Hides and Skins	Woods	Textile and Clothing	Garments, Shoes and Hats	Ceramics and Glass	Woods, paper and non-metals	Electromechanical instruments and vehicles	Miscellaneous
	Inexp	Inexp	Inexp	Inexp	Inexp	Inexp	Inexp	Inexp	Inexp	Inexp	Inexp	Inexp
Incovidkr	-0.0172 (0.0148)	-0.0191 (0.0154)	0.00434 (0.0114)	-0.0270 (0.0188)	-0.161*** (0.0327)	-0.0529* (0.0225)	-0.0955*** (0.0135)	-0.158*** (0.0259)	-0.0689** (0.0233)	-0.0616*** (0.0153)	-0.0754*** (0.0141)	-0.163*** (0.0216)
Incbec	0.844*** (0.0339)	0.745*** (0.0245)	0.451*** (0.0143)	0.452*** (0.0175)	0.724*** (0.0277)	0.822*** (0.0214)	0.371*** (0.0146)	0.609*** (0.0197)	0.560*** (0.0237)	0.672*** (0.0247)	0.681*** (0.0108)	0.514*** (0.0191)
Incovid# Incbec	-0.00285 (0.0108)	-0.00905 (0.00783)	0.0123* (0.00482)	0.00597 (0.00571)	0.00545 (0.00911)	0.00872 (0.00693)	0.0119* (0.00479)	0.0131* (0.00657)	-0.00373 (0.00771)	0.00792 (0.00819)	0.00711* (0.00361)	0.0239*** (0.00626)
Ingdp	0.276*** (0.0237)	-0.00395 (0.0249)	-0.430*** (0.0164)	-0.160*** (0.0249)	-0.520*** (0.0498)	-0.665*** (0.0313)	-0.275*** (0.0201)	0.0887* (0.0370)	0.351*** (0.0355)	-0.000105 (0.0232)	-0.290*** (0.0188)	0.0921** (0.0309)
Indist	-1.232*** (0.0263)	-0.968*** (0.0282)	-0.0676*** (0.0200)	0.328*** (0.0290)	-0.791*** (0.0624)	-0.405*** (0.0387)	-0.389*** (0.0292)	-0.398*** (0.0442)	-0.170*** (0.0368)	-0.437*** (0.0269)	-0.0238 (0.0199)	-0.0825* (0.0359)
col	2.863*** (0.232)	3.204*** (0.289)	4.149*** (0.219)	0.453 (0.431)	1.965*** (0.481)	1.491*** (0.351)	2.250*** (0.239)	2.216*** (0.395)	2.671*** (0.409)	2.445*** (0.276)	1.580*** (0.265)	1.366*** (0.360)
fta	0.845*** (0.0646)	0.806*** (0.0658)	1.567*** (0.0490)	2.767*** (0.0805)	2.252*** (0.132)	0.406*** (0.0900)	1.432*** (0.0563)	1.126*** (0.0974)	2.153*** (0.0927)	1.995*** (0.0649)	0.321*** (0.0576)	0.946*** (0.0854)
_cons	12.52*** (0.323)	15.57*** (0.346)	13.62*** (0.244)	9.443*** (0.367)	15.84*** (0.716)	15.00*** (0.458)	13.62*** (0.320)	6.596*** (0.516)	4.981*** (0.476)	12.20*** (0.337)	12.97*** (0.263)	7.131*** (0.441)
N	31419	29880	50956	11463	7152	16890	43678	11301	13511	34664	37164	16321
R-sq	0.155	0.143	0.083	0.269	0.250	0.181	0.070	0.232	0.204	0.112	0.200	0.154

Standard errors in parentheses

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

Source: Author's Derivations from Dataset

### 3.7. Analysis by Country Income

In order to look into how the effects of CBEC and COVID-19 vary across the exports to various regions, this section repeats the regression by considering the different income groups of destination countries.

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**Table 7.** Country Income Classification Descriptive Statistics

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<b>Income Group</b>	<b>Freq.</b>	<b>Percent</b>	<b>Cum.</b>
High Income	139,845	45.65	45.98
Low Income	16,176	5.28	51.26
Lower Middle Income	77,422	25.28	76.54
Upper Middle Income	71,870	23.46	100
<b>Total</b>	306,314	100	

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Source: Author's Derivations from Dataset

The income classifications of each destination country has been derived by the list provided by the World Bank. Most transactions with South Korea were undergone with countries classified as high income countries, i.e. a country with a GNI per capita of \$13,205 or more. This is followed by lower middle income countries, then upper middle income countries, and the least with low income countries.

The regression results are shown in Table 8 for each income group classification shown above. Column (1) shows the results for 'High Income' countries, column (2) for 'Upper Middle Income' countries, column (3) for 'Lower Middle Income' countries, and column (4) for 'Low Income' countries. The interaction variable only showed significance for 'Upper Middle Income' countries. The coefficient remained positive, with a slightly larger value. This may indicate that the relationship between COVID-19, CBEC, and total exports may depend on the income level of each country. Hence, this brings up the need to look into country-level characteristics that may affect the impact of the relationship between



**Table 8.** Estimation Results by Country Income Group Classification

	(1)	(2)	(3)	(4)
	lnexp	lnexp	lnexp	lnexp
lncovidkr	-0.0617*** (0.00820)	-0.0448*** (0.0108)	-0.0516*** (0.00993)	-0.0505* (0.0212)
lncbec	0.658*** (0.00711)	0.521*** (0.0124)	0.531*** (0.0169)	0.00306 (0.128)
lncovid#lncbec	0.00332 (0.00238)	0.00892* (0.00424)	0.00496 (0.00563)	-0.0122 (0.0477)
lngdp	-0.229*** (0.0275)	0.703*** (0.0663)	0.333*** (0.0395)	-0.145*** (0.0299)
lndist	0.0340** (0.0108)	-1.319*** (0.0339)	-1.271*** (0.0366)	-1.523*** (0.187)
col	3.528*** (0.0950)	0	0	0
fta	-0.404*** (0.0357)	0.767*** (0.0486)	1.592*** (0.0450)	0
_cons	10.27*** (0.314)	13.71*** (0.712)	16.66*** (0.460)	22.03*** (1.683)
N	139845	71870	77422	16176
R-sq	0.141	0.122	0.097	0.008

Standard errors in parentheses  
\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

Source: Author's Derivations from Dataset

COVID-19 and CBEC on total exports. The results are in accordance to existing global literature, such as that by Jiang and Jia, who focused on the digital service trade, yet differ in the case of middle-income countries (Jiang and Jia, 2022, 131-156). Furthermore, the result may be due to the lack of e-commerce infrastructure in many low income countries (Fayyaz, 2019, 57-68), as shown by the eccentric negative coefficient of the interaction variable for column (4).

Another interesting point to note is that there is consensus in the current literature that developing countries are more affected by the pandemic than developed countries. Since different countries have different infrastructure, as well as different political actions to fight against COVID-19, different countries face different situations. Many literature generally focus on the recovery of the countries from the effects of COVID-19 (UNCTAD, 2022). Boosting exports through CBEC against the negative effects of COVID-19 may be shown to be the most important in the upper middle income countries group, in which countries have both the characteristics of: relatively high levels of CBEC infrastructure, as well as the relative lack of potential to recover from COVID-19 in comparison to the developed countries. In this case, methods such as CBEC may have the most crucial role in improving the exports to these countries. Along with the global consensus, this paper corroborates the phenomenon that low income countries tend to lack CBEC infrastructure as well as the infrastructure to recover quickly from external effects such as COVID-19. The negative coefficient in the low income classification of countries clearly shows that CBEC has little effect on improving the volume of exports to these countries, since the infrastructure in the destination countries in this group cannot support effective CBEC from South Korea.

## Chapter 4. Conclusion and Implications

In conclusion, COVID-19 stringency levels were negatively correlated with total exports, while CBEC exports have been positively correlated with total exports. The relationship between CBEC and total exports show the complementary relationship between the two, further emphasizing the need to focus on CBEC exports to further strengthen the total exports from Korea. Furthermore, the interaction variable shows that higher COVID-19 stringency levels are associated with higher CBEC exports, which has a positive impact on total exports. In particular, higher CBEC export levels have led to higher possibilities of higher total exports regardless of the COVID-19 stringency levels. Though the effect may not be as dramatic, this is expected to increase steeply as CBEC exports increase due to technological advancements and the shift in the system of trade due to the end of the pandemic. COVID-19 has dramatically changed the paradigm of trade and accelerated digitalisation, and it is only through careful analysis into the current trading system that will reveal the basis of how the post-pandemic trade and exports will be shaped. This provides some implications on the current (at the time of the drafting of this paper) negative trade deficit trend of Korea. It is well-known that Korea has a high dependency on its exports. While its exports are focused on semi-conductors, there rises the immediate need to diversify the exports to different products and countries. In order to accomplish this during the supply chain crisis, more emphasis needs to be placed on the effective method of exporting various products, and with the results of this paper, CBEC can be an effective method of boosting exports. More investment and support for the facilitation of CBEC exports for businesses and other exporters needs to be provide in order to go beyond the drastic effects of the supply chain crisis, post-COVID-19 trends, and the high export dependency situation which South Korea is facing all at once.

The above analysis has shown that COVID-19 and CBEC exports indeed have a relationship with each other, and that higher levels of CBEC exports have increased total exports regardless of the COVID-19 stringency levels. Though at more extreme COVID-19 stringency levels total exports have increased only moderately, CBEC exports have contributed to a kind of mitigation to the disastrous effects of COVID-19. Furthermore, upon consideration of the product level differences, the relationship between CBEC exports and COVID-19 stringency levels seem to be coming mostly from Chemicals, Minerals and Fuels, Textile and Clothing, Garments, Shoes and Hats, Electromechanical instruments and vehicles products. Though this may be because of the relatively less amount of other products that are exported, it is important to note that the CBEC exports of these products are contributing much to the increase in total exports of Korea. Furthermore, it may indicate that if CBEC exports were to cover more products, the effect of COVID-19 stringency levels may have been mitigated much more.

Furthermore, the relationship between COVID-19 stringency levels and CBEC seem to differ across countries as well. In particular, when observing between the groups of countries according to the income classification, the coefficient of the interaction term of COVID-19 and CBEC for the 'Upper Middle Income' country group showed the highest significance, with a positive coefficient, slightly higher than the regression undergone with all countries. As explained above, this goes in hand with the surrounding literature that developed countries tend to have high capacity to recover from COVID-19, as well as a stable CBEC infrastructure to support the facilitation of trade from Korea through the method of CBEC. On the other hand, low income countries tend to lack in both aspects, leading to the negative relationship CBEC and COVID-19 have on total exports to these destination countries. Perhaps further study could look into which country characteristics, such as those with higher ICT infrastructure, CBEC friendly policies, or technological advancements (Azmeah et al. 2019, 671-692) have led to these differences in their relationship and their effects on total exports. While this paper seeks to provide implications

on which destination countries' exports are mostly affected by this relationship, further studies may uncover the reason behind the differences in the impact of the two variables on total exports.

Hence, in conclusion, this paper raises several policy implications on the government and businesses. Firstly, policy makers and the government should focus on improving CBEC infrastructure for the products that are holding up total exports, such as semi-conductors, fashion items, and cosmetics. Some emphasize upon the fact that the improvement of safe international transportation and custom systems need to support the increase in CBEC exports (Lee H. and Yoo B. 2021, 15). To improve the Korean economy and help its businesses and individuals, there needs to be stronger support for CBEC exports in the products that have the highest effects on the total exports. Many major economies are already emphasizing the need to prioritize policies to strengthen CBEC exports (Tudor 2022, 31). Countries may need to work together to come up with a common regulatory system to allow free digital trade between countries (Meltzer 2019, 23-48; Walters 2022). Nevertheless, it is necessary to look into the causes and reason behind why some products are exported much more through CBEC than others, and should take the appropriate action in response to them by either building up CBEC infrastructure for other products, or finding other mechanisms of recovering from COVID-19 and to multiply the effects on increasing total exports (Shin et al. 2018, 93-112).

Furthermore, more businesses should continue to build upon their digital services in order to engage more with CBEC exports. Since many large businesses such as Samsung Electronics and Hyundai Motors are already preoccupied with online sales and e-commerce, the gap between large businesses and smaller businesses in terms of online accessibility for foreign consumers should be limited. This falls upon the hands on the businesses themselves, as well as policy makers that should support smaller businesses not to fall behind. Through the broadening of the use of CBEC for exports, more products may be efficiently exported globally, enhancing Korean total exports even further.

## 4.1. Limitations and Suggested Research

Although this paper contributes to the comprehensive understanding of how CBEC exports are shaped under total exports of Korea, there are some limitations from which future research may fill in the gaps of this research.

Firstly, since digital trade is still only at its beginning stage, further development of CBEC and more available data would lead to more accurate results. When conducting product level and country level analysis, in particular, there has been limitations of achieving comprehensive results due to the lack of data in particular products and countries. Data available in count data, such as unit of product exported, could also allow the usage of more accurate regression models, such as the PPML method briefly mentioned above. Though several robustness tests have been undertaken, since there are multiple observations with a value of 0, the PPML could provide more accurate insight into the actual effects of COVID-19 and CBEC on total exports.

Furthermore, this paper follows mainstream papers in that the COVID-19 stringency levels of the exporting country influences total exports more than that of the importing country. Since this is taken as a mere assumption, some in-depth study may provide more detailed insight into the effect of COVID-19 on total exports.

Last but not least, since this paper attempted to cover all countries and all products that Korea exports to, important country-level and product-level characteristics that may have severely influenced the relationships are left out. By observing the analysis given in this paper, further research into the relationship between CBEC and COVID-19 in major products and countries is suggested to provide more detailed implications on how to manage CBEC exports in different countries and with different products.

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## Appendix

### List of countries used in dataset

<b>Table 9.</b> List of Countries by Country Code							
AFG	BRA	DNK	HRV	LBY	NAM	SAU	TUR
AGO	BRB	DOM	HTI	LCA	NER	SDN	TUV
ALB	BRN	DZA	HUN	LKA	NGA	SEN	TWN
AND	BTN	ECU	IDN	LSO	NIC	SGP	TZA
ARE	BWA	EGY	IND	LTU	NLD	SLB	UGA
ARG	CAF	ESP	IRL	LUX	NOR	SLE	UKR
ARM	CAN	EST	IRQ	LVA	NPL	SLV	URY
ATG	CHE	ETH	ISL	MAC	NRU	SRB	USA
AUS	CHL	FIN	ISR	MAR	NZL	STP	UZB
AUT	CHN	FJI	ITA	MDA	OMN	SUR	VCT
AZE	CIV	FRA	JAM	MDG	PAK	SVK	VNM
BDI	CMR	GAB	JOR	MDV	PAN	SVN	VUT
BEL	COD	GBR	JPN	MEX	PER	SWE	WSM
BEN	COG	GEO	KAZ	MKD	PHL	SWZ	YEM
BFA	COL	GHA	KEN	MLI	PLW	SYC	ZAF
BGD	COM	GIN	KGZ	MLT	PNG	TCA	ZMB
BGR	CPV	GMB	KHM	MMR	POL	TCD	ZWE
BHR	CRI	GNQ	KIR	MNE	PRI	TGO	
BHS	CUW	GRC	KNA	MNG	PRT	THA	
BIH	CYP	GRD	KOR	MOZ	PRY	TJK	
BLR	CZE	GTM	KWT	MRT	QAT	TLS	
BLZ	DEU	GUY	LAO	MUS	ROU	TON	
BMU	DJI	HKG	LBN	MWI	RUS	TTO	
BOL	DMA	HND	LBR	MYS	RWA	TUN	

Source: Author's Derivations from Dataset

# List of countries by region

Table 10. Countries by Region									
AFG	Asia	BLR	Europe	CMR	Africa	CYP	Asia	FRA	Europe
ALA	Europe	BEL	Europe	CAN	North America	CZE	Europe	GUF	South America
ALB	Europe	BLZ	North America	CYM	North America	PRK	Asia	PYF	Oceania
DZA	Africa	BEN	Africa	CAF	Africa	COD	Africa	ATF	Africa
ASM	Oceania	BMU	North America	TCD	Africa	DNK	Europe	GAB	Africa
AND	Europe	BTN	Asia	CHL	South America	DJI	Africa	GMB	Africa
AGO	Africa	BOL	South America	CHN	Asia	DMA	North America	GEO	Asia
AIA	North America	BES	North America	HKG	Asia	DOM	North America	DEU	Europe
ATA	Antarctica	BIH	Europe	MAC	Asia	ECU	South America	GHA	Africa
ATG	North America	BWA	Africa	CXR	Oceania	EGY	Africa	GIB	Europe
ARG	South America	BVT	South America	CCK	Oceania	SLV	North America	GRC	Europe
ARM	Asia	BRA	South America	COL	South America	GNQ	Africa	GRL	North America
ABW	North America	IOT	Africa	COM	Africa	ERI	Africa	GRD	North America
AUS	Oceania	VGB	North America	COG	Africa	EST	Europe	GLP	North America
AUT	Europe	BRN	Asia	COK	Oceania	SWZ	Africa	GUM	Oceania
AZE	Asia	BGR	Europe	CRI	North America	ETH	Africa	GTM	North America
BHS	North America	BFA	Africa	CIV	Africa	FLK	South America	GGY	Europe
BHR	Asia	BDI	Africa	HRV	Europe	FRO	Europe	GIN	Africa
BGD	Asia	CPV	Africa	CUB	North America	FJI	Oceania	GNB	Africa
BRB	North America	KHM	Asia	CUW	North America	FIN	Europe	GUY	South America
HTI	North America	KIR	Oceania	MRT	Africa	NGA	Africa	MDA	Europe
HMD	Oceania	KWT	Asia	MUS	Africa	NIU	Oceania	REU	Africa
VAT	Europe	KGZ	Asia	MYT	Africa	NFK	Oceania	ROU	Europe
HND	North America	LAO	Asia	MEX	North America	MKD	Europe	RUS	Europe
HUN	Europe	LVA	Europe	FSM	Oceania	MNP	Oceania	RWA	Africa
ISL	Europe	LBN	Asia	MCO	Europe	NOR	Europe	BLM	North America
IND	Asia	LSO	Africa	MNG	Asia	OMN	Asia	SHN	Africa
IDN	Asia	LBR	Africa	MNE	Europe	PAK	Asia	KNA	North America
IRN	Asia	LBY	Africa	MSR	North America	PLW	Oceania	LCA	North America
IRQ	Asia	LIE	Europe	MAR	Africa	PAN	North America	MAF	North America
IRL	Europe	LTU	Europe	MOZ	Africa	PNG	Oceania	SPM	North America
IMN	Europe	LUX	Europe	MMR	Asia	PRY	South America	VCT	North America
ISR	Asia	MDG	Africa	NAM	Africa	PER	South America	WSM	Oceania
ITA	Europe	MWI	Africa	NRU	Oceania	PHL	Asia	SMR	Europe
JAM	North America	MYS	Asia	NPL	Asia	PCN	Oceania	STP	Africa
JPN	Asia	MDV	Asia	NLD	Europe	POL	Europe	SAU	Asia
JEY	Europe	MLI	Africa	NCL	Oceania	PRT	Europe	SEN	Africa
JOR	Asia	MLT	Europe	NZL	Oceania	PRI	North America	SRB	Europe
KAZ	Asia	MHL	Oceania	NIC	North America	QAT	Asia	SYC	Africa
KEN	Africa	MTQ	North America	NER	Africa	KOR	Asia		
SLE	Africa	THA	Asia	UZB	Asia				
SGP	Asia	TLS	Asia	VUT	Oceania				
SXM	North America	TGO	Africa	VEN	South America				
SVK	Europe	TKL	Oceania	VNM	Asia				
SVN	Europe	TON	Oceania	WLF	Oceania				
SLB	Oceania	TTO	North America	ESH	Africa				
SOM	Africa	TUN	Africa	YEM	Asia				
ZAF	Africa	TUR	Asia	ZMB	Africa				
SGS	South America	TKM	Asia	ZWE	Africa				
SSD	Africa	TCA	North America						
ESP	Europe	TUV	Oceania						
LKA	Asia	UGA	Africa						
PSE	Asia	UKR	Europe						
SDN	Africa	ARE	Asia						
SUR	South America	GBR	Europe						
SJM	Europe	TZA	Africa						
SWE	Europe	UMI	Oceania						
CHE	Europe	USA	North America						
SYR	Asia	VIR	North America						
TJK	Asia	URY	South America						

Source: Author's Derivations from Dataset

## Classification of Products

**Table 11.** Classification of Products (HS 2-Digit Codes)

<b>HS 2-digit codes</b>	<b>Product Classifications</b>	<b>Frequencies</b>
01 to 15	Animal, Plant and Marine Products	31,419
16 to 25	Food Products	13,511
25 to 38	Chemicals, Minerals and Fuels	50,956
30 to 40	Plastics and Rubber	37,164
41 to 43	Hides and Skins	29,880
44 to 49	Woods	11,301
50 to 63	Textile and Clothing	7,152
64 to 67	Garments, Shoes and Hats	16,321
68 to 71	Ceramics and Glass	11,463
72 to 83	Woods, paper and non-metals	43,678
84 to 92	Electromechanical instruments and vehicles	16,890
93 to 97	Miscellaneous	34,664
	<b>Total</b>	<b>304,399</b>

Source: World Bank WITS, Author's Calculations

## Countries in Dataset in FTA with South Korea

**Table 12.** South Korea FTA Countries

AUS	ESP	KHM	POL
AUT	EST	LAO	PRT
BEL	FIN	LTU	ROU
BGR	FRA	LUX	SGP
BRN	GBR	LVA	SLV
CAN	GRC	MLT	SVK
CHE	HND	MMR	SVN
CHL	HRV	MYS	SWE
CHN	HUN	NIC	THA
COL	IDN	NLD	TUR
CRI	IND	NOR	TWN
CYP	IRL	NZL	USA
CZE	ISL	PAN	VNM
DEU	ITA	PER	
DNK	JPN	PHL	

Source: Ministry of Trade, Industry and Energy, 2022 January

## 국문초록

디지털 무역의 도입부터 급격한 사용 증가까지 이르며, 경제 시스템의 패러다임에 큰 변화를 이르고, 현재 존재하는 무역 시스템에 대대적인 개혁을 가져올 필요성을 불러일으켰다. 이와 같이, 본 논문에서는 디지털 무역을 국경 간 전자상거래를 통한 무역의 거래로 정의하여 CBEC 와 한국의 전체 수출 구조를 국가별, 부문별로 개관하고자 한다. 또한, 코로나 19 가 전체 수출에 미치는 불균형적 영향에 대한 CBEC 의 역할을 지역별 및 품목 분류별로 분석한다. 추정결과에 따르면, 코로나 19 방역강도와 CBEC 의 상호작용항이 총수출의 변화를 설명하는데 유의미한 것으로 나타났다. 또한, 높은 코로나 19 방역강도때도, 높은 수준의 CBEC 는 높은 총 수출로 이어짐으로 보아, 코로나 19 의 영향은 총 수출에 대한 CBEC 의 영향보다 훨씬 약한 것으로 나타났다. 국가 수준 특성과 시간을 통제함으로써 세가지 요인들의 관계성은 국가 간 차이뿐만 아니라 시간 불변 요인에서도 영향을 받음으로 나타났다. 또한, 제품 수준의 차이를 고려하면, CBEC 수출과 COVID-19 방역 강도 수준 사이의 관계는 화학제품, 광물 및 연료, 섬유 및 의류, 의복, 신발 및 모자, 전기기계 및 차량 제품 등에서 보다 더 크게 나타난 것으로 보인다. 소득 분류에 따라 국가를 그룹화하면 상중소득 국가가 가장 중요성을 보였다. 결론적으로 본 논문은 정부와 기업에 대한 몇 가지 정책적 함의를 제기하고자 한다. 먼저, 정책 결정자와 정부는 총 수출을 유지하는 제품에 대한 CBEC 인프라 개선에 초점을 맞춰야한다. 또한, 더 많은 국내 기업들은 CBEC 수출에 더 관심을 갖고 디지털 서비스를 지속적으로 구축해야한다.

주제어: 전자상거래, 한국 수출, 디지털 무역, 코로나 19

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