

Strategies for the National Innovation System in the Era of Post COVID-19

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1. The world we are living today

The world is now battling World War III without gunfire. There are fierce battles between the infectious disease and economic activities in every part of the human world. It is the war against the COVID-19 pandemic. There are over 10 million confirmed cases with a death toll of 500,000 from 214 countries as of June 29, the mortality rate is approximately 4.92%. The COVID-19 that began to spread by the end of 2019 went on to the next year. It is the war on the virus in which the largest number of countries is involved for a single event since the world war II, causing the worst employment issue along with the massive economic damage. The Washington Post predicted that the COVID-19 will cost US economy USD 7.9 trillion (KRW 9,480 trillion) through 2030 based on the budget and economic outlook of the Congressional Budget Office (CBO).

COVID-19 continues to spread as of the end of June. There are approximately 200,000 new victims of the disease on average. Many experts cautiously predict that the COVID-19 infection will be continued until we have a vaccine and medicine for the disease and

there will be the second big wave in the second half of this year. In the meantime, it is expected that the outbreaks of emerging infectious diseases may occur more frequently, causing more concerns, and there is a growing need to come up with permanent measures, instead of one-time approaches.

Korea is considered as an exemplary model in the fight against the disease. It means that the country has become one of the representative countries that succeed in catching two rabbits of controlling the disease and engaging in economic activities at the same time. Specifically, the fact that the country successfully respond to COVID-19 with the aggressive testing, isolation of people confirmed with the disease, and social distancing only without closing national or local borders was highly recognized by the world as evidenced by reports from “What we can learn from South Korea about containing COVID-19”(CNN) and “Special Report: How Korea trounced U.S. in race to test people for coronavirus” (Reuter).

COVID-19 is an infectious disease that has impacted on the life of humanity most significantly since the 20th century and it may lead a new paradigm shift along with the acceleration of the paradigm of

the 4th industrial revolution. The discussions on a new normal after COVID-19 are already made. As noted by Thomas Freidman, an American opinion columnist and author of 'The World is Flat: A Brief History of the 21st Century', the world is now divided into the world B.C. -Before Corona- and the world A.C. -After Corona. It implies that we should not only respond to the global COVID-19 pandemic in the short term, but also we should prepare measures from the mid/long-term perspectives.

With regard to this, this article first provides a review on discussions on the essence of socio-economic impact of COVID-19 and the roles of government, diagnoses the national innovation system, and develops directions on the national innovation system to move forward in the future as well as strategies to achieve the goals.

2. The socio-economic impact of the COVID-19 pandemic

A. Differences between COVID-19 and other major infectious diseases

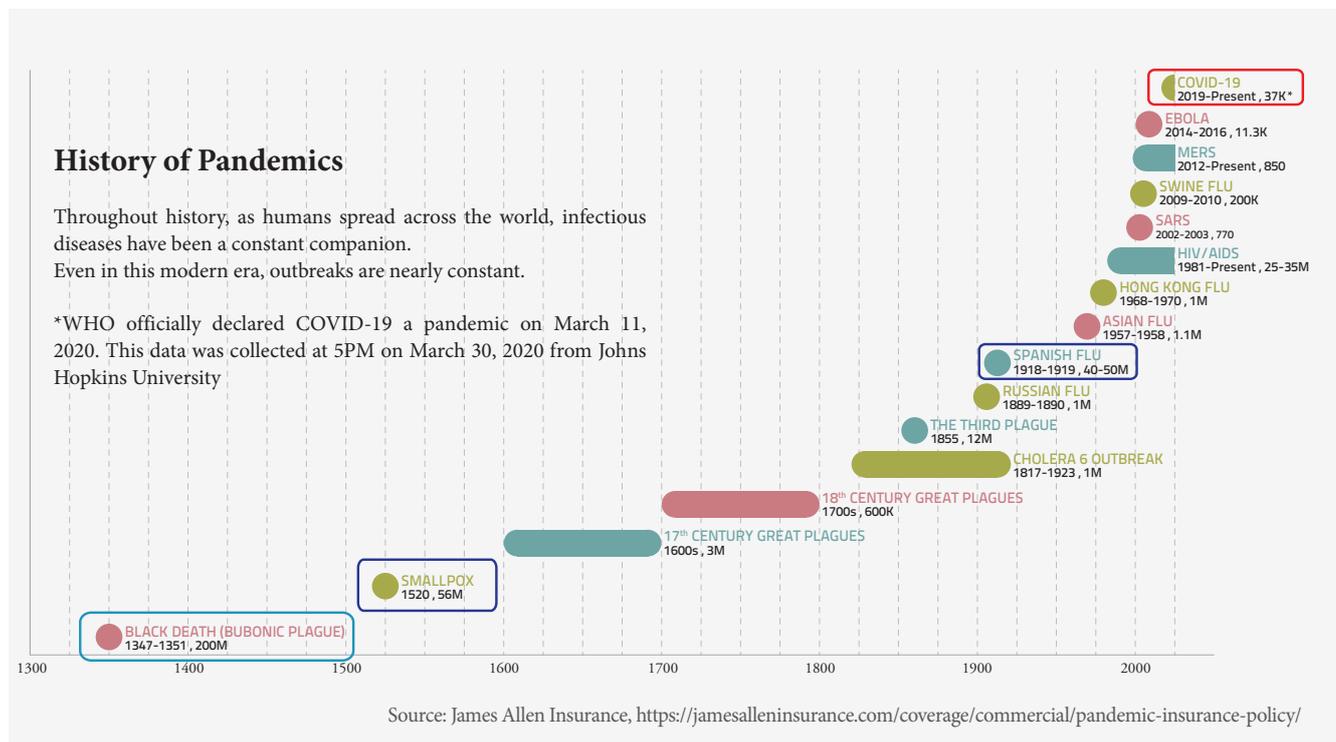
The Black Death is the deadliest pandemic recorded in human history which swept through Europe in the 14th century. The Black Death resulted in the deaths of approximately 200 million for the last 4 years. Another notorious infectious disease is Smallpox and the World Health Organization (WHO) certified the global eradication of the disease in August, 1980. The Smallpox has been with us for centuries and it was known to play a major role in the collapse of the Inca Empire in the 16th century. The Spanish flu was another infectious disease that had the biggest impact on the humanity in a short period of time. Since the outbreak

in 1918, the disease took the lives of up to 500 million people for about 10 years. Comparing to such most contagious diseases spread to become pandemics (an epidemic of an infectious disease that has spread across the world), COVID-19 has very different characteristics. First, COVID-19 is highly contagious pathogenic viral infection and spread rapidly around the whole world due to onward transmission. It takes a long time to treat the disease, but its mortality rate is relatively low. Second, it is highly likely that young people may show no symptoms, but people with underlying medical conditions and seniors have shown critical symptoms, even leading to death. COVID-19 is a highly variable disease due to the characteristics of the virus. Hence, experts predict that it will take more than 1 year to develop a vaccine or treatment for COVID-19.

The governments of the world are now going through tough times to tackle the economic fallout caused by characteristics of COVID-19. They had to close their borders due to the rapid spread of the disease with infection rates, and which halted the economic activity leading to the rapid decline in jobs. However, the number of people who are willing to work has not shrunken owing to the asymptomatic characteristics of the disease with low mortality rates. Some experts argue that the economic damage from COVID-19 would be equivalent to that of the Great Depression in the 1930s. That is why countries of the world are investing heavily for the diagnosis, prevention, and development of vaccine and treatment of COVID-19, disaster relief fund, and restoration of the economy.

B. The socio-economic impact of the COVID-19 pandemic

It is expected that COVID-19 brings or will bring huge changes in our society and economy in diverse



[Figure 1] History of pandemics (global epidemic)

aspects. “The COVID-19 outbreak will transform the way that we think about everything from family and healthcare to politics” (The Wall Street Journal, March 28, 2020). “Covidiverces’ and ‘Coronababies’: Life during a lockdown across the world. The pandemic is radically altering approaches to love, dating, sex and family relations, and the internet has emerged as a lifeline to millions of single people” (The New York Times, March 30, 2020) are examples of news report covering the impact of COVID-19. Key changes in our society and economy due to COVID-19 can be summarized as the spread of untact (non-contact) culture, increasing interest in health and environment, promotion of digital transformation, and acceleration of the 4th industrial revolution.

First, the spread of non-contact culture can be divided into two sub-categories. The former is the consumption paradigm shift. Specifically, the expansion of online consumer market, spread of the subscription economy, increase in indirect shopping experience are belonged to this category. The latter is the change in leisure and physical activities and examples are the spread of Home Ludens (a home for play)¹⁾ culture and ontact (contact online), growth of online game market, etc. The second change is an increasing interest in health and environment, and which, too, can be classified as two areas. The former is the opening of remote medicine in full swing owing to the growing interest in health and hygiene, emergence of digital healthcare, increasing demand for wellness tourism, etc. The latter is the promotion

[Table 1] Paradigm shift due to COVID-19

Classification	Major changes	Examples
Spread of untact (non-contact) culture	Paradigm shift in consumption	<ul style="list-style-type: none"> ▪ Expansion of online consumer market ▪ Spread of subscription economy* ▪ Increase in indirect shopping experience
	Changes in leisure and physical activities	<ul style="list-style-type: none"> ▪ Spread of Home Ludens culture ▪ Spread of untact (contact online) culture ▪ Growth of online game market ▪ Increase of non-contact transport means
Increasing interest in health and environment	Heightened interest in health and hygiene	<ul style="list-style-type: none"> ▪ Opening of remote medicine in full swing ▪ Emergence of digital healthcare ▪ Increasing demand for wellness tourism ▪ Expansion of the health functional food (HFF) market
	A life taking care of the natural environment	<ul style="list-style-type: none"> ▪ Promotion of echo life ▪ Expansion of the meat substitutes market ▪ Increasing demand for EVs/autonomous vehicles
Promotion of digital transformation	Changing work areas and methods	<ul style="list-style-type: none"> ▪ Increasing demand for remote work ▪ Expansion of remote learning ▪ Promotion of digital finance ▪ Realization of smart administration
	Spread of unmanned solutions	<ul style="list-style-type: none"> ▪ Spread of automation ▪ Advancement of unmanned technologies ▪ Increasing dependence on robots
Acceleration of the 4th industrial revolution	<ul style="list-style-type: none"> ▪ Internet of Things (IoT) ▪ Big data ▪ Artificial Intelligence (AI) ▪ 3D printing ▪ 5G network ▪ Blockchain ▪ Cloud, etc. 	

Subscription economy: It refers to an economic activity of consumers to receive desired products or services for a certain period by paying for the products or services on a regular basis
Source: Park Young-seo (2020), Paradigm shifts after COVID-19 and business strategies for the new normal

of echo life to care for the natural environment, expansion of the meat substitutes market, and increasing demand for EVs and autonomous vehicles. Third, changing work areas and methods thanks to the digital transformation and expansion of unmanned solution are noteworthy. The changing work areas and methods take the form of increasing demand for remote work, expansion of remote learning, promotion of digital finance, and realization of smart administration. As for the latter, the spread of automation, advance of unmanned technologies, increasing dependence on robots are the examples. Lastly, the symptoms of accelerating the 4th industrial revolution are found in technological advances such as IoT, big data, AI, 3D printing, 5G network, blockchain, and cloud (see [Table 1]).

C. Failure of a small government and changing social/economic values

Currently, discussions on the role of the government are underway due to COVID-19. Such discussion were brought after countries like the UK that have followed the small government notion failed to respond to COVID-19. The UK is a representative country privatizing or outsourcing government

1) The term was originated from Homo Ludens (playing man or a man of pleasure) argued by a Dutch historian Johan Huizinga and its meaning was transformed into a home for play. The word is currently used to describe activities and people who stay at home to work, rest, and play due to COVID-19.

functions to improve the efficiency. When a nation faces an emergency like COVID-19, the public sector of such countries has failed to fulfill its capacity, and countries have less options they can choose in order to respond to the national disaster. It was due to that investment to build the capability of the public sector has reduced, while depending more on the private sector (Mazzucato & Ouaggitto, May 19, 2020).

On the contrary, countries like Korea, Vietnam, and New Zealand are considered as ones that the government played its given roles successfully. That is why a necessity to build an efficient governance structure is emphasized along with the production and procurement capability of the government, public/private cooperation for the public interest, and the importance of building a digital infrastructure. At the same time, a need to develop the 'public/private partnership (PPP)' upon outsourcing critical capability of a nation to the private sector in order to serve for the public interest first is raised.

In the meantime, the effort to strengthen the roles and capability of the government such as building a social safety net and disaster alert system, and developing biotechnologies in response to emerging infectious diseases as national assets as well as new functions of the government to establish related governance structure are expected to be discussed in line with the failure of small government after the COVID-19 pandemic.

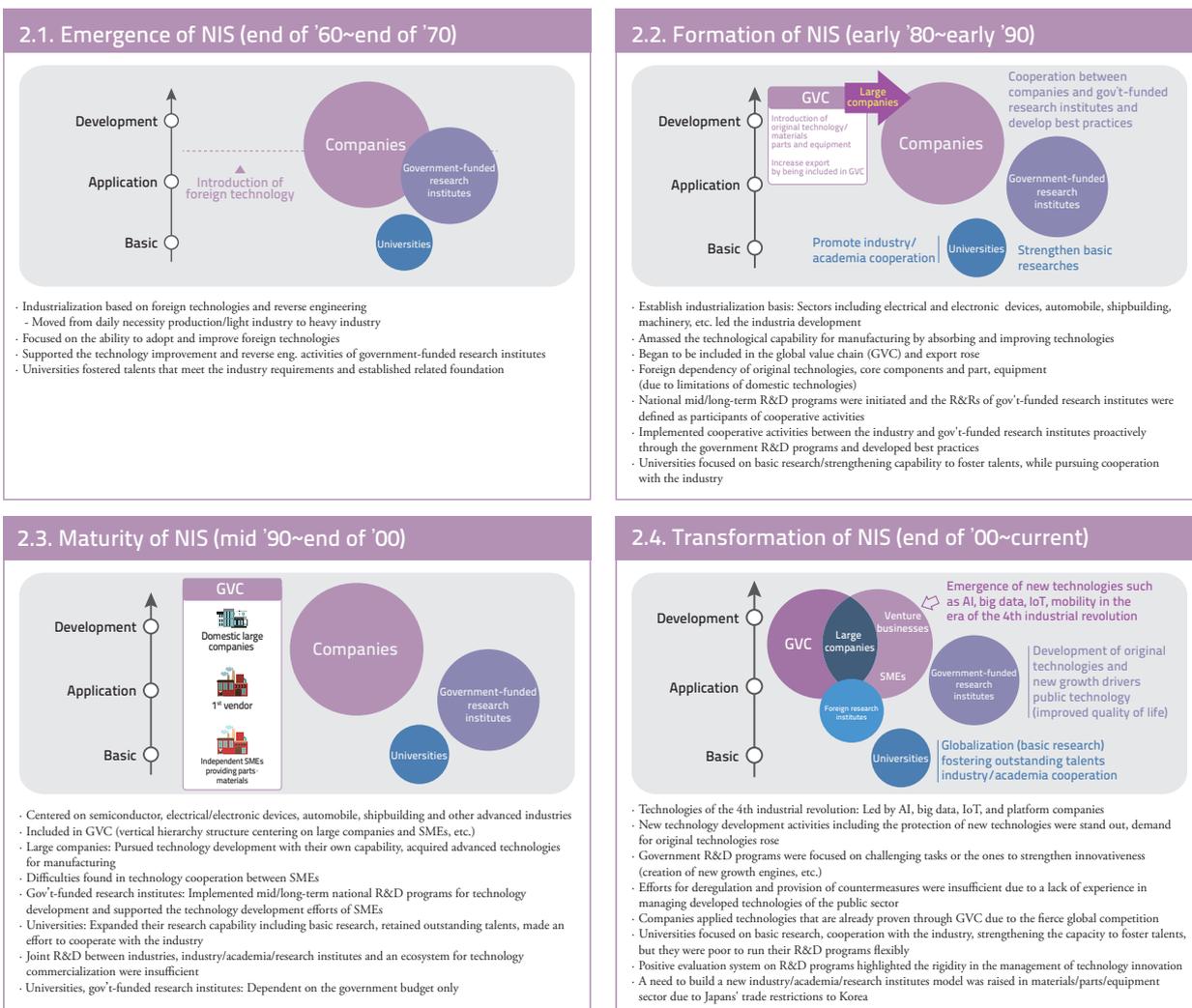
There is a growing demand for re-evaluating values that are highly praised in socioeconomic aspects as well, while discussing on the roles of the government. To be specific, more people are arguing that we need to review on the efficiency, performance-centric approach, integration, and others that are considered as the essence of capitalism until recently (Lee Jang-jae, 2020b). Instead, values like publicness,

effectiveness, decentralization and redundancy began to stand out. In a nutshell, the time has come that we need to explore options to strike a new balance in the value system.

3. A diagnosis on the status of national innovation system (NIS)

The national innovation system (NIS) of a country is not fixed. Rather, it is flexible and changes while interacting with domestic/international politics, economy, society, culture, and technological environment (Lee Jang-jae, et al., 2019). Each country has its unique development paths and such elements affect the selection and implementation of NIS. For countries that have to chase others, therefore, matters on how to establish a NIS that would serve best for their development paths or how to improve the current system are significantly important topics for discussions to determine their approaches to build the NIS. In reality, many countries feel the need to improve their national innovation system due to its inefficiency or inconsistency with the environment of the time. With regard to the discussion on NIS, the roles of the government that can have an impact on all players leading the innovation, the system, and their functions are considered as important. Here, approaches for NIS have become useful tools to develop policy options to build the optimum NIS (Lee Jang-jae, et al., 2019).

The national innovation system of Korea has developed following the stages of emergence in the 1960s, formation in the early 1990s, and maturity in the mid-1990s and end of 2000s (see [Figure 2]). The national innovation system of today has a series of characteristics as follows (Lee Jang-jae, et al., 2019).



Source: Lee Jang-jae, et al.(2019), as cited in Lee Jang-jae (2020a)

[Figure 2] The evolution and characteristics of the national innovation system in KOREA

First, the country pursued a strategy to innovate its technologies to bridge the gap as a follower and which led to a phenomenon of path dependency. Therefore, the symptom of the 'loss of premium on the innovation of technologies as a follower' is getting worse as evidenced by the recent decline of the potential rate of growth. It appears that the law of diminishing marginal utility is applied rapidly when it comes to the performance of catch-up innovation

technology path. Second, measures to respond to the paradigm shift in technology, economy and society properly in the era of the 4th industrial revolution that induces the transition to a new era of technology innovation are not insufficient. It is due to that the country fails to transform its development path from catch-up to post catch-up. Third, a series of symptoms are detected in the structure as a result that technology innovation was largely occurred by

being reliant on external sources, rather than by being motivated and led by internal force. The decoupling of domestic innovation leaders who prefer to be linked with and operated by the external sources of innovation than interacting and cooperating with each other, and their decentralization and fragmentation are largely noticed. As the manufacturing process of multinationals operating in Korea maintains the optimal state of operation as it is belonged to the global supply chain or global value chain (GVC), the linkage of domestic innovation leaders with it is relatively weak. Therefore, the decoupling brings difficulties for the industry, academia, research institutes work together throughout the entire process from technology innovation to economic activities and it also intervenes the learning from the flow of knowledge, undermining the performance of technology innovation.

Fourth, the capability of the government and its governance structure related to technology innovation are inconsistent with the times, and which means that the two elements are designed to serve the best in the catch-up model. It can be summarized as that the NIS of Korea has evolved to be optimal to implement catch-up strategies. Hence, the system has revealed its weakness in the period of new paradigm shift, although it helps the nation maintain the position of manufacturing powerhouse on the global stage up until now.

In times of crisis like the COVID-19 pandemic, the capability of public sector is particularly important. Thus, we need to remind the lessons learned from the failure of small government, emphasizing efficiency. In addition, a new point of balance with regard to the value system that the government should pursue in the future should be reflected in the national innovation system. The NIS of Korea has encountered a moment of transition to the one that reflects new

paradigms and values, while getting away from the conventional catch-up model.

4. Strategies for NIS in the post COVID-19 era

We have prepared strategies for the NIS that meet the demands of post COVID-19 era based on the diagnosis and solutions for the national innovation system of Korea which was built before COVID-19 in 2019 (see [Table 2]). To develop the strategies for NIS, the researchers have reflected new changes in our society and economy from COVID-19 and the roles and values of the government to previous strategies established based on the paradigms of the 4th industrial revolution.

First, we need to provide strategies to pursue the genuine path-creating innovative growth and implement them in practice in order to overcome the deteriorating conditions we are experiencing now for the loss of premiums as a follower, one of distinctive features of countries that follow the catch-up path to innovate their technologies. To this end, preemptive investment on untact (non-contact) technologies and industries and prioritizing them as key national agendas should be made as an important strategic direction considering changes after COVID-19. In the meantime, we need to foster K-biotechnology and industry as a pillar of innovative growth along with K-quarantine which was recognized by the world as the best approach in responding to the disease. Second, we should build an ecosystem for the industry/academia/research institutes cooperation proper to new paradigms and adjust related systems, and develop new policies to promote the coupling among domestic innovation leaders as an effort to overcome the issue of their decoupling. At the same time, preparations

to build an open NIS that reflects the international cooperation and linkage on personnel, materials, and data and information that are clearly noticed during the COVID-19 pandemic. In the meantime, providing strategic measures to complement and prepare for national emergency such as the US-China trade conflict, Japan's exclusion of Korea from its whitelist of nations, and the collapse of global supply chain due to COVID-19 (ex. reshoring the manufacturing of key items, etc.) has emerged as an important task. Third, it is urgent to build an ecosystem for the creation of new values such as the platform economy, data economy, smart mobility solution, etc. in response to paradigm shifts in technology, economy, and society along with the 4th industrial revolution. Furthermore, we should build the digital infrastructure and platforms

proactively and prepare the systems and ecosystem to support them accordingly through the digital new deal initiative that is currently underway and others. In addition, we should embark on the digital transformation and set an order of priority in terms of personnel/physical investment on untact (non-contact) and unmanned solutions. The last strategy is related to the efforts to overcome a lack of government capability and inconsistency of governance with the times. Namely, we should make an effort to enhance the capability of the government related to technological innovation required to meet the new paradigms and reorganize national S&T innovation governance. With regard to expanding the role of government as a social safety net in the midst of COVID-19 crisis, the government needs to improve its capability. To make this happen, we

[Table 2] Diagnosis and proposed solutions on the NIS

Diagnosis	Strategic directions (I): Respond to the paradigms of the 4th industrial revolution	Strategic directions (II): Respond to the paradigms of the 4th industrial revolution + Post COVID-19
Worsening loss of premiums on technological catch-up and innovation	Setting goals of NIS and implementation: Pursue a new path-creating innovative growth	<ul style="list-style-type: none"> · Same · Preemptive investment on the non-contact technologies and innovation and prioritization · Build K-bio, K-quarantine platforms and lead the technology innovation
Poor operating performance of NIS due to decoupling among technology innovation leaders	Create a cooperative ecosystem among the industry/academia/research institutes and change related system, increase learning curve and openness within NIS	<ul style="list-style-type: none"> · Same · Strengthen the openness of NIS (pursue international cooperation, etc.) · Strategies to complement GVC (reshoring the manufacturing of key items, etc.)
Poor to respond to paradigm shifts in technology, economy, and society along with the 4th industrial revolution	Build an ecosystem to create new values such as the platform economy, data economy, smart mobility solution, etc.	<ul style="list-style-type: none"> · Same · Proactively build the digital infrastructure · Promote the digital transformation
A lack of government capability and inconsistency of governance with times	Improve the capability of the government and consistency of NIS	<ul style="list-style-type: none"> · Same · Strengthen the role of government as a social safety net and reinforce related capability · Establish a governance on public/private cooperation · Reflect new values such as publicness, effectiveness, decentralization, redundancy, etc.

Source: Compiled based on Lee Jang-jae, et al. (2019)

should implement and reorganize the governance on private/public cooperation that puts the public interest first. In the meantime, the development, operation, and performance evaluation of NIS rebuilt based on new values such as publicness, effectiveness, decentralization, etc. should be made. Of course, such values should be properly reflected on the system, while striking a balance with the conventional ones. Specifically, the importance of redundancy, which was previously excluded in the catch-up model, should be reconsidered.

5. Conclusion

People of the world will remember 2020 as the year that marked a milestone in human civilization. As the globalization has reached a plateau from the physical and cyber perspectives, the outbreak of novel virus has devastated one side of a coin abruptly. In 2020, we are now living a bizarre world where the physical world has collapsed while the cyber world has flourished further. Fortunately, humans have imagined and prepared for such world as they have predicted for a long time. Globalization in the cyber space allows us to see and experience the world, although countries have closed their borders and the globalization in the physical aspect has contained. A problem occurs in that the globalization in the cyber space has not prepared to encompass the socio-economic systems. We are facing various issues caused by the disease including job and unemployment, economic slowdown and negative growth, conflicts between haves and have-nots and between generations, conflicts caused by digital divide, etc. It is highly likely that changes and new aspects that have emerged recently will not go away, even though COVID-19 has ended with the development of vaccines and treatments. That is why we should accept

the paradigm shifts due to COVID-19 with a heavy heart in the midst of the 4th industrial revolution.

The 4th industrial revolution and post COVID-19 era may serve as another entry barrier for Korea as the country begins to embark on the uncharted journey called post catch-up technology innovation strategy. On the other hand, we may have expected for catching two birds with one stone, considering that we need to get away from the path dependency any way. In other words, the role of national think tank has become all the more important. The government should have the capability to conduct the functions with the authority to design all relevant systems and institutions, adjust and implement them. In the modern world, the government cannot build and exert its capability all by itself. It can fulfill the responsibility and live up to the expectation of the public based on close linkage and cooperation with the leaders of knowledge and innovation in the private sector such as think tanks both at home and abroad. To this end, we need close cooperation between the private/public sector and among the industry, academia, research institutes, and the government, as well as governance to support such cooperative efforts.

In order to respond best to the paradigm shifts, we need to explore them precisely and make decisions accurately for the future based on concrete analysis and diagnosis on the present. We hope that the digital new deal and green new deal initiatives and others that are deemed to be implemented through the 3rd supplementary budget of the government can reflect the elements mentioned above with a sense of urgency.

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