Impact of Government Response to COVID-19 on the Role of GVC and Transportation[*]

Hyuksoo Cho
Department of International Trade, Chungnam National University, South Korea

Sang-kyun Kim[†]
SKK Business School, Sungkyunkwan University, South Korea

Abstract

Purpose – study aims to investigate the relationships between global value chain (GVC)- and transportation-related determinants and economic performance. Also, moderating effects of COVID-19 on the relationships are theoretically and empirically discussed. A limitation of previous studies includes their over-reliance on the opportunities of GVC participation and larger transportation. This study represents the challenges associated with them. Also, it shows how GVC and logistics can be difficult in case of a market fluctuation such as COVID-19.

Design/methodology – The sample for this study includes 828 observations from 138 countries. A semi-panel data set has been used. Six observations for each country are used to empirically test the hypotheses and a Two-way cluster model is conducted.

Findings – It is confirmed that GVC forward participation contributes more than the backward participation to enhance performance. Transportation infrastructure is critical, but large scales of marine and air transportations are not positive in terms of economic performance. Stricter government response to COVID-19 negatively moderates economic performance by GVC backward participation and transportation infrastructure.

Originality/value – The spread of COVID-19 is causing a severe collapse of GVC and transportation. This study empirically verifies the moderating effects of the government stringency on GVC and transportation. Previous studies usually discuss a positive impact of GVC and transportation size on economic performance. However, this study aims to show various challenges behind GVC participation and large scale transportation.

_____

Keywords: Global Value Chain (GVC), Length of Participation, Lack of Participation Diversity, Transportation, Large Scale, New Coronavirus (COVID-19), Government Stringency, Panel Data Analysis

JEL Classifications: F14, F21, J11, M16, R40

1. Introduction

The development of transportation, communication, and information during the 4th industrial revolution has led to convergence among individual countries and industries around the world. The global interconnected value chain can be defined as global value chain (GVC) which refers to a series of processes where the different stages of production are located across borders. GVC has become a primary topic of research and analytical attention in business and other social sciences (Kano et al., 2020). In particular, the multinational enterprises (MNEs) can profitably strengthen and exploit their unique firm-specific advantages through GVC participation (Buckley, 2009; Laplume et al., 2016).

_____

[†] **Corresponding author:** sangkkim@skku.edu

GVC participation may have implications on economic performance. GVC participation provides various opportunists to access better resources, technology, know-how, trade networks, and so on at the firm level (Gereffi, 2014). Also, the developing countries can integrate with the GVC network as a means of achieving higher economic growth. Additionally, GVC participation enables the developed countries to maximize efficiency and optimize industrial connectivity around the world. As a result, GVC participation across all countries has been increased significantly (Reddy et al., 2021). Policy makers across countries are trying to push for greater integration in the GVC (Reddy et al., 2021). Consequently, most previous studies discuss a positive impact of GVC participation in terms of economic performance.

This study discusses GVC participation from a new angle. We analyze shorter and wider GVC paradigm with general forward and backward participations. Due to the spread of new Coronavirus (COVID-19), human and economic activities among countries are restricted leading to a severe collapse of GVC. This study analyzes the length of GVC participation and lack of participation diversity in case of a market fluctuation such as the COVID-19 pandemic.

Additionally, this study aims to investigate transportation size with a new approach. Most previous studies deal only with the opportunities of large scale transportation. This manuscript discusses how this can lead to challenges in terms of performance. We suggest that large scale transportation such as container ships and cargo aircraft may not always be positive for logistics industry and economic performance. Last, this study analyzes the impact of government response to COVID-19 concerning large scale transportation.

Fig. 1 shows the theoretical model of this study. The model illustrates the relationships between a dependent variable (economic performance), independent variables relevant to GVC participation (i.e., forward participation, backward participation, length of participation, and lack of participation diversity), independent variables relevant to transportation (i.e., transportation infrastructure, large scale marine transportation, and large scale air transportation), moderator (government stringency due to COVID-19), and control variables (seaborne and airborne trades).

2. Changing Paradigm of Global Value Chain

2.1. Global Value Chain in COVID-19 Pandemic

According to the data released by OECD-WTO TiVA (trade in Value Added), participation in GVC has been increased in most countries since the mid-1990s. The increased GVC participation is not limited only to the movement of production facilities, but also to the systematic connectivity in various areas such as raw materials, manufacturing, logistics, marketing, sales, and so on. Interdependence among countries are strengthened and trade patterns are advanced with the increased GVC. GVC participation level of small open countries such as Korea, Taiwan, and Singapore is higher than that of countries with large domestic markets. Emerging economies or developing countries play an important role in GVC. In particular, Asian countries such as China are optimized as production bases with low wages and developing social and financial infrastructures. According to related statistics, since 2010, the ratio of exporting in China and the ASEAN has exceeded that of the EU countries (Choi Jung-eun, 2014).

Recently, however, GVC activities have faced severe challenges. COVID-19 is changing the traditional GVC paradigm, resulting in various market fluctuations. John Denton, Secretary-General of the International Chamber of Commerce (ICC) states that "border closures may show what a full-blown trade war looks like"(Lau, 2020). Concentrated and rigid structures are cited as serious problems of GVC relevant to COVID-19. Many companies and industries are heavily exposed to a single country regarding GVC. For example, China has been a center of global consumption and manufacturing. China's market share in the world's intermediate goods jumped from 5% in 2003 to 13% in 2018 (Ko, 2020). Therefore, almost all sectors around the world are exposed to China's economy. During the pandemic, international trade and transport associated with China were seriously disrupted. Various industries such as electronics and textile were also highly affected by the pandemic which are among the most active areas between China and Europe (Demertzis and Masllorens, 2020).

Fig. 1. Conceptual Model of This Study

Control variables: Seaborne and airborne trades
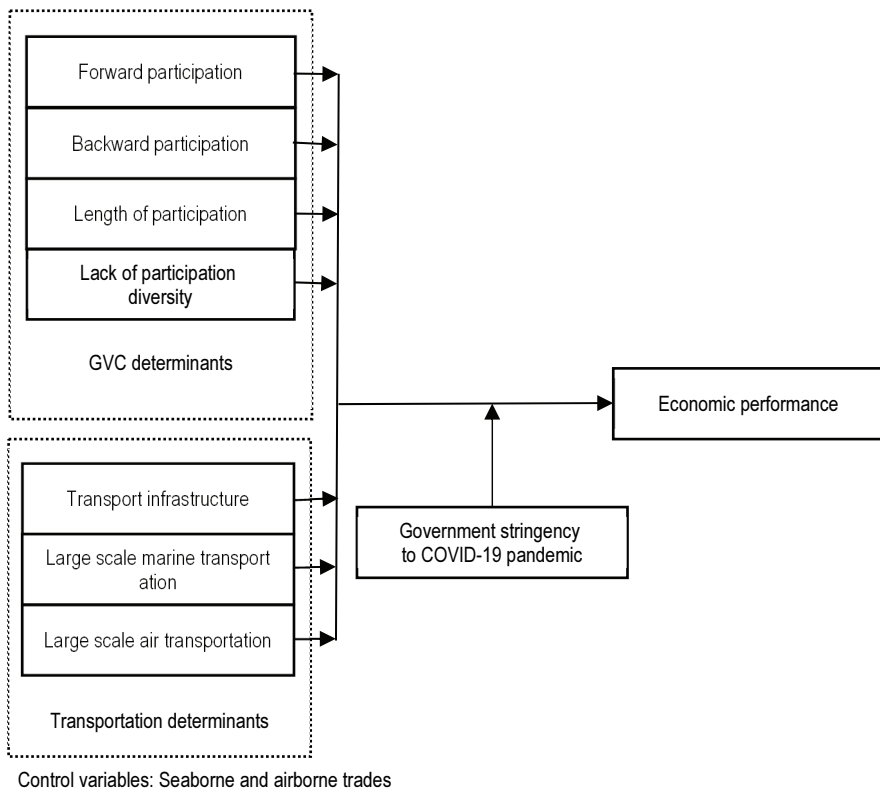
It is another challenge of GVC to manage various vendors under COVID-19. MNEs are engaging and interacting with various type and level of vendors in GVC activities. In general, risk management of GVC was relevant to 1st vendors. However, in COVID-19, the collapse of 2nd and 3rd vendors accelerated the crisis of GVC around the world. As a result, a phenomenon, 'manufacturing desert' has become a serious cause of concern (Ko, 2020). The

GVC crisis is closely associated with protectionism. COVID-19 spawned serious protectionism to restrict exports of medical supplies and food in many countries including the U.S. As a result, GVC activities became shorter and wider than before. Additionally, some industrialized countries such as the U.S. are emphasizing a re-shoring policy, which brings back manufacturing bases to home countries. Healthcare industry can be a major target for the policy during COVID-19. Therefore, COVID-19 is fundamentally changing the GVC paradigm.

2.2. Global Value Chain and Logistics Industry

Logistics industry is closely associated with GVC. A series of processes in which goods are produced in GVC and finally consumed are linked like a chain. This accelerates economic development and reduces trading cost (Yoon, 2015). In addition, logistics companies can expect market growth and improve productivity through GVC.

Besides of designing, Apple outsources the majority of manufacturing and production of its products (i.e. iPhone and iPad) to the contractors which are the Original Development Manufacturer (ODM) and Contract Manufacturer (CM) located outside of the US. That is, Apple depends on the international partners for outsourcing the value chain activities, including components and product manufacturing, transportation, and logistics management (Apple, 2022). Another IT conglomerate, Samsung tends to build a value chain with subsidiaries and partners based on managerial relationships. The type of vale chain in Samsung is differentiated compared to that of Apple. GVC activities represented by Apple type and Samsung type are realized specifically by logistics. GVC performance may vary depending on logistics industry. Among the various areas of logistics industry, transportation is directly associated with GVC. Transportation has been considered one of key determinants of economic development (Mačiulis et al., 2009). Thus, policy makers have widely promoted investments in transportation in order to enhance economic development (Melo et al., 2013).

This study aims to analyze the influence of GVC activities (i.e., forward participation, backward participation, length of participation, and lack of participation diversity) on economic performance. In addition, this study is designed to analyze how transportation affects GVC and economic performance. In particular, we discuss the impact of various aspects of transportation (i.e., large scale of transportation and infrastructure). As mentioned before, GVC and logistics industry have faced severe challenges during COVID-19. Therefore, this study discusses the impact of COVID-19 on the role of GVC and transportation in terms of economic performance.

3. Role of Global Value Chain in Economic Performance

3.1. GVC Forward Participation and Economic Performance

Corporate activities such as R&D, raw material supply, manufacturing, transportation, investment, and sales are conducted in many countries. They intend to optimize the production process by locating the various stages across different sites. Thus, the value chain activities including design, production, marketing, and distribution have been dispersed around the globe. In other words, the activities of international production, trade, marketing, transportation, and investments are increasingly organized within GVCs. Firms, in particular

MNEs are now specializing activities to produce some parts in one country and the other components in another country. Consequently, their production activities have spread worldwide.

Globalization accelerates corporate to restructure their operations internationally through outsourcing and offshoring (OECD, n.d.). GVC has increasingly expanded with corporate value maximizing efficiency and globalized market environment. Greater resilience and efficiencies in terms of international activities across borders are essential in GVCs. Better performance can be achieved by outsourcing logistics functions to third-party logistics services providers, especially those with integrated, end-to-end solutions capabilities (Twinn et al., 2020).

GVC participation can be calculated as the sum of backward and forward participations. While the proportion of intermediate goods trade in the world is rapidly decreasing, GVC forward participation is seeing a steady rise. This indicates that GVC is unevenly distributed among participants or countries. The ability to supply sophisticated and hard-to-imitate products or services to GVC may cause this inequality. Therefore, it is necessary to differentiate between backward and forward participations (Kersan-Škabić, 2019). Recently, customized GVC participation has been emphasized in terms of either forward or backward participation. A customized approach can maximize the positive effects of GVC participation. And, it can be presumed that the level of forward or backward participation may affect the overall performance of GVC participation by individual countries.

Forward participation refers to the ratio of value added to the intermediate goods used in the export of another country in a country's total exports, which is defined as forward partition (Park et al., 2018). In addition, forward participation represents the extent to which a country's exports is used in partner countries as inputs for their own exports (Kowalski et al., 2015), and shows the ratio of domestic value added sent to third economies to the economy's total exports (WTO, n.d.). Forward participation is consistent with the seller's perspective or supply side in GVC participation (TWO, n.d.). Forward participation can be measured by domestic value-added exports which enter other countries' exports as a proportion of global value-added exports in GVC.

Many previous studies have emphasized the positive aspects of forward participation. Kowalski et al. (2015) shows a positive impact of forward participation on Gross Domestic Product (GDP). Tsakanikas et al. (2020) argues that forward participation has a general positive effect on a country's productivity performance. Countries with strong forward participation are headquarters' economies such as the United States and Germany. Kummritz (2016) shows that forward participation in GVC enhances productivity. Urata and Baek (2019) also emphasizes a positive impact of GVC participation on productivity. Specifically, they suggest that a country participating in forward GVC can acquire advanced technology and managerial know-how from its export destinations or partners (Urata and Baek, 2019). Findings of Korwatanasakul et al. (2020) are in line with other studies. They found that GVC participation, both forward or backward enhances the individuals' wages and productivity of labor market. Specifically, countries participating in forward GVC tend to upgrade and shift towards high-skilled labor content. As a result, there is a significant positive impact on individuals' monthly wages (Korwatanasakul et al., 2020).

However, forward participation cannot always be positive in individual countries. Díaz-Mora et al. (2018) discuss the influence of GVC participation on export survival focusing on the differences between advanced and developing countries and concludes that the

developing countries can enhance export performance in GVC forward participation with their advanced destination countries. However, their export survival for forward participation can be negative with developing destination countries (Díaz-Mora et al., 2018). Interestingly, according to Wang and Hou (2007), major resource exporters including Norway, Russia, and Australia tend to have a much higher degree of forward participation than backward participation. Kowalski et al. (2015) also argue that there is a negative relationship between the share of the manufacturing sector in GDP and forward engagement in GVC.

It can be difficult for the developing or under-developed countries to foster sufficient value-added industries with simple resource exports. Also, it is not easy to make manufacturing industries competitive with simple forward participation. This is why some studies discuss a negative impact of forward participation on economic performance. Despite some arguments, individual countries can generally enhance value added and efficiency for its industries through forward participation, which in turn, contribute to the countries' economic performance. Building upon the literature review in GVC participation, we develop the following hypothesis.

H1: There is a positive relationship between GVC forward participation and economic performance.

3.2. GVC Backward Participation and Economic Performance

Backward participation refers to the ratio of foreign value added content of exports to the economy's total gross exports. Backward participation explains the extent to which domestic firms use foreign intermediate value added for exports (Kowalski et al., 2015). It is consistent with the buyer perspective in GVC (WTO, n.d.). According to Hollweg (2019), backward participation represents the buyer's perspective or sourcing side in GVC. In other words, it is considered for an economy importing intermediate goods to produce its exports. Since backward participation shows the proportion of foreign-generated added value in a country's total exports, which is defined as a backward partition (Park et al., 2018), it can be measured by foreign value-added (FVA) content in value-added exports of a country as a proportion of global value-added exports in GVC.

According to Yanikkaya and Altun (2020), either backward or forward participation has a considerable positive impact on growth. Jona-Lasinio and Meliciani (2019) also suggest that backward participation can strengthen productivity returns of global production activity and found a positive and statistically significant productivity impact of backward participation. Similarly, Kummritz (2016) discusses backward participation in GVC as an important driver affecting productivity, and Díaz-Mora et al. (2018) argue that the higher the backward participation, the longer will be the export flows.

Additionally, the benefits of backward participation are getting better for the developing countries. This result is associated with the productivity-enhancing effect of importing intermediate inputs. Moreover, a higher use of technology transfer associated with the imported intermediate inputs can play an important role in bringing forth the benefits (Díaz-Mora et al., 2018). Taguchi and Thet (2021) discuss that the emerging market economies involve intermediate inputs containing foreign technology through backward participation. Therefore, they can enhance the industrial and economic development by facilitating the

combination of foreign technology with their own labor, capital, and technology (Taguchi and Thet, 2021). According to Constantinescu et al. (2017), GVC expansion is contributing to the growth of world productivity; it emphasizes the importance of backward participation in GVC such as the reliance on imported inputs to produce for exports. Kowalski et al. (2015) argue that backward and forward linkages in GVC tend to bring about economic benefits. Countries participating in backward and forward GVC can enhance productivity, sophistication, and diversification of exports even when there is some heterogeneity across income groups. Also, there is a positive relationship between the share of the manufacturing sector in GDP and backward engagement in GVC.

However, there are controversies regarding the impact of backward participation. Hollweg (2019) indicates the challenges of backward participation in terms of employment. The author argues that a higher backward participation has negatively influenced the employment growth in developing countries such as India (Hollweg, 2019). Unlike backward participation, higher forward linkages did not have any significant impact on employment in these countries (Hollweg, 2019). It implicitly implies that the type of GVC involvement (forward and backward participations) varies depending on the level of industrialization. In the early stage of industrialization, countries engage in factory-type activities such as assembly; while, in the later stage technological development and competitive services sector supporting headquarter-type activities can be much more important. Countries in the later stage of industrialization tend to have higher forward involvement, but those in the early stages tend to have higher backward involvement (Kowalski et al., 2015; Lopez-Gonzalez, 2012). These previous studies emphasize that backward participation can strengthen the manufacturing base of individual countries. Additionally, backward participation with industrialized countries enables developing countries to learn advanced technologies and know-how. Based on literature reviews, backward participation generally has a positive impact on individual countries despite a few controversies. Therefore, this study makes the following hypothesis.

H2: There is a positive relationship between GVC backward participation and economic performance.

3.3. Length of GVC Participation and Economic Performance

Due to COVID-19, many companies are trying to manage their GVC activities with the purpose of minimizing risk rather than maximizing efficiency or optimizing cost. Also, the length and variety of GVC activities have become important issues. Shortened and broadened GVC activities have appeared since the pandemic. Length of GVC participation represents the length of time for which the GVC activities are being operated in each industry. Fally (2012) examines an index to measure the number of production stages required to realize a product or provide a service in an industry producing the final products. According to OCED, the index measures the length of GVC in each industry. Ayadi et al. (2020) argue that trade facilitation is a key issue in improving economic connectivity among counties in GVC. There are some barriers to trade facilitation. One of them is the length of procedure. According to Ayadi et al. (2020), the length negatively affects the clearance of intermediate goods. Companies participating in long GVCs can be at high risk. Extensive webs of transactions with local firms and institutions are expected to face various local norms and codes of conduct, something that may create uncertainty.

According to Transaction Cost Economies (TCE) (Williamson, 1975), the bounded rationality is the assumption that decision makers have constraints on their cognitive capabilities and limits on their rationality (Rindfleisch and Heide, 1997). Opportunism is the assumption that decision makers may unscrupulously seek to serve their self-interests (Barney, 1991). Also, the longer the GVC, the more is the participation of companies and institutions. Therefore, the length of GVC participation becomes an opportunism-enhancing influence. The length of participation may increase the level of transaction uncertainty in GVC. Uncertainty can be defined as an unanticipated change in circumstances surrounding an unpredictable or complex environment (Noordewier et al., 1990). According to Hallikas et al. (2002), uncertainty has a considerable influence on searching costs. Uncertainty can give rise to transaction costs relevant to communication, negotiation, and coordination. Additionally, uncertainty can make an estimation of future costs difficult (Cho and Tansuhaj, 2013). In the agricultural and fishery industries, the length of GVC can have a negative impact on performance. According to Sari (2015), lengthy routes can deteriorate the quality of fishery products and increase the risk of contamination, thus, leading to uncertainty of the products. Given the nature of uncertainty, an increase in the level of uncertainty may raise transaction costs. Based on previous studies, the length of GVC participation can negatively affect the overall economic performance.

H3: There is a negative relationship between the length of GVC participation and economic performance.

3.4. Lack of GVC Participation Diversity and Economic Performance

About 70% of the international trade involve exchange of raw materials, parts, and components that are used by firms to produce goods within GVCs. More than 30% of the world's production are done by MNEs and they account for half of the world's trade (OECD, n.d.). GVC has brought many benefits in terms of producing goods and accessing resources efficiently. Moreover, GVC can create new markets beyond the domestic economy. Many countries and companies are interdependent and interconnected with each other due to the GVC. However, such market circumstances are becoming a double-edged sword during the COVID-19 pandemic. During the pandemic, restrictions in international trade and transportation have led to disruptions in GVC in many industries and countries. New and different economic vulnerabilities were created during the pandemic.

Various risks involved in GVC activities. We can classify the risks depending on the source of uncertainty. According to Tang (2006), there are two risks: operational and disruption related risks. Operational risk is rooted in the intrinsic uncertainties of supply chain (i.e., transportation times and costs, uncertainty in supply, and demand) and disruption risks is an uncontrollable and unpredictable event relevant to supply chain (i.e., earthquakes, floods, and war) (Govindan et al., 2017). Therefore, it is necessary for firms using GVC to distribute the risks through participation diversity. According to Verbeke (2020), diversity is a critical factor to overcome a global crisis in terms of GVC. Leading companies in GVC will be able to reduce the possible ravaging effects of a future crisis through higher product and industry diversification (Verbeke, 2020). GVC activities are highly clustered and there are three manufacturing hubs: Germany, China, and the United States (Baldwin and Lopez-Gonzalez, 2013; Kowalski et al., 2015). Among them, China is the world largest hub for GVCs.

China's economic miracle was fueled by industry and investment within GVCs. Most MNEs and countries engage in GVC activities in China. According to Li et al. (2019), China has been a supply and demand hub in traditional trade and simple GVC networks. Most MNEs are using China as a production country or consumption market. Due to the important role of China, countries and industries that were closely related to China suffered significant damage during the COVID-19 pandemic. The closure of factories in China at the end of January 2020 drew attention to the issue of negative impact on industries and countries that are heavily exposed to a single country in relation to GVC.

TCE provides a theoretical foundation to explain how lack of participation diversity in GVC can be negative. TCE introduced by Coase (1937) has emphasized the efficiency of boundary between the firms and markets. Additionally, TCE posits that minimizing transaction costs is central to the study of firms (Williamson, 1975). In other words, TCE posits that firms prefer to conduct their business in a way that minimizes costs relevant to transaction uncertainty or risk (Cho and Tansuhaj, 2013). In GVC, the higher the diversity of participation, the lower the degree of uncertainty. Therefore, lack of GVC participation diversity may cause a rise in transaction costs.

In sum, problems with rigid GVC activities concentrated in certain countries are being raised. The variety of participation in GVC can also affect the overall economic performance of a country. According to theoretical foundations and literature reviews, a lack of GVC participation diversity may have a negative effect on economic competeness. Additionally, the effect can be worse under a worldwide crisis such as COVID-19. In this regard, we suggest the following hypothesis.

H4: There is a negative relationship between the lack of GVC participation diversity and economic performance.

4. Role of Transportation in Economic Performance

4.1. Transport Infrastructure and Economic Performance

International trade has expanded with globalization and trading barriers decreased. Particularly, transport development relevant to the 4th Industrial Revolution such as autonomous vehicle and smart port is leading to increased international trade and economic growth of individual countries. With the development of intermodal transportation, infrastructure connecting different modes has become important. Maparu and Mazumder (2017) argue that development of transport infrastructure can play a major role in promoting the economic development and urbanization in a region. According to Mačiulis et al. (2009), individual countries can expand transport capacity, increase efficiency, and enhance reliability or service quality with increased investment in infrastructure. As a result, the advanced transport infrastructure can lower the transport cost and transit time leading to logistics competitiveness (Mačiulis et al., 2009).

Lakshmanan (2011) discusses cost savings of transport infrastructure investments. The article emphasizes distance reduction through less circuity and expanded transport network capacity, and suggests that transport infrastructure investments can enhance productivity of individual firms. According to the meta-analysis conducted by Melo et al. (2013), produc-

tivity effect of transport infrastructure can be different depending on countries and industries. For example, the positive effect tends to be higher for the U.S than European countries. In addition, it is higher for roads rather than other modes of transportation (Melo et al., 2013).

The role of transport infrastructure can be theoretically explained by Resource-Based View (RBV), which argues that idiosyncratic resources create superior market position and comparative advantage (Barney, 1991; Hunt and Morgan, 1995). Assets, capabilities, information, knowledge, organizational attributes, and organizational processes are typical resources included in physical, human, or organizational capital (Cho and Yang, 2011). Also, they are classified in terms of tangible and intangible resources. According to RBV, intangible resources such as human and organizational capital can be more important. It is difficult for the competitors to imitate and acquire intangible resources. Based on the theoretical foundation, transport infrastructure in terms of value, uniqueness, inimitability, durability, and non-substitutability can be a intangible resource, which plays an important role for individual countries in sustaining comparative advantage and enhancing economic performance (Cho et al., 2018).

However, there are some controversies regarding whether transport infrastructure enhances economic development or economic development leads to investment in transport infrastructure. Maparu and Mazumder (2017) argue that economic development may lead to the development of transport infrastructure. Despite this argument, there is enough evidence to support the positive role of transport infrastructure in enhancing economic performance in previous studies (Melo et al., 2013). Therefore, we propose the following hypothesis.

H5: There is a positive relationship between transport infrastructure and economic performance.

4.2. Large Scale of Marine Transportation and Economic Performance

Logistics industry faces many difficulties due to high competition and global recession. Large scale transportation has been an important area for enhancing competitiveness. Most previous studies agree with the opportunities that large scale transportation offers (e.g., Kim and Park, 2009). However, there are various accompanying challenges. Large-scale transportation has been considered to enhance logistics competitiveness. It is closely associated with the traditional wisdom of 'economy of scale'. Previous studies have emphasized the importance of the economy of scale and larger transportation in enhancing economic performance. They have discussed the positive impact of large scale on competitiveness (Kim and Park, 2009; Park, 2011).

However, there are some challenges behind larger transportation (Cho and Lee, 2020). Controversies are occurring in aspects such as efficiency, customer satisfaction, infrastructure, and so on. The large scale of seaborne transportation is a double-edged sword with both, positive and negative aspects. We shed light on how the large scale of seaborne transportation can negatively affect economic performance. Currently, more than 20,000 TEUs of ships are operated for marine transportation. Marine transportation has achieved a revolutionary success in terms of the large scale; however, there are some challenges relating to lack of demand and infrastructure. Ultra Large Container Vessels (ULCVs) may cause additional costs relating to port infrastructure, dredging, and hinterland. Next-generation container

ships might be less effective than previous large-sized ships. Moreover, supply chain risk can be worse due to supersized container ships (Cho and Lee, 2020). Another challenge of mega container ships is a market downturn due to the oversupply and high competition.

According to literature in marine transportation, maximizing mega container ships can decrease cost efficiency. Cost reduction of next-generation container ships can be worse compared to that of previous mega container ships. According to the OECD/ITF (OECD, 2017), cost savings are decreasing as ships become bigger. Specifically, the newest generation of container ships are four to six times smaller than the previous ones (OECD/IFT, 2017). According to Jansson and Shneerson (1982), there is an inverse relationship between ship size and freight, but other related costs may increase proportionally with ship size. Three large cost categories of the container shipping industry including capital, operation, and voyage costs can respond differently to changes in vessel size. In sum, the large scale of marine transportation cannot always be positive.

H6: There is a negative relationship between large-scale marine transportation and economic performance.

4.3. Large Scale Air Transportation and Economic Performance

Supply and demand of airfreight is rapidly growing worldwide with small and high value added cargo. Economy of scale and large scale have been crucial issues in air transportation. According to previous studies, larger airborne transportation plays an important role in increasing cargo traffics and achieving economy of scale. In the market, Boeing B747 and Airbus A380 airplanes have driven the aircraft size. Airfreights are flying worldwide through cargo-only aircraft (freighters) and passenger aircraft (belly freight) (Cho and Lee, 2020).

Most researchers emphasize opportunities of large scale air transportation. However, there are controversies in large scale of air transportation. A380 of Airbus is a large-scale aircraft, but it has been in severe difficulties recently with poor sales volume and operating profit. It had only two orders in 2015, no order in 2016 and two cancelations in 2017. As a result, on February 14, 2019, Airbus (2022) officially announced that it would suspend production of A380 from 2021.

Moreover, there are some other challenges in terms of large-scale air transportation. Flagship airlines in Korea such as the Korean Air and Asiana Airlines are under a heavy burden due to fuel cost inefficiency related to its A380 operations (Kim, 2016). Also, the market circumstances are not positive. COVID-19 and trade conflicts are lowering the status of large aircrafts. In other words, worldwide pandemic, protectionism, and trade wars are worsening the crisis of large-scale air transportation. Previous studies argue in favor of a positive impact of mega aircrafts on better performance due to economy of scale. However, this study aims at investigating the challenges of large scale airborne transportations. In this regard, we suggest the following hypothesis.

H7: There is a negative relationship between large-scale air transportation and economic performance.

5. Impact of COVID-19 on GVC, Transportation and Economic Performance

5.1. Government Response to COVID-19 and GVC

The paradigm for participating in GVC is constantly changing. This change is accelerating with the recent COVID-19. The impact of COVID-19 on GVC began in China which occupies an important position as a supply and demand hub in international trade and GVC networks (Li et al., 2019). In particular, Wuhan, a Chinese city of eleven million people, is playing a significant role in global GVC. More than 200 of the Fortune Global 500 companies are doing business in Wuhan (Twinn et al., 2020).

GVC has various opportunities as well as challenges in regard to international production and logistics; COVID-19 has reignited the controversies. According to OCED, the pandemic has highlighted both the costs and benefits of GVC. On the one hand, international production networks based on GVC were disrupted by COVID-19. The collapse could cause the propagation of economic shocks across countries and industries. On the other hand, at the same time, countries and industries could recover faster due to the well-networked GVC (OECD, n.d.).

There have been some very critical global crises in the past few decades. The 2008 global financial crisis and COVID-19 are the two major crises. The 2008 global financial crisis heightened market fluctuation and uncertainty as the current COVID-19 is doing now. According to Li et al. (2019), the global financial crisis had a dramatic, negative impact on GVC participation for all countries around the world. Before the crisis, GVC participation had been increased by 4.3% every year since 2000. GVC participation was declined by 14.9% in 2009, but it has recovered since 2010 (Li et al., 2019). Therefore, we may expect COVID-19 to have a significant negative impact on various activities relevant to GVC as the global financial crisis did.

GVC participation can be relevant to a country's policy. For example, backward participation is involved in imports into the country levying the tariff. Moreover, trade policy may also have an impact on regional integrations that are highly relevant to GVC participation (Kowalski et al., 2015). Individual countries used various types and levels of measures during COVID-19. Most of them responded to the pandemic by designating ports, shipping, and trucking services as essential. Essential services were exempt from the lockdown measures (Twinn et al., 2020). Nevertheless, lockdown measures were extensively used to tackle COVID-19.

The negative impact of COVID-19 on GVC may vary depending on the government's response to the pandemic. According to Kowalski et al. (2015), quality of institutions is strongly associated with GVC activities. Government policy is a representative institutional factor and its response to COVID-19 can make impact a country's performance regarding to GVC. Government's stringent restrictions over private areas have many negative effects on exchanges and interactions among people, firms, and even countries. In sum, government's stringent response to the pandemic can negatively moderate the relationships between various activities of GVC and economic performance. Therefore, this study hypothesizes moderating effects as follows.

H8: Government stringency negatively moderates the relationship between GVC forward

participation and economic performance during COVID-19 pandemic such that GVC forward participation is less positively related with economic performance.

H9: Government stringency negatively moderates the relationship between GVC backward participation and economic performance during COVID-19 pandemic such that GVC backward participation is less positively related with economic performance.

H10: Government stringency negatively moderates the relationship between the length of GVC participation and economic performance during COVID-19 pandemic such that the length of GVC participation is more negatively related with economic performance.

H11: Government stringency negatively moderates the relationship between a lack of participation diversity and economic performance during COVID-19 pandemic such that a lack of GVC participation diversity is more negatively related with economic performance.

5.2. Government Response to COVID-19 and Transportation

COVID-19 has a tremendous impact on most countries and industries around the world. It is no exaggeration to say that our life is divided between before and after the pandemic period. International trade is a comprehensive concept that encompasses a wide range of areas such as manufacturing, logistics, marketing, and so on. Logistics is a means of realizing international trade which has developed through international trade.

As a part of logistics, transportation facilitates trade and helps MNEs get their products to customers. International transportation, which is involved in the movement and storage of goods across borders, has been directly affected by COVID-19. In particular, GVC including international transportation was disrupted by the pandemic. In early 2020, due to COVID-19, the shortage of components from China impacted manufacturing operations around the world. Production of automotives, electronics, pharmaceuticals, medical equipments and supplies, and other consumer goods were affected due to the shortage from China (Twinn et al., 2020). This shows how GVC can be seriously disrupted by a global market fluctuation like COVID-19.

Risk management has been a crucial aspect of logistics. At this time when the world is suffering from COVID-19, the risk management in logistics has become very important. Choi (2021) investigates risk management in logistics during COVID-19. Many cities saw complete lockdown and obstructed transportations due to the pandemic as COVID-19 spreads quickly and the infection rate was very high among workers relevant to logistics (Choi, 2021). Countries are pursuing measures to ensure and secure health and safety. These measures have impacted international trade, investment, and logistics. In addition, these policies also impacted on country performance relevant to activities of logistics.

The policy of stringent restrictions may have many negative effects on international transportation. In addition, the negative effects of COVID-19 related to transportation may vary depending on the type and extent of government response. In sum, the relationship between transportation and economic performance can be worsened by government's stringently response to COVID-19. Therefore, this study hypothesizes the moderating effects as follows.

H12: Government stringency negatively moderates the relationship between transport infrastructure and economic performance during COVID-19 pandemic such that transport infrastructure is less positively related with economic performance.

H13: Government stringency negatively moderates the relationship between large-scale marine transportation and economic performance during COVID-19 pandemic such that large-scale marine transportation is more negatively related with economic performance.

H14: Government stringency negatively moderates the relationship between large-scale air transportation and economic performance during COVID-19 pandemic such that large-scale air transportation is more negatively related with economic performance.

6. Methodology

6.1. Data Samples

This study aims to investigate the relationships between GVC- and transportation-related determinants and economic performance. In addition, moderating effects of COVID-19 on the relationships are theoretically suggested and empirically tested with data obtained from various sources. Unlike previous literature which emphasize only on GVC participation, this study analyzes various GVC paradigm relevant to COVID-19 such as the length of participation and lack of participation diversity. In addition, unlike prior studies which only emphasize on the economy of scale, this study discusses large-scale transportation using a relatively new perspective.

The sample of this study includes 828 observations from 138 countries from Africa, Asia, Australia / New Zealand, Europe, and North / South America. It is a semi-panel data set in that six-year observations for each country are used to empirically test the hypotheses. The data was retrieved from World Development Indicators (WDI) database of the World Bank, International Transport Forum (ITF) statistics of OECD, Eora Global Value Chain Database of UNCTAD, UNCTAD stat of UNCTAD, trade data of Trend Economy, and Coronavirus pandemic data of Our World in Data.

6.2. Measures

Economic performance. There are different measurements for economic performance. GDP indicates the level of development and economic potential, while GVC represents a dispersion of production processes among different countries (Kersan-Škabić, 2019). Therefore, GDP can be an important indicator to show economic performance relevant to forward participation. To be consistent to our research purpose, we use GDP to measure economic performance of an individual country. GDP was retrieved from WDI database of the World Bank.

GVC forward participation. GVC participation is the use of foreign intermediates and integration into international production networks (Jouanjean et al., 2017). GVC participation is considered the most widely used indicator to measure the decentralization of the production process among different countries. There are various aspects of GVC participation. One of them is forward participation which refers to the ratio of value added to

the intermediate goods used in the export of another country in a country's total exports, which is defined as forward partitioning (Park et al., 2018). Forward participation is measured by domestic value-added exports, which enter other countries' exports as a proportion of global value-added exports in GVC.

GVC backward participation. GVC backward participation is measured by foreign value-added (FVA) content in value-added exports of a country as a proportion of global value-added exports in GVC. Backward participation represents the proportion of foreign-generated added value in a country's total exports, which is defined as a backward partition (Park et al., 2018). GVC overall, forward and backward participations are retrieved from Eora Global Value Chain Database of UNCTAD.

Length of GVC participation. Following Fally (2012), the length of participation is measured as the number of production stages required to realize a product or provide a service in a given final-good industry. De Backer and Miroudot (2013) state that the index can be used to reflect domestic production stages and foreign production stages. The data is retrieved from the OECD Global Value Chains indicators.

Lack of GVC participation diversity. According to related statistics, almost all sectors around the world are exposed to China's GVC. China accounts for more than 20 percent of global consumption in 17 out of 20 categories in manufacturing (Woetzel et al., 2019). In other words, China is a center of global GVC. Based on statistics of the World Bank and Trend Economy, we calculate how individual countries are dependent on or exposed to China in terms of export and import. In contrast, China is highly dependent on the US in terms of trading volumes and prices. Therefore, through the process, we can indirectly measure the GVC participation diversity in a given country.

Transportation infrastructure. The other three independent variables are related to transportation aspects. Transportation infrastructure represents investment, maintenance spending, and capital value of transport infrastructure in individual countries. The index is collected from the ITF statistics of OECD with an annual basis from its member countries.

Large scale marine transportation. Large-scale marine transportation can be measured by merchant fleet of beneficial ownership and container traffics in individual countries. In this measure, beneficial ownership represents the economy in which the company that has the main commercial responsibility for the vessel is located. In addition, the economy of beneficial ownership may be different from the country in which the vessel is registered (UNCTAD, 2020). Container traffics measures the flow of containers from the land to sea transport modes and vice versa in twenty-foot equivalent units (TEUs).[1] It is difficult to identify the accurate number of all cargo vessels in a country and the volume of cargo traffic handled by the cargo vessels. As an alternative, we use the number of merchant fleet and container traffic in a country. Thus, we can indirectly estimate the volume of container traffics per unit vessel. Through the process, we measure the large scale of marine transportation in a country. The data is retrieved from the UNCTAD stat and WDI database of the World Bank.

Large scale air transportation. Worldwide registered carrier departures and airfreight are used to quantify the large-scale air transportation. We had some difficulties in measuring the accurate number of all cargo flights in a country and the volume of cargo traffic handled by the flights. As an alternative, we measure the number of registered carrier departures world-

---

[1] Data available from https://databank.worldbank.org/source/world-development-indicators

wide and airfreight in individual countries. The number represents the total scheduled traffic carried by the air carriers registered in a country. Airfreight is the volume of freight carried. In practice, air cargo is being transported by airliners (belly cargos) and cargo flights. Therefore, through the process, we indirectly measure and utilize the volume of airfreight per unit flight. The data is retrieved from the WDI database of the World Bank.

Stringency to COVID-19 pandemic. We use government response stringency to COVID-19 as a moderator. The variable is useful to better understand the nature of moderating effects of government stringency on the relationship between GVC- and transportation-related determinants and economic performance during the pandemic. There are various stringent restrictions including school closures, workplace closures, cancellation of public events, restrictions on public gatherings, closures of public transport, stay-at-home requirements, public information campaigns, restrictions on internal movements, and international travel controls. Such measures are used to quantify governments' stringently response to COVID-19. Oxford's public policy school, the Blavatnik School of Government, calculates a composite measure of nine of the response metrics called the Government Stringency Index.[2]

6.3. Results

To test hypotheses, we conducted the two-way cluster model and also applied the Hausman specification test to choose an appropriate model (Johnston and DiNardo, 1997). According to the chi-square p-value of the Hausman test, a random-effect model tends to be more appropriate rather than a fixed-effect model. Relationships among variables were analyzed by using the STATA statistical software. Variables with large values, such as GDP, GVC forward and backward participations, large-scale marine and air transportations were log-transformed. In addition, we applied the centering method to reduce the problem of multicollinearity between variables (Gujarati, 2003).

Table 1 shows the correlation matrix for all variables. The direction of the relationships among variables are generally consistent with the proposed hypotheses. Both forward and backward participations partitions originate in GVC participation; thus, forward participation is highly correlated with backward participations. Given that the key topic of this study is to compare between forward participation and backward participation, a high correlation between two variables seems to be inevitable. In addition, economic performance is highly correlated with transport infrastructure. The average of the variance inflation factor (VIF) is 3.53, which is relatively lower than the threshold. VIFs of all variables are also below 10. The result indicates that multicollinearity is not problematic (Myers, 1990).

Table 2 represents the results of two-way clustered regression analysis. Model 1 shows the coefficients of control variables (i.e., seaborne trade and airborne trade). According to previous studies, there is a correlation between economic performance and international trade at the cross-country level (Alcalá and Ciccone 2004; Frankel and Romer, 1999). For example, Korea has a high dependence on trade. More than 90% of its GDP comes from trade (Cho and Lee, 2020). Important border crossings for international trade are seaports and airports. In recent years, airborne trade has become more important with the increase in the numbers of high-value imported and exported products (i.e., semiconductors and information technology products) (Cho and Lee, 2020). The directions of the relationships between the control and the dependent variable are generally consistent with previous studies.

---

[2] Data available from https://ourworldindata.org/grapher/covid-stringency-index

Coefficients of seaborne trade (β=0.509, p<0.01) and airborne trade (β=0.035, p<0.01) are positive and statistically significant. It indicates that seaborne trade can be more critical in achieving high economic performance in individual countries.

Model 2 represents the relationships between GVC- and transportation-related independent variables and economic performance. Based on literature reviews, we hypothesized the positive impacts of forward participation (H1) and backward participation (H2) on economic performance. The results of Model 2 show that forward and backward participations can play important roles in improving economic performance. Coefficients of forward participation (β=0.391, p<0.05) and backward participation (β=0.077, p<0.05) are positive and statistically significant, which support H1 and H2. It is also found that forward participation rather than backward participation can be more critical in enhancing economic performance. As discussed before, there are some challenges of GVC backward participation regarding employment (Hollweg, 2019). Many developing and under-developed countries are engaged in higher backward involvement. However, most industrialized countries tend to have higher forward involvement (Kowalski et al., 2015; Lopez-Gonzalez, 2012). In sum, forward participation is more important than backward participation in terms of increasing value-added in a given industry. The empirical findings are consistent with the arguments.

In addition, negative influences of the length of participation (H3) and lack of participation diversity (H4) in terms of economic performance were hypothesized, but these hypotheses are not supported. The coefficient for the length of participation in Model 2 (β=0.232) is positive that may represent a positive role to enhance economic performance, but the coefficient is not statistically significant. In addition, the coefficient for lack of participation diversity (β=0.038) is positive but not statistically significant. H5 proposes a positive relationship between transport infrastructure and economic performance. The coefficient (β=0.106, p<0.05) is positive and statistically significant, which supports H5.

H6 and H7 suggest the negative impacts of large-scale marine and air transportations on economic performance. Unlike the previous studies, we theoretically discuss how the large-scale of marine and air transportations can lead to challenges instead of the typical beneficial effects. Both coefficients of large-scale marine transportation (β=-0.267, p<0.01) and air transportation (β=-0.469, p<0.01) are negative and statistically significant. Therefore, consistent with H6 and H7, we can conclude that there are negative relationships between large transportation size and economic performance. In addition, the result shows that large-scale air transportation can be much worse than that of marine transportation with respect to performance.

Model 3-9 test the moderating effects of government stringency, and Model 10 is a full model with all variables. This study examined government stringency due to COVID-19 as a moderator. The variable is useful to understand the nature of moderating effects of government response on the relationships between GVC- and transportation- related determinants and economic performance during the pandemic. Unlike H8, the coefficient of interaction term (β=0.305, p<0.01) in Model 3 is positive and significant, providing the relationship between GVC forward participation and economic performance can be improved by the stricter government response to COVID-19. A possible interpretation of such unexpected result could be that countries with strong forward participation are industrialized countries, which are more likely to successfully cope with COVID-19. In other words, a negative impact of government stringency to COVID-19 is not critical for countries with high forward participation.

The moderating effect relevant to backward participation (H9) is supported. The coefficient of interaction term in Model 4 (β=-0.274, p<0.01) is negative and statistically significant. The coefficients in Model 5 and 6 are not statistically significant. Therefore, H10 and H11 about the negative moderating effect of government stringency on the relationship between length of GVC participation, lack of GVC participation diversity and economic development are not supported.

H12 proposes the relationship between transport infrastructure and economic performance can be negatively moderated by the government stringency during the pandemic. The coefficient of interaction term (β=-0.064, p<0.05) in Model 7 is negative and significant, which supports H12. However, the negative moderating effects for large-scale marine and air transportations suggested in H13 and H14 are not supported in that the coefficients of interaction terms in Model 8 and 9 are not statistically significant.

To better understand the nature of moderating effects, we plot the economic performance by varying the level of forward participation, backward participation, transport infrastructure, and the level of government stringency to COVID-19 in Fig. 2. Specifically, as expected, the positive relationships between backward participation, transport infrastructure and economic performance are negatively moderated by the of government stringency to COVID-19. However, as the stringency increases, the positive relationship between forward participation and economic performance became stronger.

Table 1. Correlation Matrix

	-1	-2	-3	-4	-5	-6	-7	-8
1. Economic performance	-1							
2. Forward participation	-0.001	-1						
3. Backward participation	-0.012	-0.809***	-1					
4. Length of participation	-0.028	-0.039	-0.012***	*1				
5. Lack of participation diversity	-0.330***	-0.037	-0.031	-0.093***	-1			
6. Transport infrastructure	-0.661***	-0.001	-0.004	-0.056	-0.101***	-1		
7. Large scale marine transportation	-0.090**	-0.039	-0.013	-0.257***	-0.036	-0.282***	-1	
8. Large scale air transportation	-0.417***	-0.019	-0.028	-0.074	-0.145***	-0.455***	-0.046***	1

Note: *p < 0.1, **p < 0.05, ***p < 0.01.

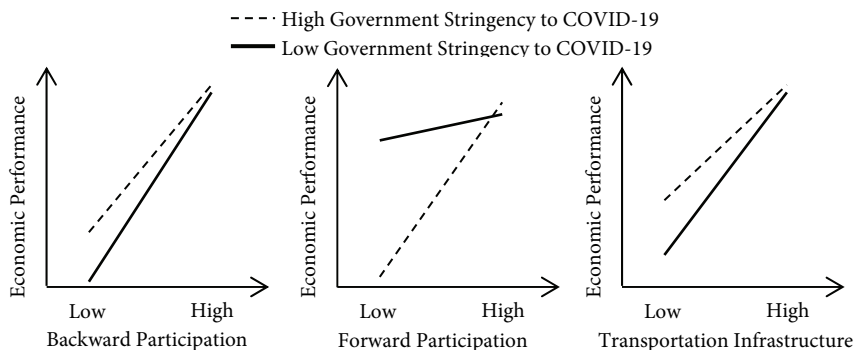**Fig. 2.** Moderating Effects of Government Stringency to COVID-19

Table 2. Results of the Two-Way Clustered Regression Analysis

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
Seaborne trade	-0.510***	-0.367***	-0.405***	-0.402***	-0.404***	-0.402***	-0.402***	-0.401***	-0.404***	-0.356***
Airborne trade	-0.035***	-0.451***	-0.409***	-0.419***	-0.409***	-0.410***	-0.408***	-0.418***	-0.414***	-0.436***
Forward participation		-0.391**	-0.451	-1.717**	-0.590	-0.682	-0.532	-0.690	-0.829	-0.997
Backward participation		-0.077**	-0.312**	-1.422**	-0.114	-0.130	-0.103	-0.132	-0.157	-0.881
Length of participation		-0.232	-0.588	-0.569	-0.649	-0.629	-0.788*	-0.662	-0.594	-1.433
Lack of participation diversity		-0.038	-0.055	-0.059	-0.095*	-0.063	-0.097*	-0.092*	-0.096	-0.051
Transport infrastructure		-0.106**	-0.255***	-0.259***	-0.243***	-0.210**	-0.421***	-0.242***	-0.232**	-0.411***
Large scale marine transportation		-0.267***	-0.110	-0.111	-0.136*	-0.138**	-0.135*	-0.158	-0.134*	-0.144
Large scale air transportation		-0.469***	-0.061	-0.049	-0.027	-0.016	-0.012	-0.019	-0.033	-0.010
Government stringency due to COVID-19 pandemic			-0.247**	-0.341**	-0.057***	-0.040**	-0.087***	-0.042**	-0.029	-0.176
Forward participation X Government stringency			-0.305***							-0.091
Backward participation X Government stringency				-0.274**						-0.156
Length of participation X Government stringency					-0.340					-0.560**
Lack of Participation diversity X Government stringency						-0.011				-0.008
Transportation infrastructure X Government stringency							-0.064**			-0.073**
Large scale maritime transportation X Government stringency								-0.004		-0.010
Large scale air transportation X Government stringency									-0.016	-0.017
Constant	-0.094	-0.109	-0.717	-1.695*	-0.729	-0.708	-0.718	-0.685	-0.575	-0.578
R2	-0.689	-0.882	-0.404	-0.404	-0.409	-0.401	-0.403	-0.401	-0.404	-0.420

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

7. Discussion and conclusion

Most previous studies agree to a positive impact of GVC participation on performance, irrespective of many controversies. In line with the arguments of GVC participation, large-scale transportation in logistics industry has been an important issue in terms of economy of scale and competitiveness. However, these relationships may not hold in the context of collapse of GVC during the COVID 19. For example, suppliers facing significant barriers within GVC (i.e. small size, poorer industry position) cannot always take benefits from GVC participation, and it may depends on the extent of their managerial agency and ability to leverage multiple upgrading and downgrading trajectories (Choksy and Sinkovics, 2017).

Unlike the typical benefits, this study emphasizes challenges of GVC participation and transportation. Specifically, we suggest that GVC participation and transportation could affect economic performance in different way because of challenges derived from a particular circumstance. Since late 2019, we have suffered from aspects of politics, economy, culture, and society due to the spread of COVID-19. The pandemic is causing the collapse of GVC and logistics in many countries and industries. In sum, this study aims to show how GVC participation and transportation can be severely affected by a pandemic.

According to the empirical results, GVC forward and backward participations play an important role. It is confirmed that forward participation contributes more than backward participation in terms of economic performance. However, the impact of GVC participation length and lack of participation diversity are not empirically confirmed. In logistics industry, transport infrastructure is critical, but large scales of marine and air transportations can be negative in regard to performance. In addition, stricter government response to COVID-19 negatively moderates economic performance by backward participation and transport infrastructure. Unlike our hypothesis, the stricter government response may positively moderate the relationship between GVC forward participation and economic performance.

One of key theoretical contributions of our study is to provide a new insightful perspective to the existing literature. The previous studies in GVC participation and transportation have mainly paid attention to the benefits side for economic performance. This approach is truly accepted as the world has become one big huge market through globalization. However, a limitation of previous studies is their over-reliance on positive impacts. That is, over reliance on opportunities and benefits could limit a new theoretical approach in understanding the real phenomenon in particular context. Our research addresses this theoretical gap by delineating the challenges in case of a market fluctuation such as COVID-19. The empirical results confirm that not all dimensions of GVC and logistics contribute to the economic development and that government stringency due to COVID-19 may bring about a contrary effect.

Practical implication to policy makers and authorities can be another contribution. Policy makers tend to push for greater integration in GVC. However, during the pandemic, the pursuit of the greater GVC participation is not viable option, and even, it may not lead to better economic performance and competitive advantage as expected. For example, Korea is highly dependent on intermediate goods made in China due to its industrial structure. To overcome the challenge from the collapse of GVC between China and Korea, it is recommended to strengthen the backward integration of GVC though linkages with third countries. Managers in Korean firms may pursue near-shoring and reshoring with strategic purpose in order to reduce their high reliance on a single country. Although we could not

find support for the importance of participation diversity, risk management by diversifying their global networks and operations would be more important than efficiency and cost saving.

In terms of logistics, the negative effects of large-scale transportation also provide meaningful implication. Market downturn from oversupply and high competition ruins the benefits of large-scale transportation and increase the cost of mega ships and aircraft. Thus, firms in shipbuilding and aircraft manufacturing industries should utilize both strategic and operational flexibility to respond to the change in demand and supply side. In doing so, it is necessary for managers to consider new trends including but not limited to small- and medium-scale transportation, fuel efficiency, environmental-friendly technology, flexible fleet composition, trade barriers and facilitators, and so on. More importantly, firms need to develop a dynamic ability (Teece, Pisano, Shuen, 1997) to respond to the collapse of GVC due to the pandemic.

From the government perspective, of course, health and safety is the most important during the pandemic, but our result shows that the government stringency to the COVID-19 leads to the collapse of GVC, which has detrimental impact on economic performance. It implies that policy maker should learn from experience in order to prepare for the future. Beyond a dichotomous decision between 'to lockdown' or 'not to lockdown', the government need to scrutinize the potential impact of the government stringency on GVC, logistics, economy, firms, people, and the world.

This study also has some limitations despite its contributions. First, we could not identify all determinants of GVC and logistics in terms of economic performance. It is suggested for future research to identify the comprehensive determinants and effects. Second, this study could not represent precise moderating effects of COVID-19. Our measure may not fully reflect the overall influence from COVID-19 concerning GVC participation and large-scale transportation, because the pandemic is still progressing. It is necessary to estimate the moderating effects numerically using time series data. Third, our measure of lack of GVG participation diversity is based on a country's reliance on China. Since each country has developed its unique trajectory in GVC participation, it would be worth for future research to investigate the impact of diversity by reflecting such distinction. Last, combining country- and industry-level data to investigate GVC participation and logistics industry is an interesting topic for future research. Overall, we hope that this research encourages further theoretical and empirical studies on various aspects of GVC, logistics and market fluctuation.

References

Airbus (2022), *Orders and Deliveries.* Available from https://www.airbus.com/aircraft/market/orders-deliveries.html (accessed November 20, 2020)

Alcalá, F. and A. Ciccone (2004), "Trade and productivity", *The Quarterly Journal of Economics*, 119(2), 613-646.

Apple (2022), 2022 Annual report (10-K). Available from investor.apple.com/ (accessed April 24, 2023)

Ayadi, R., G. Giovannetti, E. Marvasi and C. Zaki (2020), *Global value chains and the productivity of firms in MENA countries: Does connectivity matter?* (EMNES Working Paper 28). Available from https://www.emnes.org

Baldwin, R. and J. Lopez-Gonzalez (2013), *Supply-chain trade: A portrait of global patterns*

and several testable hypotheses (NBER Working Paper 18957), National Bureau of Economic Research, Inc., Available from http://www.nber.org/papers/w18957

Barney, J. B. (1991), "Firm resources and sustained competitive advantage". *Journal of Management*, 17, 99-120.

Buckley, P. J. (2009), "Internalization thinking: From the multinational enterprise to the global factory", *International Business Review*, 18(3), 224–235.

Cho, Hyuk-Soo and Jung-Sun Lee (2020), "Does transportation size matter for competitiveness in the logistics industry: The cases of maritime and air transportation", *The Asian Journal of Shipping and Logistics*, 36(4), 214-223.

Cho, Hyuk-Soo., Jung-Sun Lee and Hee-Cheol Moon (2018), "Maritime Risk in Seaport Operation: A Cross-Country Empirical Analysis with Theoretical Foundations", *The Asian Journal of Shipping and Logistics*, 34(3), 245-252.

Cho, Hyuk-Soo and S. P. Tansuhaj (2013), "Becoming a global SME: determinants of SMEs' decision to use e-intermediaries in export marketing", *Thunderbird International Business Review*, 55(5), 513-530.

Cho, Hyuk-Soo and Kun-Woo Yang (2011), "Identifying country environments to increase container traffic volumes", *The Asian Journal of Shipping and Logistics*, 27(1), 205-223.

Choi, Jung-Eun (2014), "Expansion of GVC and change of trade pattern", *International Economy Review*, 2014-13, 1-13.

Choi, T-M (2021), "Risk analysis in logistics systems: A research agenda during and after the COVID-19 pandemic", *Transportation Research Part E: Logistics and Transportation Review*, 145, 102190.

Choksy, U. S. and N. Sinkovics (2017), "Exploring the relationship between upgrading and capturing profits from GVC participation for disadvantaged suppliers in developing countries", *Canadian Journal of Administrative Sciences*, 34(4), 356-386.

Coase, R. H. (1937), "The nature of the firm", *Economica*, 4, 386-405.

Constantinescu, I. C., A. Mattoo and M. Rut (2017), "Does vertical specialization increase productivity?", *The World Economy,* 42(8), 2385-2402.

De Backer, K. and N. Yamano (2007), *The measurement of globalisation using international input-output tables* (*STI Working Paper* 2007/8). Available from https://www.oecd-ilibrary.org/the-measurement-of-globalisation-using-international-imput-outpout-tables_5kzmzzhdh2g0.pdf?itemId=
%2Fcontent%2Fpaper%2F242020221356&mimeType=pdf

De Backeri, K. and S. Miroudoti (2013), *Mapping global value chains* (OECD Trade Policy Paper 159). Available from https://doi.org/10.1787/5k3v1trgnbr4-en

Demertzis, M. and G. Masllorens (2020), "The cost of coronavirus in terms of interrupted global value chains", *Bruegel Blog Post*. Available from https://www.bruegel.org/2020/03/the-cost-of-coronavirus-in-terms-of-interrupted-global-value-chains/ (accessed September 14, 2022)

Díaz-Mora, C., R. Gandoy and B. Gonzalez-Diaz (2018), "Strengthening the stability of exports through GVC participation: The who and how matters", *Journal of Economic Studies*, 45(3), 610-637.

Fally, T. (2012), *On the fragmentation of production in the US*, University of Colorado.

Frankel, J. A. and D. H. Romer (1999), "Does trade cause growth?", *American Economic Review*, 89(3), 379-399.

Gereffi, G. (2014), "Global value chains in a post-Washington Consensus world", *Review of International Political Economy*, 21(1), 9-37.

Govindan, K., M. Fattahi and E. Keyvanshokooh (2017), "Supply chain network design under uncertainty: A comprehensive review and future research directions", *European Journal of*

44

Operational Research, 263, 108-141.

Gujarati, D. N. (2003), *Basic Econometrics*, 4th ed, McGraw-Hill.

Hallikas, J., V-M. Virolainen and M. Tuominen (2002), "Understanding uncertainty and risk in supplier networks: A transaction cost approach", *International Journal of Production Research*, 40(15), 3519-3531.

Hollweg, C. H. (2019), "Global value chains and employment in developing economies", *Global Value Chain Development Report*, 63-81.

Hunt, S. D. and R. M. Morgan (1995), "The competitive advantage theory of competition", *Journal of Marketing*, 59(April), 1-15.

Jansson, J. O. and D. Shneerson (1982), "The optimal ship size", *Journal of Transport Economics and Policy*, 16(3), 217-238.

Johnston, J. and J. DiNardo (1997), *Econometric Methods*, 4th ed, McGraw-Hill

Jona-Lasinio, C. and Meliciani, V. (2019) "Global value chains and productivity growth in advanced economies: Does intangible capital matter?", *International Productivity Monitor*, 36, 53-78.

Jouanjean, M., J. Gourdon and J. Korinek (2017), *GVC participation and economic transformation: Lessons from three sectors* (OECD Trade Policy Paper 207). Available from http://dx.doi.org/10.1787/617d7a19-en

Kano, L., E. W. K. Tsang and H. W. C. Yeung (2020), "Global value chains: A review of the multi-disciplinary literature," *Journal of International Business Studies*, 51, 577–622.

Kersan-Škabić, I. (2019), "The drivers of global value chain (GVC) participation in EU member states", *Economic Research-Ekonomska Istraživanja*, 32(1), 1204-1218.

Kim, Chang-Hun (2016, July 21), "A380 are a headache", *HankookIlbo*. Available from http://www.hankookilbo.com/News/Read/201607210461224426 (accessed September 14, 2022)

Kim, Chan-Ho. and Sang-Wook Park (2009), "Analyzing competitive of Korea's logistics industry", *Management Information Systems*, 90(1), 15-31.

Ko, Eun-Ji (2020, April 30), "Global value chain shaking with COVID-19…shorter and wider", *Yonhap News Agency (YNA).* Available from https://www.yna.co.kr/view/AKR20200429 180900003) (accessed September 14, 2022)

Korwatanasakul, U., Y. Baek and A. Majoe (2020), *Analysis of global value chain participation and the labour market in Thailand: a micro-level analysis*, ERIA Discussion Paper Series, 331, Economic Research Institute for ASEAN and East Asia. Available from http://hdl.handle.net/11540/12088

Kowalski, P., J. L. Gonzalez, A. Ragoussis and C. Ugarte (2015), *Participation of developing countries in global value chains: Implications for trade and trade-related policies* (OECD Trade Policy Papers 179). Available from http://dx.doi.org/10.1787/5js33lfw0xxn-en

Kummritz, V. (2016) *Do global value chains cause industrial development?* (CTEI Working Papers Series 01-2016), Centre for Trade and Economic Integration, The Graduate Institute.

Lakshmanan, T. R. (2011), "The broader economic consequences of transport infrastructure investments", *Journal of Transport Geography*, 19(1), 1-12.

Laplume, A. O., B. Petersen and J. M. Pearce (2016), "Global value chains from a 3D printing perspective", *Journal of International Business Studies*, 47(5), 595-609.

Lau, S. (2020, March 15), "Coronavirus: border closures 'may show what a full-blown trade war looks like'", *South China Morning Post*, Available from https://www.scmp.com/news/china/diplomacy/article/3075262/coronavirus-border-closures-may-show-what-full-blown-trade-war (accessed September 14, 2022)

Li. X., B. Meng and Z. Wang (2019), "Recent patterns of global production and GVC participation". *Global Value Chain Development Report 2019*, World Trade Organization (WTO), Available from https://www.wto.org/english/res_e/booksp_e/gvc_dev_report_

2019_e_ch1.pdf

Mačiulis, A., A. V. Vasiliauskas and G. Jakubauskas (2009), "The impact of transport on the competitiveness of national economy", *Transport*, 24(2), 93-99.

Maparu, T. S. and T. N. Mazumder (2017), "Transport infrastructure, economic development and urbanization in India (1990–2011): Is there any causal relationship?", *Transportation Research Part A: Policy and Practice*, 100, 319-336.

Melo, P. C., D. J. Graham and R. Brage-Ardao (2013), "The productivity of transport infrastructure investment: A meta-analysis of empirical evidence", *Regional Science and Urban Economics*, 43(5), 695-706.

Mudambi, R. (2008), "Location, control and innovation in knowledge-intensive industries", *Journal of Economic Geography*, 8(5), 699-725.

Myers, R. (1990), *Classical and modern regression with applications*, (2nd ed.). Boston: Duxbury.

Ndubuisi, G. and S. Owusu (2020), *How important is GVC participation to export upgrading* (Working Paper), Maastricht Economic and social Research institute on Innovation and Technology (UNU-MERIT). Available from https://www.merit.unu.edu/publications/wppdf/2020/wp2020-026.pdf

Noordewier, T., G. John and J. Nevin (1990), "Performance outcomes of purchasing arrangements in industrial buyer-vendor relationships", *Journal of Marketing*, 54, 80-93.

OECD (2017), *ITF Transport Outlook 2017*. Available from https://doi.org/10.1787/e979b24d-en

OECD (n.d.), *Global Value Chains (GVCs)*. Available from https://www.oecd.org/industry/ind/global-value-chains.htm (accessed October 09, 2021)

Park, Hong-Gyun (2011), "Efficiency analysis of total logistics provider", *Journal of Korea Port Economic Association*, 27(2), 261-273.

Park, Soon-Chan., Chang-Gui Park and Jun-Seong Bae (2018), *Changes in global value chain and strengthening the competitiveness of manufacturing industry in Chungnam, Korea*, Bank of Korea, Available from https://www.bok.or.kr/ucms/cmmn/file/fileDown.do?menuNo=200560&atchFileId=FILE_000000000007397&fileSn=2 (accessed September 14, 2022)

Reddy, K., R. Chundakkadan and S. Sasidharan (2021), Firm innovation and global value chain participation", *Small Business Economics*, 57(4), 1995-2015.

Rindfleisch, A. and J. B. Heide (1997), "Transaction cost analysis: Past, present, and future applications", *Journal of Marketing*, 61(4), 30-54.

Sari, I. (2015), "*Understanding the capability of Indonesian shrimp producers to participate in lucrative export markets: Using the integrated sustainable livelihoods approach (SLA) and global value chain (GVC) analyses*", Doctoral Dissertation, University of Technology, Sydney, Available from https://opus.lib.uts.edu.au/handle/10453/39186

Shah, M. and M. Ram (2006), "Supplier diversity and minority business enterprise development: Case study experience of three US multinationals", *Supply Chain Management: An International Journal*, 11(1), 75-81.

Tang, C. S. (2006), "Perspectives in supply chain risk management", *International Journal of Production Economics*, 103(2), 451–488.

Taguchi, H. and M. S. Thet (2021), "Quantitative linkage between global value chains' backward participation and logistics performance in the host country: A structural gravity model analysis of emerging ASEAN economies", *Asia-Pacific Journal of Regional Science*, 52(2), 435-475.

Teece, D. J., G. Pisano, A. Shuen (1997). "Dynamic capabilities and strategic management", *Strategic Management Journal,* 18(7), 509-533.

Tsakanikas, A., R. Roth, S. Caliò, Y. Caloghirou and P. Dimas (2020), "The contribution of intangible inputs and participation in global value chains to productivity performance: Evidence from the EU-28, 2000-2014", *Hamburg Discussion Papers in International Economics*, 5, University of Hamburg, 1-25.

Twinn, I., N. Qureshi, M. L. Conde, C. G. Guinea, D. P. Rojas, J. Luo and H. Gupta (2020), *The impact of COVID-19 on logistics,* International Finance Corporation (IFC) World Bank Group. Available from https://www.ifc.org/wps/wcm/connect/2d6ec419-41df-46c9-8b7b-96384cd36ab3/IFC-Covid19-Logistics-final_web.pdf?MOD=AJPERES&CVID=naqOED5

UNCTAD (2020), *Review of Maritime Transport 2020.* Available from https://unctad.org/system/files/official-document/rmt2020_en.pdf (accessed November 20, 2020)

Urata, S. and Y. Baek (2019), *Does participation in global value chains increase productivity? An analysis of trade in value added data* (ERIA Discussion Paper Series 301). Economic Research Institute for ASEAN and East Asia. Available from http://hdl.handle.net/11540/11355.

Verbeke, A. (2020), "Will the COVID-19 pandemic really change the governance of global value chains?", *British Journal of Management*, 31(3), 444-446.

Wang, B. and M. Z. Hou (2007), "Global value chain theory: A new paradigm for contemporary industry and trade research under economic globalization condition", *Journal of International Trade*, 2007, 92-97.

Williamson, O. E. (1975), *Markets and hierarchies: Analysis and antitrust implications*. New York, NY: The Free Press

Woetzel, J., J. Seong, N. Leung, J. Ngai, J. Manyika, A. Madgavkar, S. Lund and A. Mironenko (2019), *China and the world: Inside the dynamics of a changing relationship*, McKinsey Global Institute, Available from https://www.mckinsey.com/featured-insights/china/china-and-the-world-inside-the-dynamics-of-a-changing-relationship (accessed November 20, 2020)

WTO (n.d.), *Trade in Value-Added and Global Value Chains: Country profiles Explanatory notes.* Available from https://www.wto.org/english/res_e/statis_e/miwi_e/Explanatory_Notes_e.pdf (accessed November 20, 2020)

Yanikkaya, H. and A. Altun (2020), "The impact of global value chain participation on sectoral growth and productivity", *Sustainability*, 12(12), 1-18.

Yoon, Woo-jin (2015), "International division of labor between Korea and major economies Changes and Implications", *Korea Institute for Industrial Economics and Trade (KIET) Issue Paper*, 2015-378, 1-91.