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CONTENTS

Analysis of Introducing a Land Border Customs Clearance System in Korea

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I. Introduction

The Republic of Korea (ROK) is surrounded by the sea on three sides. However, as goods from other countries cannot be imported to the country through North Korea, except for the limited goods produced in the Kaesong Industrial District, inland trade has been non-existent. With no inland trade, the ROK relies on air and sea for its exports and imports. As such, though the country's customs clearance system has been designed with a focus on trade by air and sea, research on inland customs clearance holds great significance for the ROK's preparation for the possibility of future inland trade.

To date, the majority of proposals have focused on northern trade using the continental railway to Europe via Central Asia. Indeed, many Korean exports are transported to Europe by railway through China. Railway transport costs less than air transport, and is less time-consuming than sea transport, which raises the viability of the inland importing of goods from North Korea, China, Russia, the European Union (EU), and other countries via North Korea.

In this study, we focus on the inland customs clearance for general imported goods. As

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stated above, the ROK has been transporting goods from the Kaesong Industrial District by road. However, given the small volume of goods from this district, the scope is different from the importing of goods from other countries. In addition, the transport of goods from the Kaesong Industrial District technically constitutes domestic trade, not international import and export. Therefore, this transport requires the approval from the Minister of Unification. For this reason, the ROK needs to conduct research on the inland customs clearance system in advance, so that it can commence customs clearance operations whenever the importing of goods from other countries begins via North Korea.

Customs clearance is a common issue related to international trade involving numerous countries. Therefore, to be sustainable, customs clearance systems should be designed in compliance with the requirements specified in international agreements. The ROK needs to find ways to align its customs clearance system with international standards by incorporating the inland customs clearance systems under international agreements into the ROK Customs Act and other laws. International agreements on inland customs clearance include: the Customs Convention on the International Transport of Goods under Cover of TIR Carnets (TIR); the Convention on the Contract for the International Carriage of Goods by Road (CMR); the Convention Concerning International Carriage of Goods by Rail (COTIF); the International Convention concerning the Carriage of Goods by Rail (CIM); the Agreement on International Railway Freight Communications (SMGS); and the Agreement on International Passenger Traffic by Rail (SMPS).

Based on these agreements, we seek to propose an inland customs clearance system for the ROK. In this study, we examine inland customs clearance in two categories: cargo customs clearance and passenger customs clearance. The World Customs Organization (WCO) recommends establishing separate customs clearance systems for cargo and passengers. We also propose separate inland cargo customs clearance systems for railways and roads.

In addition, as passenger transport does not significantly vary depending on the mode of transport, we propose an inland customs clearance system for general passenger transport.

This study consists of the following chapters. In Chapter II, we examine international agreements governing inland customs clearance systems. In Chapter III, we use the findings on international agreements from Chapter II to propose inland customs clearance systems for cargo and passengers in the ROK. We also discuss the issue of possible misconduct and illegal trading associated with inland customs clearance. Finally, in Chapter IV, we summarize the preceding chapters and offer our conclusions.

II. International Agreements on Inland Customs Clearance

International trade inevitably involves a transport process that moves goods across borders. Various international agreements have been signed to ensure the facile and effective transport and trading of goods between countries.

1. Agreements on Container Transport

Since their first use for railway transport in the United States in 1920, containers have radically transformed the goods transport landscape. The use of containers greatly reduced the time and cost of transport over conventional containers such as wooden boxes and paper bags. In particular, the introduction of ship containers in the late 1950's led to an explosive growth in international trade. According to Matson, the shipping and unloading volume per port worker increased by seven times between 1959 and 1976, from 0.625 tons to 4.234 tons. The average docking time of ships also declined, from three weeks to just 18 hours.[1] This widespread use of containers in international trading resulted in the establishment of international agreements on the customs clearance of cargo containers.

A. Customs Convention on Containers

In 1956, the United Nations Economic Commission for Europe (UNECE) adopted the Customs Convention on Containers in an attempt to streamline customs clearance procedures for containers used in international transport. Inland transport is quite active in Europe, which led to the frequent use of multimodal transport using containers.[2] As many goods transitioned from sea transport to road transport, or from railway transport to road transport, an international agreement was needed in order to determine ways to handle these goods.

The Customs Convention on Containers (CCC) was signed by 44 countries in 1956, and went into effect in 1959. A partial revision to the CCC was adopted and effectuated in 1972. Under the CCC, containers re-exported within three months from the date of original import

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[1] Feenstra and Taylor (2016), p. 38, cited from Learning International Trading from News.

[2] Multimodal transport refers to the transport of goods under a single contract to transport goods using two or more different modes of transport (UNCTAD/ICC Rules for Multimodal Transport Documents, 1991, Rule 2-1).

are exempt from customs and other taxes, as well as from documents required for import clearance or re-export.[3] In addition, the convention also defined the conditions and procedures for an importing country's approval of goods transported under a customs seal issued by the government of a signatory country.

As of June 2020, the 1973 CCC was joined by 40 countries and regional associations. The ROK signed the convention in 1973, and completed the accession process in October 1981 after ratification by the National Assembly. The Russian Federation and China acceded to the convention in 1976 and 1986, respectively. North Korea has not joined the convention, to date.

B. Customs Convention on the International Transport of Goods under Cover of TIR Carnets

The Customs Convention on the International Transport of Goods under Cover of TIR Carnets, or the TIR Convention in short,[4] was signed under the supervision of the UNECE in 1975. Before the current TIR Convention, European countries entered into the TIR Agreement in 1949, which was replaced by the 1959 TIR Convention.

The TIR Convention contains similar provision to the CCC that provides for special case rules for goods temporarily imported or passing through a country without processing or consumption. However, whereas the CCC provides for special case rules for the importing and exporting of containers, the TIR Convention provides for special case rules for customs clearance of, and tariff imposed on, 'goods' transported by road. In other words, whereas the CCC applies to containers transported by any mode of transport including land, sea, and air, the TIR Convention specifically applies to goods transported to the delivery points by road vehicles through specific countries.

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3 UN, "Customs Convention on Containers," 1972.
Article 3
1. Subject to the conditions laid down in Articles 4 to 9, each Contracting Party shall grant temporary admission to containers, whether loaded with goods or not.
Article 4
1. Containers granted temporary admission shall be re-exported within three months from the date of importation. However, this period may be extended by the competent Customs authorities.
4 TIR stands for "Transports Internationaux Routiers," which in English means "International Road Transports".

The TIR Convention defers the due dates of taxes and tariffs imposed on cargo transported by road and sealed under the TIR Carnet, and exempts such cargo from inspection at customs offices of stopover countries. It also specifies international agreements on the handling of goods transported under the cover of the TIR Carnet.

As of June 2020, 76 countries and regional associations have signed the TIR Convention, including the EU, and the ROK acceded in January 1982. With the joining of China in July 2016, the signatories of the convention include most countries on the pathway from the Korean Peninsula to Europe, and include Russia and Mongolia.

2. Convention on the Contract for the International Carriage of Goods by Road

The Convention on the Contract for the International Carriage of Goods by Road (Convention Relative au Contrat de Transport International de Merchandise par Route; CMR) was entered into effect in Geneva, Switzerland, in 1956. A member of the CMR applies the convention to a partner of international road transport that has not signed the convention. The International Road Transport Union developed a waybill standard that provides information on 24 items, including the basic information on transported goods, based on the CMR. A carrier presents the document at the border of a CMR member state for a simplified customs clearance process. Recently, some countries have adopted an electronic CMR waybill (eCMR waybill).[5]

The key provisions of the convention concern liabilities and compensation. Under the CMR, a carrier is liable for issues regarding transported goods.[6] However, in cases where damage, loss, or delayed transport is caused by a claimant's illegal act, negligence, or instruction, or caused by the very nature of the goods or a situation that cannot be avoided by the carrier, the carrier is not liable for the issue.[7] In cases where a carrier is liable for

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[5] UNECE, https://www.unece.org/fileadmin/DAM/trans/conventn/e-CMRe.pdf, searched on: June 1, 2020.

[6] UN, "Convention on the Contract for the International Carriage of Goods by Road," 1956.
    Article 17
    1. The carrier shall be liable for the total or partial loss of the goods and for damage thereto occurring between the time when he takes over the goods and the time of delivery, as well as for any delay in delivery.

[7] UN, "Convention on the Contract for the International Carriage of Goods by Road," 1956.
    Article 17
    2. The carrier shall however be relieved of liability if the loss, damage or delay was caused by the wrongful act or neglect of the claimant, by the instructions of the claimant given otherwise than as the result of a

compensation for all or a part of the transported goods, the amount of the compensation is calculated in accordance with the value of the goods at the place and time at which they were accepted.

One of the characteristics of the CMR is the high percentage of European countries that are among its members, which reflects the high level of road transport activity in the region. As of June 2020, 56 countries have signed the convention, which mostly consist of European, North African, and Middle East countries. East Asian countries and North American countries have not signed the convention to date, including the ROK, China, Mongolia, and the United States.

3. International Agreements and Organizations on Railway Transport

The CMR and the International Convention concerning the Carriage of Goods by Rail (CIM) are two of the most important international agreements for cargo transport among European countries. Railway transport offers the lowest transport cost per unit in terms of long-distance transport, as well as superb safety. Railways are commonly used as a mode of transport covering long continental sections or connecting inland areas with ports.

A. Convention Concerning International Carriage of Goods by Rail

The International Convention concerning the Carriage of Goods by Rail (CIM) is a multilateral treaty on railway transport, led by European countries. The Intergovernmental Organization for International Carriage by Rail (OTIF) is an international organization covering railway transport based in Europe. With the adoption of the CIM in 1965, the organization introduced unified rules on international railway transport. The CIM was absorbed into the Uniform Rules Concerning the Contract for International Carriage of Goods by Rail, one of the seven annexes of the International Convention Concerning International Carriage by Rail (COTIF) signed in 1980.

The Uniform Rules Concerning the Contract for International Carriage of Goods by Rail consists of 52 provisions that comprehensively cover matters regarding railway transport in Europe, including contracts, liabilities, and jurisdictions A railway cargo contract is finalized

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wrongful act or neglect on the part of the carrier, by inherent vice of the goods or through circumstances which the carrier could not avoid and the consequences of which he was unable to prevent.

by a railway consignment note that satisfies the requirements of the rules, and is then used as a transport document.

Rules on passenger transport (including their cargo and accompanying animals) are specified in the International Convention for the Transportation of Passengers (CIV). The CIV pertains to agreements on the transport of passengers and their baggage between two different member states. It also offers protection for passengers and their baggage at the same level as the Warsaw Convention (currently, the Montreal Convention) or the Athens Convention on passenger transport by sea.

The OTIF currently has 50 member states, most of which are EU member states. The other countries include North African countries (Algeria and Albania, etc.) and Middle East countries (Iran, Iraq, Afghanistan, and Pakistan, etc.).[8] The Gulf Cooperation Council and the OTIF signed a memorandum of understanding (MOU) in 2014, followed by a China-OTIF MOU in 2016, by which the OTIF seeks to expand its scope to Asia.[9] The ROK and North Korea have not joined the OTIF due to the absence of continental railway transport activities.

Figure 1_OTIF Members
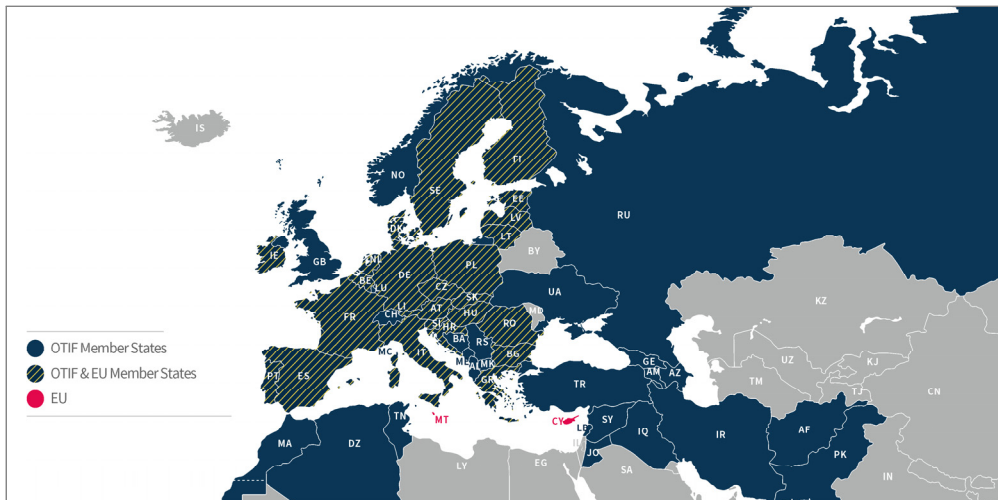
Source: OTIF, https://otif.org/fileadmin/new/1-About/OTIF%20-%20EU%20Member%20States.pdf, accessed on June 10, 2020.

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8 OTIF, https://otif.org/en/?page_id=51, accessed on June 3, 2020.

9 OTIF, https://otif.org/en/?page_id=3, accessed on June 3, 2020.

B. Agreement on International Railway Freight Communications[10]

The Organization for Cooperation between Railways (OSJD) was established in 1956 to develop the cargo and passenger transportation infrastructure for the old Soviet Union and Eastern European countries, foster a railway transport environment in Eurasia, advance railway transport technologies, and expand transcontinental railways. It consists of 29 members including Russia, China, Mongolia, and North Korea, and four observers (Germany, France, Finland, and Greece). The ROK joined the organization in 2018. A total of 280,000 km of railways, including the Trans-Siberian Railway Network (TSR) and the Trans-China Railway (TCR), are under the influence of the OSJD.

The OSJD complies with the SMGS in relation to railway cargo transport. The SMGS consists of 8 chapters, 41 provisions, and 22 annexes. It reflects agreements on the execution, implementation, and revision of transport contracts, the liabilities of railways, claims and legal actions, payment, and other matters pertaining to railway cargo transport. In addition, the agreement lays down waybill criteria for international railway cargo transport. However, in practice, the railway bill based on the waybill under the SMGS is used.

The SMGS classifies cargo transport expenses into sender country expenses collected from senders, arrival country expenses imposed on recipients, and border transport expenses collected from senders or recipients. Specifically, a recipient is responsible for the expenses caused by track guage differences between countries.

In terms of passenger transport, the Agreement on International Passenger Traffic by Rail (SMPS) provides for the cross-border railway transport of passengers and their baggage. Comprised of nine chapters and 45 provisions, the SMPS covers the overall matters pertaining to passenger transport, baggage transport, transport fees, transport liabilities, the scope of liabilities, and claims.

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10 Korail, "UN General Assembly of Continental Railways to be Held in Seoul Next Month!," press release, March 15, 2019.
Based on Korea National Railway, *Transcontinental Railway Network - The Current Status of OSJD and Transport System,* 2014, pp. 14~19.

Table 1_International Agreements (Treaties) on Inland Transport

Agreement (Treaty) or Organization	Members	Key participants	ROK's status
· Customs Convention on Containers (CCC)	40 countries and regional associations	EU, Russia, China, US	ROK (1981) North Korea ×
· Customs Convention on the International Transport of Goods under Cover of TIR Carnets (TIR Convention)	76 countries and regional associations	EU, Russia, China, US	ROK (1982) North Korea ×
· Convention Relative au Contrat de Transport International de Merchandise par Route (CMR)	56 countries	Europe, some North African countries, Middle East countries	ROK × US × China ×
· Intergovernmental Organization for International Carriage by Rail (OTIF)	50 countries	Western Europe, North Africa, Middle East countries	ROK × China ×
· International Convention Concerning International Carriage by Rail (COTIF) · International Convention Concerning the Carriage of Goods by Rail (CIM)			
· Organization for Cooperation of Railways (OSJD)	28 countries	Eastern Europe, Russia, China	ROK (2018) North Korea (1956)
· Agreement on International Railway Freight Communications (SMGS) · Agreement on International Passenger Traffic by Rail (SMPS)			

Source: Present study

III. Proposals for Inland Customs Clearance Systems in Korea

The inland customs clearance systems proposed in this study are designed to prepare for the inland trading of goods from Europe, China, and Russia in the medium- to long-term. Once the inland customs clearance systems for general goods are completed, tariff-exempt North Korean goods can be handled within the same framework. The parts of the systems that are applicable to goods imported by air or sea should also be applied to such goods. However, new systems will be further required, given the characteristics of inland customs clearance. Overall, the customs clearance system should be designed such that it complies with the requirements specified in these international agreements, in order to be sustainable.

Customs clearance systems can be grouped into two categories: cargo customs clearance and passenger customs clearance. The World Customs Organization (WCO) recommends establishing separate customs clearance systems for cargo and passengers. Here, we discuss

inland customs clearance systems for cargo separately from passenger inland customs clearance systems. Railways and roads are two of the most widely used inland modes of cargo transport. As such, matters applicable to both railway and roads are discussed in the sections on the mode of transport more closely associated with the matter. Finally, we discuss the control of risk factors unique to inland customs clearance, and the necessity and importance of cross-border cooperation.

1. Proposals for Cargo Inland Customs Clearance

A. Customs Clearance System for Railway Cargo

1) Inland Customs Clearance Station

A train crossing a national border stops at a customs clearance station. The section of the railway between the inland border and the customs clearance station is designated as the tariff passage. The Korea Customs Service has designated two border customs clearance stations: Dorosan Station and Jejin Station. As such, cargo transported by rail must go through one of these two stations.

In the future, if a large amount of goods is exported or imported inland through North Korea, the current border customs clearance stations may become overloaded. Therefore, a possible option for the ROK is to use the existing border customs clearance stations for passengers or for limited goods, and open new inland customs clearance stations for international railway cargo. Once the information of a train entering the national border is delivered to a border customs clearance station, the train can stop at the inland customs clearance station after passing through the border customs clearance station. Trains can transport cargo from the national border to inland locations without stopping, which restricts the possibility of misconduct or illegal elements during the process.

Countries such as the United States operate border customs offices dedicated to either cargo or passengers. In this case, the inland customs clearance station should be operated as a bonded area. A train stops in the bonded area to have its cargo inspected, and the cargo is unloaded, loaded, and inspected at the area. Such tasks require the installation of railway cargo inspection systems at airports and seaports. Just as imported and exported goods are transported from and to the ROK after reporting, storage, and quarantine processes at airports and seaports, the inland customs clearance station may provide the same customs clearance services. However, the station needs additional elements, including X-ray

equipment dedicated to railway cargo and an inspection area.

2) Prior Submission of Manifest

Just as other countries with inland customs clearance systems, as well as the rules applicable to the ROK airports and seaports, a manifest for railway cargo should be submitted to the customs office prior to the arrival of the cargo at the office. By revising the manifest in advance, the customs office can identify illegal cargo and select cargo that will be subject to additional inspection. The inspection allows the office to monitor and control wrongful and/or illegal trade.

The WCO recommends manifest submission 24 hours in advance for air and sea transport, and 1 to 2 hours in advance for inland transport. Following these guidelines, the ROK can include a requirement to submit a manifest 1 to 2 hours prior to arrival in the customs clearance system.

3) Multimodal Transshipment

International multimodal transport refers to the transport of goods using two or more modes of transport under a single international cargo transport agreement. For example, a product exported from the ROK to the United States East Coast can be transported first to the West Coast by sea, and then transported to the East Coast by rail.

Currently, multimodal transport in the ROK only consists of combinations between sea transport and air transport. However, once inland cargo transport begins in the ROK, the country will see various forms of multimodal transshipments, including those between railway and roads, ships and railway, and airports and roads. Such diversity will increase the workload on the customs office, relative to the current level.

With regard to multimodal transshipments, new regulations must be enacted for international cargo transported using modes of transport certified under the TIR Convention, as well as a guarantee system for transfer cargo.

The relevant systems need to be improved in preparation for the addition of various multimodal transport routes. In addition, the efficient management and transfer of inland cargo going through the ROK need to be ensured by, for example, linking the UNI-PASS system with railway and road carriers in order to facilitate information exchanges, and by enacting domestic regulations on transport and inspection procedures between inland railway stations and border stations.

4) Domestication of International Agreements on International Railway Transport

International railway transport is largely governed by two major international agreements: the CIM led by the OTIF, and the SMGS led by the OSJD. The CIM governs European countries, as well as some North African and East Asian countries. The SMGS member states mostly consist of Asian countries, including the ROK, North Korea, China, and Mongolia.

As both the ROK and North Korea are members of the SMGS, the waybill and rules under the SMGS will apply to cargo exported or imported to or from SMGS member states via North Korea.[11] However, the SMGS waybill is not recognized for cargo exported or imported to or from non-SMGS member states via North Korea. To improve on the situation, the OTIF and the OSJD introduced the CIM/SMGS consignment note for railway cargo transport between countries subject to the CIM and the SMGS. The CIM/SMGS consignment note is recognized as a CIM waybill in CIM countries, and an SMGS waybill in SMGS countries, thereby increasing the efficiency of cargo transport going through countries subject to different agreements.

With its approval by Russia in 2010, the CIM/SMGS consignment note is on its way to becoming the common waybill form for intercontinental railway transport. However, neither the ROK nor North Korea have adopted the CIMS/SMGS consignment note. Currently, the ROK does not require the note because it does not trade any goods by rail. North Korea appears to have no need for the CIM/SMGS consignment note because its railway cargo mainly comes from China, and the consignment note is already required for railway transport in Europe.

As such, the adoption of the CIM/SMGS consignment note is not urgently needed. However, given the rapid growth of intercontinental railway transport between China and Europe, it is recommended that the ROK focus on adopting the CIM/SMGS consignment note in the long term, in order to prepare for railway transport from and to Europe. China has already adopted the CIM/SMGS consignment note, which can be used as a replacement for a SMGS waybill. Therefore, the early adoption of the CIM/SMGS consignment note will allow the ROK to operate railway transport using a single waybill form.

However, for the CIM/SMGS consignment note to have meaningful effect, both of the Koreas will need to adopt the form. Therefore, inter-Korean cooperation will be required in

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[11] While the SMGS provides for a waybill form, the actual form used in practice is an adapted version based on the SMGS form.

order to induce North Korea's full participation.

5) Inter-Korean Cargo and Transfer Cargo

Existing systems and rules on inter-Korean trade are based on the assumption that the starting points and destinations are all located in either North Korea or the ROK. However, once inland transport resumes, goods will be transported to and from China, Russia, and even Europe, and will inevitably go through North Korea. However, under the current regulations, regardless of whether the final destinations of the goods are in North Korea, all goods transported to and from North Korea require a cooperation business operator approval and the export/import approval from the Ministry of Unification. In addition, a manifest should be prepared for all imported goods. However, applying the same requirements for additional approval and reporting to goods imported and exported via North Korea may disrupt international trade by inland transport. To address this issue, a dual management system should be designed to distinguish between goods originating from or arriving at North Korea, and goods simply passing through North Korea, and to then apply less demanding import/export procedures for the latter.

B. Customs Clearance System for Road Cargo

Goods imported and exported by road can be transported by trucks, passenger cars, buses, and other inland modes of transport. Passenger cars and buses are designed for passenger transport, along with their baggage and other belongings. As such, in this section, we will focus on cargo transported by trucks.

1) Inland Customs Clearance Areas

Goods imported and exported by roads must go through customs clearance areas at a national border. The ROK currently operates customs clearance areas in Dorasan Mountain and Goseong. These two areas serve as border customs offices for goods from the Kaesong Industrial District and for passengers visiting Mount Kumgang.

After the revitalization of inland transport, the current customs clearance areas may not be sufficient for handling the increased import and export volume that will occur via North Korea. Some countries including the United States operate border customs offices that specialize in either cargo or passengers. Likewise, the ROK needs to consider using its existing

border customs clearance areas for passengers or for goods from the Kaesong Industrial District, and to then set up inland customs clearance areas for road-transported goods, similar to the existing inland customs clearance station. However, unlike railways, the nature of road transport poses risks of switching or removing cargo before its arrival at the inland customs clearance area.

Therefore, once goods get past national border, they need to be transported under the principle of bonded transport or the TIR Convention.

Inland customs clearance areas require X-ray equipment for vehicle cargo, cargo inspection equipment, and container inspection equipment. Vehicles carrying cargo containers can be inspected using the same approach as for containers imported into the ROK by rail.

Another possible option is to operate separate border customs clearance areas specializing in cargo or passengers, respectively. The ROK can use the existing border customs clearance areas in Dorasan Mountain, Goseong, and Dorasan Station for passengers only, and then build a separate border customs clearance area for cargo. The WCO also recommends establishing separate customs clearance systems for cargo and passengers.

2) Entry Procedures for Transport Vehicles

Transport vehicles passing national borders should be registered in advance. All transport vehicles traveling to and from the Kaesong Industrial District should be registered with the border customs office. After the revitalization of inland transport, there will also be transport vehicles of third countries carrying goods into the ROK. Such vehicles should be also required to be registered with the customs office. In addition, the ROK needs to follow the international customs of managing transport vehicles of third countries under the TIR Convention. As previously mentioned, the TIR Convention has 70 members, including European countries and China, with the ROK also being a member of the convention.

Ships and aircraft carrying cargo do not cross the customs line. However, inland transport vehicles travel past national borders. As such, they need to be managed by the customs office. If such a truck is sold in the ROK as a used car, it would constitute an illegal sale/purchase of vehicle not imported into the ROK. Therefore, the arrival and departure of such a transport vehicle should be reported to the customs office, along with additional management measures from the office.

3) Time Requirement for Inland Customs Clearance

Inland customs clearance should be conducted faster and shorter than is required for sea or air customs clearance. Goods transported by sea or air should be unloaded from the aircraft or ships and moved for customs clearance. In general, unloading large volumes of goods from ships for customs clearance requires a significant amount of time. In addition, after customs clearance, these goods are carried by domestic modes of transport in the ROK. On the other hand, while the volumes of goods transported inland are small, cargo carriers still have to wait for the customs clearance process to be completed. In addition, when the number of such cargo vehicles is large, the volume may cause side issues such as traffic congestion and increase the accommodation needs of carriers.[12] Therefore, inland customs clearance should be conducted faster than transport by air or sea. As such, the pre-registration of vehicle and driver information and pre-submission of cargo manifests are crucial for rapid customs clearances and risk control. Pre-submitted driver information and manifests can then be used to identify cargo (vehicles) requiring inspection. Therefore, systems are required for the pre-submission of the required information.

Customs clearance can be expedited by introducing a type of pre-screening system utilizing pre-registration of vehicles crossing national border and attaching them with radio-frequency identification (RFID) marks for electronic identification.

To cite another example, the Estonian customs office has a booking system in place to reduce the wait times of cargo carriers. It offers a time slot selection feature that allows carriers to locate and book available time slots for customs inspections.

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[12] According to a customs office in Estonia, during peak hours, trucks carrying goods from Estonia to Russia once had to wait for five to six days for customs clearance.

Figure 2_Customs Inspection Time Slot Table in Estonia

Select your border crossing time

17. May	18. May	19. May	20. May
Full	Full	00:00-01:00	00:00-01:00
Full	01:00-02:00	01:00-02:00	01:00-02:00
Full	02:00-03:00	02:00-03:00	02:00-03:00
Full	03:00-04:00	03:00-04:00	03:00-04:00
Full	04:00-05:00	04:00-05:00	04:00-05:00
Full	05:00-06:00	05:00-06:00	05:00-06:00
Full	06:00-07:00	Full	06:00-07:00
Full	07:00-08:00	Full	07:00-08:00
Full	08:00-09:00	08:00-09:00	08:00-09:00
Full	Full	09:00-10:00	09:00-10:00
Full	Full	10:00-11:00	10:00-11:00
11:00-12:00	11:00-12:00	11:00-12:00	11:00-12:00
12:00-13:00	12:00-13:00	12:00-13:00	12:00-13:00
Full	13:00-14:00	13:00-14:00	13:00-14:00
14:00-15:00	14:00-15:00	14:00-15:00	14:00-15:00
15:00-16:00	15:00-16:00	15:00-16:00	15:00-16:00
16:00-17:00	16:00-17:00	16:00-17:00	16:00-17:00
17:00-18:00	17:00-18:00	17:00-18:00	17:00-18:00
18:00-19:00	18:00-19:00	18:00-19:00	18:00-19:00
Full	19:00-20:00	19:00-20:00	19:00-20:00
20:00-21:00	20:00-21:00	20:00-21:00	20:00-21:00
Full	21:00-22:00	21:00-22:00	21:00-22:00
22:00-23:00	22:00-23:00	22:00-23:00	22:00-23:00
23:00-00:00	23:00-00:00	23:00-00:00	23:00-00:00

Source: WCO (2017), p. 109.

4) Customs Clearance Under the TIR Convention

The TIR Convention is a customs convention pertaining to the international transport of goods under the coverage of the TIR carnets. To transport goods under the TIR Convention, the vehicle should be registered in advance. The TIR Convention applies to both individual vehicles and containers. After the vehicle is checked for TIR approval and the reported goods are inspected and sealed at the customs office of the starting location, the customs office at the stop over area inspects the manifest and checks the seal. Then, the customs office at the destination runs a final inspection of the reported goods and checks the seal for any damage, before clearing the goods.

All cargo transported under the TIR Convention should be delivered within the set time point, depending on the pre-suggested transport routes. The customs offices at the starting point checks the container seals, transport schedules, and transport routes in order to prevent illegal acts during transport. Goods transported under the TIR Convention can go through multiple stopover points during delivery. However, the number of starting and arrival customs offices may not exceed 4. This regulation pertains to the risk control of goods transported under the TIR Convention. If goods pass through multiple locations, a new approval is required under the TIR Convention.

The ROK regulations on inland transport should incorporate the document, seal, and inspection requirements and methods current established under the TIR Convention. However, more detailed provisions of the TIR Convention need to be domesticated in the form of Korea Customs Service Public Notifications.

5) Distinction Between Specific North Korean Goods and International Goods

Currently, tariffs are not applied to North Korean goods, including those produced in the Kaesong Industrial District. However, tariffs are imposed on goods imported from other countries depending on their places of origin. Once goods from other countries begin to go through the ROK inland customs clearance, North Korean goods that can be easily separated and managed, such as those from the Kaesong Industrial District, should be eligible for simplified customs clearance procedures for faster clearance. Another possible option is to inspect goods after separating them into Kaesong Industrial District goods and the other goods. In addition, the customs clearance efficiency can be improved by applying rapid customs clearance procedures to goods that are frequently cleared, and to those that can be easily separated and managed.

2. Proposals for Passenger Inland Customs Clearance

Here, we separate custom clearance for passengers traveling by rail or roads in to two aspects: short-term and long-term. The reason for this distinction is that the two Koreas will need to make agreements across several levels before people can freely travel through the inter-Korean borders. The scope of travel can be first limited to a specific group of people, such as personnel related to the Kaesong Industrial District. Later, it can be widened to include all passengers visiting Mount Kumgang, and people from third countries can even be allowed to pass the inter-Korean border. In this section, we analyze the unique characteristics and limitations of customs clearance for passengers traveling inland, and explore inland customs clearance systems applicable to those passengers in the medium- to long-term. Then, based on our findings, we move on to passenger inland customs clearance systems that are applicable in the short term.

A. Border Control
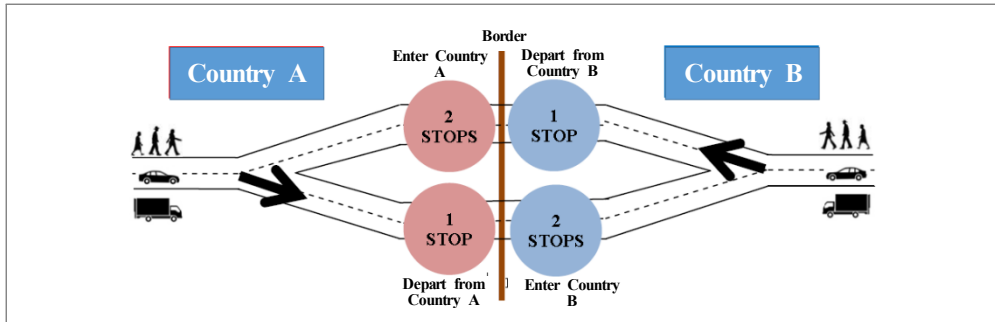
1) Border Customs Clearance Area

Currently, a person visiting the Kaesong Industrial District by passenger car must register the driver and the vehicle in advance. Only the driver is allowed to be in the vehicle. All companies personnel are transported by bus. When crossing the border, the driver goes through the clearance process without disembarking from the vehicle. Both the ROK and North Korea have their own immigration offices in their respective territories. As such, inspections and searches are conducted at each office.

Customs clearance for inland passengers requires clear cooperation between countries sharing borders in the entry/departure and clearance process. Under the traditional border control method, the departing country and the arriving country separately conduct the entry/departure procedures for cross-border passengers. It means that similar procedures are repeated only a few meters apart, which undermines the efficient use of time and expenses. The Agreement on Trade Facilitation of the World Trade Organization (WTO) emphasizes cooperation between border-sharing countries, and mentions the establishment of one-stop border posts (PSBPs). In addition, the WCO recommends the establishment of juxtaposed customs offices in cooperation with neighboring countries in the Revised Kyoto Convention.

In the short term, the ROK can use Dorasan Station, in addition to the border customs clearance areas in the Dorasan Mountain and Goseong, for passenger customs clearance. The

ROK and North Korea currently operate traditional two-stop border posts, with both countries conducting entry/departure procedures for passengers in their respective territories.

Figure 3_Traditional Border Control Two-stop Border Post

Source: African Union Development Agency (2016), p. 53, Figure 1-3.

In the long term, as recommended by the WCO, juxtaposed OSBPs can expedite customs clearance process for passengers. By conducting border control activities at juxtaposed OSBPs at Dorasan Station or in the border customs clearance area in Dorasan Mountain or Goseong, the two Koreas will be able to facilitate the exchange of information and communication between the two Koreas' border control agencies, and thereby reduce costs by sharing facilities.

Figure 4_Juxtaposed OSBP Model
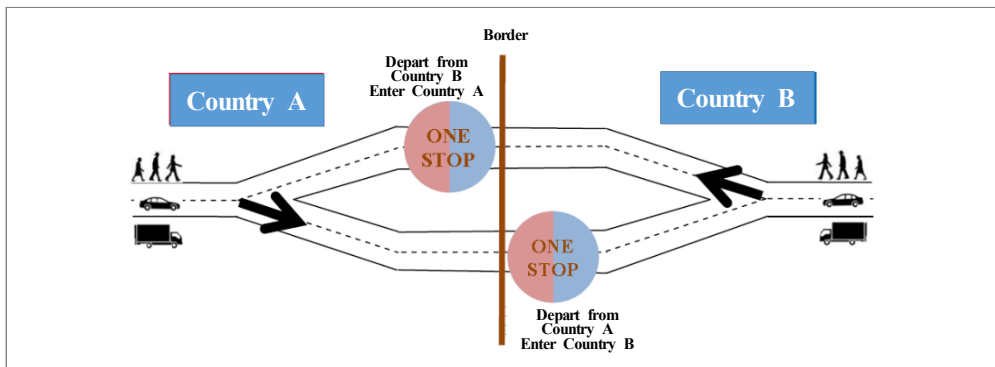
Source: African Union Development Agency (2016), p. 55, Figure 1-4.

Another possible option is to operate separate border customs clearance areas specializing in either cargo or passengers. As previously mentioned, the ROK can use the existing border customs clearance areas in the Dorasan Mountain and Goseong, as well as those in Dorasan Station, for passengers only, and build a separate border customs clearance area for cargo.

2) Passenger List

All vehicles and drivers crossing national borders should acquire visas issued in advance, and submit the list of passengers in the vehicle prior to arrival. A vehicle crossing a national border should be registered with the customs office so that the latter can identify the vehicle, as well as the driver and the passenger list, in advance.

The same condition applies to passengers crossing the border by sea or air. ROK customs offices collects lists of passengers entering the ROK by sea or air, and uses the Advance Passenger Information System (APIS) to detect and inspect high-risk passengers. The same risk control measures can be applied to inland passengers, including the pre-collection of passenger lists and the use of the APIS information. These are basic measures that are being applied to passenger customs clearance.

3) Management of Transport Vehicles

Inland customs clearance is distinguished from the customs clearance of passengers entering the country by sea or air by the fact that, after customs clearance, the same vehicle continues to carry passengers past the national border. Aircraft and ships carrying international passengers do not continue to carry passengers to their final destinations. Unlike trains, which operate on railways, passenger cars and buses can freely travel in the ROK, which means that there a need to control drivers and their vehicles.

Under the ROK Customs Act, all vehicles and drivers crossing a national border should acquire visas issued in advance. In addition, the customs office should control vehicles crossing the national border. If a passenger car carrying passengers across the national border is sold in the ROK in a used car market, it would constitute an illegal sale/purchase of vehicle not imported for sale in the ROK. Other issues include the evasion of tariffs and value-added taxes (VATs), in addition to environmental certifications including those for noise and exhaust gas. As such, the customs office must track whether vehicles crossing the border into the ROK subsequently leave the country across the border. In the case of operating multiple border customs clearance areas, a system should be developed to identify such vehicles.

B. Customs Clearance for Inland Passengers

1) Customs Clearance for Passengers

There are two major types of vehicles transporting passengers by road: passenger cars and buses. In the case of using railway, passengers are transported by passenger trains. A bus carries more passengers than a passenger car, and a train has more capacity than a bus. As such, the border customs clearance procedures for passengers will vary depending on the mode of transport.

Passengers are required to visit a border customs clearance area while carrying their carry-on items for review and inspection, and then return to their vehicle to cross the border. Passengers traveling by air or sea do not have any choice but to disembark from the vehicle and pass through a border customs clearance area with their carry-on items. However, it is possible for inland passengers to complete customs clearance without disembarking from the vehicle, which sets them apart from passengers at airports or seaports.

Currently, passengers visiting Mount Kumgang and other areas in North Korea are required to disembark from their vehicles for review and inspection. The current approach is viable when the number of border-crossing passengers is small. However, as the number of passengers increases in the long term, the current approach will increase the time required for customs clearance, as well as increase the inconvenience felt by passengers. For this reason, the current system is not feasible when passengers from other countries will frequently cross the inter-Korean border in the medium- to long-term. Granted, in the absence of appropriate control over passengers by customs offices or the Ministry of Justice, disembarkation may continue to be required for review and inspection.

Passengers traveling in passenger cars may be allowed to go through the process while remaining in their vehicles if they have submitted passenger lists in advance, as the number of passengers in each group is small. The clearance process can be further expedited by using a pre-screening program similar that used in the United States. For passengers that need to be separately inspected, they can be escorted to a separate inspection area before being allowed to cross the border.

Another option worth considering is to apply simplified procedures to frequent passengers, such as Kaesong Industrial District personnel, by exempting them from certain document requirements.

Passenger trains can accommodate more passengers than buses. Customs clearance for train passengers can be conducted by requiring them to disembark and then return after the

clearance process, or they may be allowed to complete the process while staying in the vehicle. As for the latter approach, we need to consider both entry control requirements imposed by the Ministry of Justice as well as clearance by the customs office.

For these reasons, inland customs clearance practices for passengers differ from one country to another. In Hong Kong, all inland passengers traveling from China are required to disembark from their vehicles for customs clearance. The same practice applies to passengers traveling from Mexico or Canada into the United States by bus. Passengers in passenger cars are required to disembark from their vehicles for customs clearance. However, the United States has a type of pre-screening program in place, which allows passengers to be cleared while sitting in their vehicles. Turkey conducts customs clearance with passengers remaining in passenger cars. As for buses, passengers are required to leave the vehicles while carrying their personal items, and then return to the bus after the customs inspection. The same applies to bus passengers entering Russia. However, train passengers go through customs while remaining in the vehicle.

One of the drawbacks of rapid customs clearance conducted with passengers remaining in their vehicles is that it adds to the difficulty of risk control. On the other hand, requiring all passengers to disembark with their personal items increases the time and cost of the customs clearance. The issue is simple for passengers at airports and seaports, as they have to disembark from the vehicle to go through customs. For passengers traveling by car, the customs office has the option of allowing them to remain in their vehicles during the process, which further complicates the task of determining the most appropriate solution. The ROK can consider requiring passengers to disembark in the short term while the number passengers remain low, and after acquiring information on passenger risk in the long term, establish separate clearance procedures for passengers traveling by passenger cars, buses, and trains.

2) Passenger Pre-Screening Program

The United States has a type of pre-screening program for passengers entering the country from Canada and Mexico, called the Trusted Travelers Program. The program is designed to ensure rapid border-crossing for pre-approved low-risk passengers.

The purpose of the program is to reduce the congestion cost associated with inland customs clearance, and selectively control passenger risks by distinguishing between low-risk and high-risk passengers. The program benefits passengers as well, as it reduces the wait time as well as the time and cost of immigration review, customs clearance, and inspection.

3. Unique Characteristics of Inland Customs Clearance

Once revitalized, inland trade will pose additional risks not found in customs clearance for air and sea transport. In addition, inland customs clearance requires cooperation from neighboring countries because it is conducted by countries on either side of the border.

A. Risks Associated with Inland Customs Clearance

1) Cargo Customs Clearance

Customs clearance for cargo transported by roads poses greater challenges than cargo transported by railways. Manifests should be submitted 24 hours in advance for all goods imported by air and sea, and the goods can be inspected at the relevant airports and seaports over a certain period of time. On the other hand, manifests for cargo transported by land should be submitted by 1 to 2 hours in advance. The WCO recommends the same time requirements, as the volume of inland transport per vehicle is smaller than for air and sea transport. However, with such a large number of transport vehicles, the customs office does not have enough time to inspect them all. In addition, waiting for customs clearance has different connotations for inland transport than for air or sea transport.

When the scope of transshipment expands to include trains and trucks, the types of multimodal transshipments will also be diversified, and international goods will be transported all across the ROK. This change requires the application of international standards, as well as the control of risks associated with bonded transport. These factors add to the burden felt by the customs offices. For this reason, measures for the efficient management of multimodal transshipments need to be introduced, including creating a linkage between the UNI-PASS system and the systems at railway and road carriers.

Controlling the risks associated with inland customs clearance for goods transported on roads requires the ability to identify information about cargo and carriers in advance, and then separating low-risk goods from high-risk goods. For this task, the ROK needs to implement measures to identify carrier and cargo information in advance, subject high-risk goods to extensive inspection including X-ray, and minimize the clearance time for low-risk goods. The FAST program in the United States and Canada provide a good reference point. Other measures worth considering include a booking system similar to the one adopted by the Estonian customs office, so as to reduce complaints of long wait times and congestion, and to allow sufficient time for inspections.

2) Customs Clearance for Passengers

Inland customs clearance for passengers poses additional risks. To start with the obvious risk passengers entering by land are more difficult to control than those entering by sea or air.

The latter passengers have to go through airports and seaports before traveling to their respective destinations. For this reason, all passengers from aircraft or ships have to carry their personal belongings out of the vehicles. As it takes considerable time to move to the airport or the seaport, the customs office can use the time to inspect the consigned baggage. However, for inland customs clearance, passengers can simply return to their vehicles—even when they are asked to disembark—which may not give the customs office enough time to inspect the passengers' baggage. On the other hand, subjecting them to a prolonged inspection may give rise to complaints.

In addition, inland passengers may hide illegal items in their cars or trains, and not bring them to the inspection area. It is difficult to discover items hidden in cars or trains. As such, preventing inland passengers from transporting drugs, weapons, and other items that may pose threats to public safety is expected to be more difficult than controlling passengers entering the ROK by sea or air.

According to the European Border and Coast Guard Agency, 84% of the detections and seizures of illegal firearms during customs clearance were at inland customs, followed by airports (13%), and seaports (3%). Seaport seizures comprised 52% of the drugs seized during customs clearance, slightly surpassing inland customs. However, inland customs officers discovered a wider range of drugs in small quantities in passenger cars, buses, and truks.[13]

The adoption of pre-screening passengers needs to be considered in order to supplement the risk control by inland customs clearances. The purpose of the pre-screening is to expedite the clearance of low-risk passengers and to then focus on high-risk passengers using the passenger information provided.

The need to control the vehicles used by passengers adds to the burden imposed on the customs offices. The illegal sale of vehicles entering the ROK for transport purposes may cause various problems, which means that the customs offices should track vehicles entering the ROK to ensure that they also leave the country. In the case of operating multiple border customs clearance areas, a system should be developed to identify such vehicles.

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13 European Border and Coast Guard Agency (2020), pp. 39~41.

B. Cooperation Between Neighboring Countries

Cross-border cooperation is crucial for inland customs clearance operations. Airports and seaports are not located at borders shared by other countries. On the other hand, immigration and customs clearance at inland borders need to be conducted in close cooperation between the neighboring countries. International organizations have highlighted this need in their documents.

Article 8 of the WTO Agreement on Trade Facilitation emphasizes the need for cooperation between border-sharing countries. Specifically, the agreement proposes the alignment of working days and hours, alignment of procedures and forms, development and sharing of common facilities, and joint control of the areas. The agreement also lists the establishment of OSBPs as an example of cooperation and coordination between countries. The WCO recommends the establishment of juxtaposed customs offices in cooperation with neighboring countries in the Revised Kyoto Convention.

Finally, the most difficult yet essential element for the operation of inland customs clearance system in the ROK is cooperation with North Korea in border control areas. The North Korea customs' cooperation is important for the facilitation of inland customs clearance in the south. Therefore, the ROK needs to consider operational alignment and harmonization with the North Korean customs system, including the exchange of information and joint control of specified areas. In addition, facile trade can only be expected when the goods going through the North Korean customs office are managed in accordance with international standards.

IV. Conclusion

In this study, we conducted basic research aimed at the need to develop customs clearance systems in preparation for the future commencement of inland customs clearance via North Korea. The ROK currently imports and exports goods by sea or air, with no inland trade. As such, the country's customs clearance systems are currently focused on air and sea transport.

Various international agreements have been signed to promote the facile and effective inland trading of goods between countries. Among these agreements, this study examined the CCC, the TIR Convention, the CMR, the COTIF, the CIM, the SMGS, and the SMPS. As customs clearance is an international trade issue involving multiple countries, all systems need to be designed to satisfy requirements in the relevant international agreements in order to

ensure medium- to long-term sustainability.

Once inland transport is revitalized, it will increase the workload of customs offices, and the control of customs clearance risk will emerge as one of the key missions. Unlike airports and seaports, cargo transport by roads is characterized by the need for drivers to wait for customs clearance. Therefore, when the total volume of cargo on standby increases, the need for rapid clearance conflicts with the need for risk control, adding difficulties to the customs clearance work. In addition, when the scope of transshipments expands to include trains and trucks, the types of multimodal transshipments will become further diversified, and international goods will be transported all across the ROK. This change will require the application of international standards, and will also increase the significance of the control of risks associated with bonded transport. The same concern applies to inland customs clearance. The ease of travel by roads and railways is likely to further increase the number of inland travelers. Items hidden by inland travelers in trains and vehicles are commonly difficult to find.

When the period of inland customs clearance begins, the control of risks pertaining to wrongful or illegal trade will emerge as a key issue for the customs administration. Therefore, the ROK needs to find ways to control such risks.

Finally, unlike customs clearance by sea or air, cross-border cooperation is important for inland customs clearance operations. Therefore, to facilitate inland customs clearance, cooperation from the North Korean customs office is essential. The ROK needs to consider harmonization and operational alignment with the North Korean customs system. In addition, facile trade can be only be expected when goods going through the North Korean customs office are managed in accordance with international standards.

The ROK is surrounded by the sea on three sides. However, as it shares its only inland border with North Korea, the country has been operating its customs clearance systems focused solely on air and sea transport. For this reason, research on inland customs clearance holds great significance for the ROK's preparation for the possible opening of inland trade in the future. In this study, we focused on inland customs clearance for general imported goods. In the long term, once the inland customs clearance for general imported goods begins, we expect that our preliminary findings on inland customs clearance systems can be used as foundational data. In addition, we expect that, through further study on inland customs clearance systems for the ROK, the ROK will be able to develop systems that fit the country's needs.

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An Analysis of the Corporate Tax Incidence Using Industrial Variations

Bitmaro Kim*

I. Introduction

In typical cases, the persons taxed by laws and tax systems do not completely match the persons who bear the actual tax burdens. The term "tax incidence" refers to the distribution of the actual tax burden. For the individual income tax, the incongruence between persons taxed under the law and those bearing the actual tax burdens could be relatively small. However, the congruence between the two groups is likely to be significant for the corporate tax, because it is imposed on legal entities that serve as conduits for profits.

Corporate taxes are one of the largest sources of tax revenues, along with income tax and value added tax (VAT). It is also a major policy instrument that directly affects firms' after-tax returns and their employment, investment, and R&D choices. Therefore, it is highly important to reflect how economic agents respond to changes in corporate tax burdens, and how actual corporate tax burdens are distributed when designing corporate tax policies.

Many researchers have taken interest in the incidence of corporate tax burdens. Despite this extensive research, however, consensus on the incidence of the corporate tax have yet to be achieved. As such, an empirical analysis on the incidence of the corporate tax based on the latest data would provide highly useful reference points for designing corporate tax policies.

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To this end, this study first presents theoretical findings that the incidence of corporate tax burdens may vary depending on the market structure, and empirically estimates the incidence of corporate tax burdens using variations of marginal effective tax rates across industries. Firms in the same country may use different asset mixes across industries. Therefore, the marginal tax rate that an average firm faces varies depending on the industry. As such, this study combines the estimates on the marginal effective tax rates applicable to different asset types from previous studies with industry-specific asset mix data to calculate industry-specific marginal effective tax rates. Then, it analyzes this data along with individual characteristics data to identify the incidence of the corporate tax in Korea. In particular, this study explicitly considers the market structure of each industry, to examine whether it affects the corporate tax incidence.

This report proceeds as follows. Chapter II reviews previous literature to understand the major channels and key factors affecting the corporate tax incidence. Chapter III explains the empirical approach and findings. Chapter IV presents the conclusions of this study.

II. Theoretical Discussions on the Incidence of the Corporate Tax

This chapter reviews previous theoretical studies pertaining to the corporate tax incidence on different economic agents. It first looks into the early findings of Harberger, based on assumptions of closed economy and perfect competition, and provides an intuitive explanation on the channel of corporate tax incidence. Then, the chapter introduces theoretical findings on the corporate tax incidence under imperfect competition, which are closely related to the empirical analysis in Chapter III. Lastly, key previous studies are selected and presented in order to explain the key channels and economic intuitions on the incidence of the corporate tax burdens in an open economy.

1. Closed Economy Models

A. Perfect Competition

Harberger (1962) provided a seminal early study by theoretically analyzing the incidence of the corporate tax. He used a two-sector and two-production factor general equilibrium model to analyze the economic effect of the partial factor tax (corporate tax) on corporate capital. Harberger (1962) also imposed many assumptions for simplification, including a

closed economy, perfect competition, free movement of production factors, and the fixed total volume of production factors. This section focuses on the major channels through which corporate tax burdens are beared by economic agents in the simple model economy proposed by Harberger (1962).

In his model, the economy consists of the corporate sector and the non-corporate sector. There are two main production factors: capital and labor. All production factors can move freely between the two sectors, and the total amount of the production factors is fixed. In the simple model economy, the level of corporate tax incidence is determined by the output effect and the factor substitution effect. Here, the output effect refers to consumers in the final outputs market substitutes away from the non-corporate sector to the corporate sector, due to the price increase of corporate sector outputs driven by the taxation of capital held by firms (corporate tax). In turn, changes in the demand for final goods affect choices on the production factors used in the goods. The factor substitution effect refers to the partial replacement of capital with labor in the corporate sector, due to an increase in capital costs driven by the imposition of the corporate tax. As such, the corporate tax affects both the product market and the production factor market.

The incidence of the corporate tax can be identified by looking into how the relative prices $(\frac{r}{w})$ of production factors change. For example, an increase in the relative price of a production factor $(\frac{r}{w})$ implies a relative decline in wages, which can be interpreted as labor bears more corporate tax burdens.

Changes in the relative prices of production factors are affected by whether the relevant industry is capital-intensive or labor-intensive, the demand elasticity and cross elasticity of final goods (between the final goods from the corporate sector and those from the non-corporate sector),[1] and the rate of technical substitution between production factors in each sector.

First, how the output effect affects $\frac{r}{w}$ varies depending on whether the relevant industry is capital-intensive or labor-intensive. The output effect reduces the production of final goods

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[1] Harberger (1962) assumes that the final goods from the corporate sector are starkly different from those from the non-corporate sector. Therefore, the substitution elasticity of final goods is implied to be very small. Subsequent studies used the differentiated product model (DPM) and the mutual production model (MPM) to analyzed the incidence of corporate taxes under weaker assumptions.

from the corporate sector, which indicates a decline in the production factors (labor and capital) employed to produce final goods. Therefore, if the relevant industry is labor-intensive, the relative price declines ($\frac{r}{w}$ increases). On the other hand, in a capital-intensive industry, the relative price of capital declines ($\frac{r}{w}$ decreases). Also, the output effect is amplified if the demand elasticity of the final goods from the corporate sector is more elastic. In cases where the demand for final goods from the corporate sector significantly drops in response to relative price increase, the resulting redistribution effect of production factors also increases. The rate of technical substitution also affects changes in relative factor prices. If the rate of technical substitution in the corporate sector is high, indicating an easier substitution between capital and labor, it amplifies the factor substitution effect and the incidence of corporate tax burdens on capital. A higher rate of technical substitution in the corporate sector means that firms respond more sensitively to changes in capital prices in the corporate sector, significantly reducing capital and increasing labor. This results in a significant decline in the relative price of capital, which means the level of corporate tax burdens that capital bears increases.

Figure 1 represents the channels of corporate tax incidence in the simplest economic model assuming a closed perfect competition economy with two sectors and two production factors. In the model proposed by Harberger (1962), in a capital-intensive corporate sector, the imposition of the corporate income tax lowers the relative price of capital ($\frac{r}{w}$ decreases). In a labor-intensive corporate sector, the direction of change in the relative price of price ($\frac{r}{w}$) is unclear. In other words, in a labor-intensive corporate sector, if the absolute size of the output effect is larger than the factor substitution effect, a larger corporate tax burden lands on labor.

Harberger (1962) is one of the earliest studies analyzing the economic effect of the corporate tax from the perspective of general equilibrium, and had a great influence on subsequent studies. However, it relies on somewhat unrealistic assumptions in order to analyze the corporate tax incidence. Importantly, it assumes that the total amount of production factors is fixed, which does not hold in cases where savings and investments are allowed or when production factors freely move between countries. In addition, the perfect competition assumption will not hold in real economy.

Figure 1_Output Effect and Factor Substitution Effect of the Corporate Tax
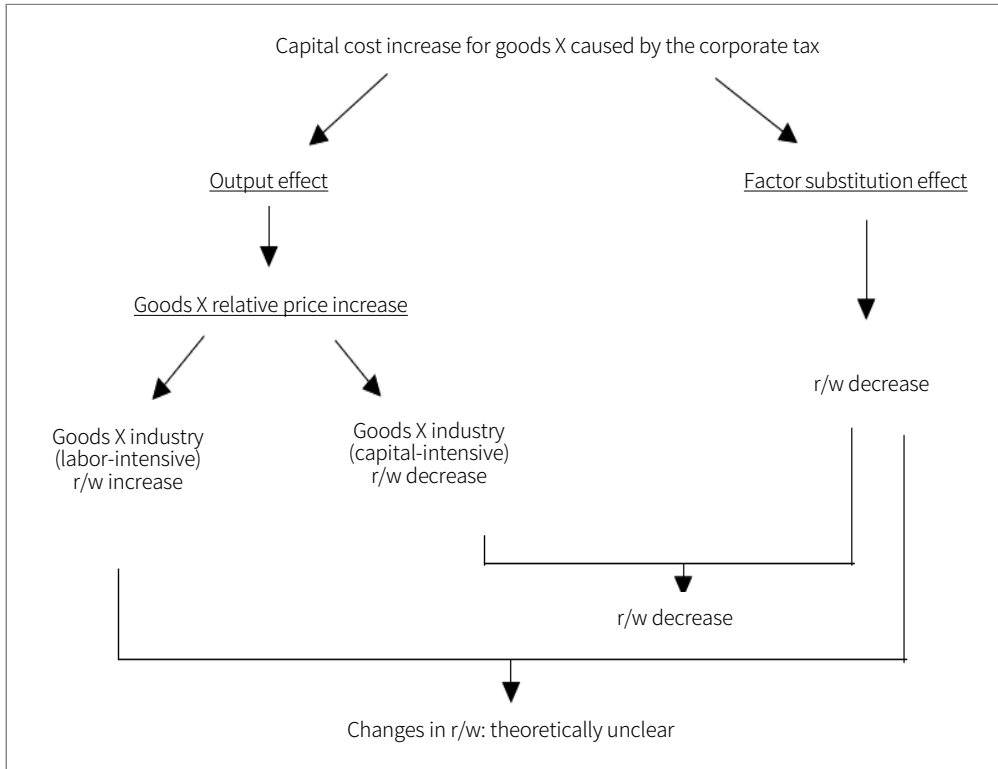
Source: Kim and Kim (2016), p. 91 [Figure 2]

B. Imperfect Competition

Davidson and Martin (1985) developed and analyzed a theoretical model for the incidence of the corporate tax with imperfect competition. Also, Liu and Altshuler (2013) conducted a comparative static analysis and empirically tested the theoretical findings of Davidson and Martin (1985). The main theoretical findings proposed by Davidson and Martin (1985) and Liu and Altshuler (2013) are summarized below.

In a labor-intensive corporate sector, an increase in the corporate tax may raise or lower the relative price of capital ($\frac{r}{w}$). If the size of the output effect and the imperfect competition effect is larger than the factor substitution effect, the majority of corporate tax burden lands on labor. On the other hand, if the factor substitution effect is larger than the sum of the other

two effects, the relative price of capital $(\frac{r}{w})$ declines. In other words, the majority of the corporate tax burden lands on capital. Also, in an imperfect competition market, imperfect competition effect magnifies the output effect. Therefore, in an imperfect competition market, labor bears more corporate tax burden than in a perfectly competitive market. In contrast, in a capital-intensive corporate sector, an increase in the corporate tax always lowers the relative price of capital $(\frac{r}{w})$. That is, the corporate tax burden mostly lands on capital. This is because, when the corporate tax is imposed, the relative price of capital is lowered not only by its factor substitution effect and output effect, but also by the imperfect competition effect. Therefore, in an imperfect competition market, the relative price of capital declines more than in a perfect competition market.

Table 1_Changes in the Relative Prices of Production Factors Driven by a Corporate Tax Increase

	Labor-intensive		Capital-intensive	
	Perfect competition	Imperfect competition	Perfect competition	Imperfect competition
Factor substitution effect	↓	↓	↓	↓
Output effect	↑	↑	↓	↓
Imperfect competition effect	-	↑	-	↓
Total effect	Unclear	Unclear	↓	↓↓

Source: Present study

Liu and Altshuler (2013) also proposed changes in relative factor prices driven by changes in the number of firms in the corporate sector.[2] In a capital-intensive industry, a decline in the number of firms (a higher level of concentration) works in a way that increases the relative price of labor even further. In a labor-intensive market, a decline in the number of firms lowers wages. They also found that the effect of the number of firms on the elasticity of wages with respect to the corporate tax rate in a labor-intensive industry is determined by the relative size of the factor substitution effect and the output effect.

2. Open Economy Model

Many of the early studies assumed a closed economy to analyze the effect of the corporate

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2 The number of firms can be understood as a proxy variable for the market concentration.

tax incidence. However, Harberger himself and other researchers conducted follow-up studies in an open economy.

Labor bears more corporate tax burdens in an open economy model, as capital is more mobile than labor, capital holders now can avoid corporate tax burdens by moving their investments abroad. Gravelle (2013) presents findings of key studies analyzing the incidence of the corporate tax in an open economy. In particular, in an open economy, it notes that the international capital mobility, the international production substitution, and the sizes of countries could also affect the incidence of the corporate tax.

Table 2_Additional Determinants for Corporate Tax Incidence in an Open Economy

Category	Share falling on capital	Share falling on labor
High international capital mobility	↓	↑
High international product substitution	↓	↑
Large country	↑	↓

Source: Gravelle (2013), p. 188 <Table 1>

A higher level of international capital mobility results in higher corporate tax burden falling on labor, which is less mobile. The imposition of the corporate tax lowers the after-tax return on capital in the corporate sector of the country, resulting in an overseas exodus of capital. When the capital stock of a country declines, the marginal productivity of the remaining capital increases until the after-tax return equals before-tax return. A smaller stock of remaining capital in the country indicates a lower marginal productivity of labor, resulting in relative decline of labor demand and lower wages. In other words, a higher international capital mobility results in more capital leaving the country, which in turn lowers the marginal productivity of labor and wages at a higher rate. In this sense, the international capital mobility is positively correlated with the share of the corporate tax falling on labor.

International product substitution also affects the incidence of the corporate tax. In the case of low substitution elasticity, firms have less room to move their capital overseas after the imposition of the corporate tax. Even if the country imposes taxes on its corporate sector, thereby increasing the prices of domestic products, the resultant decline in the demand for domestic products would be limited due to the low substitution elasticity. Therefore, the demand substitution elasticity of international products is also positively correlated with the share of the corporate tax falling on labor.

The size of the country determines its ability to influence global factor prices. In order to analyze the effect of the country size on corporate tax incidence, we can use an open economy

model that assumes perfect international capital mobility, and perfect substitution between domestic and foreign products. If the country is large enough to affect global factor prices, and the country imposes a corporate tax, the resulting exodus of capital stock will lower the world return to capital. In the taxed   country, the decline in capital stock increases the marginal productivity of domestic capital until it reaches the world return to capital. However, as the corporate stock leaving the country lowers the world return to capital itself, part of the corporate tax burden lands on capital. Therefore, when perfect capital mobility and product substitution are assumed, a higher level of corporate tax burden falls on capital in a large country.

Other than the three determinants discussed above, both the technical rate of factor substitution and the capital intensity of industries also affect the corporate tax incidence as in the closed economy model.

When rate of factor substitution is low, that is, if firms experience more difficulties in substituting capital with labor, the tax burden falling on labor increases. If the country imposes a corporate tax in a situation where labor and capital are not mutually substitutable, capital leaves the country and the decrease in capital stock lowers the labor demand and therefore wages. As a result, most corporate tax burdens fall on labor which are non-substitutable and immobile factor.

The capital intensity of the sector subject to the corporate tax is another key factor that determines the corporate tax incidence in either a closed or open economy. In a closed economy, higher capital intensity increases tax burden falling on capital due to the output effect. However, in an open economy, the direction of the effect may change depending on other factors including the international product substitution between domestic and foreign products and international capital mobility. To understand the above, let us suppose that there are two sectors where international movement of capital is allowed. In one of the sectors, domestic and foreign products are perfect substitutes. In the other sector, they are not perfectly substitutable. If the first sector is capital-intensive and the country imposes a corporate tax on the sector, domestic capital leaves the country, resulting in a wage decline. As a result, most tax burden lands on labor. On the other hand, if the second sector is capital-intensive and imposed with the corporate tax, the decline in product demand driven by domestic product price increase is limited, which restricts the amount of capital leaving the country. In other words, firms have less room for corporate tax burdens evasion by exporting their capital overseas, in which case most tax burden falls on capital. To summarize, in a closed economy, the share of the tax burden falling on capital is always high in a capital-intensive industry. On the other hand, in an open economy with low international product substitution,

tax burdens mostly fall on capital. In case of high international product substitution, the tax burden lands on labor due to the overseas exodus of capital.

Table 3_Effect of Capital Intensity on Corporate Tax Incidence in an Open Economy

Category	High capital intensity
High international product substitution	Tax burden on capital ↓
Low international product substitution	Tax burden on capital ↑

Source: Gravelle (2013), p. 188 <Table 1>

The above discussions show that in an open economy the corporate tax burden could fall on labor in an economic equilibrium, even with a capital-intensive corporate sector. However, it should be noted that these findings are not the result of adopting an open economy assumption alone. Gravelle (2013) emphasizes that the share of the corporate tax burden falling on labor increases only under certain conditions, such as a high international capital mobility and high international product substitutions. On the other hand, if the international capital mobility or international product substitutions is low, the tax burden may fall on capital—even in an open economy.

3. Implications

The incidence of the corporate tax in a closed economy can be summarized as follows. First, in a capital-intensive corporate sector, most of the corporate tax burden falls on capital. In a labor-intensive corporate sector, the result is unclear. In a closed economy with imperfect competition, if the relevant industry is labor-intensive, share of the corporate tax burden falling on labor increases. If the industry is capital-intensive, it increases the tax burden landing on capital.

In an open economy, where firms can avoid corporate tax burdens by exporting capital overseas, the majority of the corporate tax burden falls on labor, even if the industry is capital-intensive. In an open economy with low international product substitutions, the tax burden mostly lands on capital. In the case of high international product substitutions, the tax burden lands on labor due to the overseas exodus of capital.

These findings indicate that the incidence of the corporate tax is an empirical question, and the factors proposed by the theories explained above should be accounted for in the empirical analysis.

III. Empirical Analysis of the Corporate Tax Incidence

This chapter constructs data on industry-specific marginal effective corporate tax rates, and uses variations in the rates to empirically analyze the incidence of the corporate tax. The corporate tax incidence can be analyzed from various perspectives. Specifically, this chapter focuses on whether an increase in marginal corporate tax burden faced by Korean firms pass a part of the tax burden to workers, by reducing wages.

1. Empirical Literature

Numerous empirical studies have been conducted on the incidence of the corporate tax. A number of researchers analyzed the incidence using the cross-country or the cross-state data. For example, Arulampalam et al. (2012) tested whether corporate tax burden is passed to workers by analyzing the corporate tax amounts imposed on more than 500,000 firms in nine European countries between 1996 and 2003, as well as their wage data. They found that a $1 increase in the tax amount reduces the VAT-adjusted median wage by $0.49. Felix and Hines (2009) used the corporate tax rate differences across states in the United States in 2000 to empirically analyze the effect of corporate tax burdens on the union wage premium. According to their findings, a 10% tax rate decline in a state increased the union wage premium by 3.6%, and a $1 increase in the corporate tax reduced the wages received by union workers by $0.54. Arulampalam et al. (2012) and Felix and Hines (2009) both analyzed the effect of changes in taxation on firm and worker outcomes from the partial equilibrium perspective.

Hassett and Mathur (2010) used cross-country data to identify the general equilibrium effect of the corporate tax burden on wages. They used wage and corporate tax data obtained from the manufacturing sectors of 72 countries between 1981 and 2002, and reported that wages are sensitive to changes in the corporate tax rate. They estimated that the elasticity of wages with respect to corporate income tax rates ranges from 0.4 to 0.6, indicating that a $1 increase in corporate tax revenues leads to a $3 to $4 decrease in real wage. Felix (2007) looked into the wage data of workers having different skill levels across 19 OECD countries, and reported that a 1%p increase in the top statutory corporate tax rate decreased wages by 0.7%. They found no difference in the corporate tax incidence across the different skill levels.

Desai et al. (2007) used data on American multinational firms operating in 50 countries, to estimate the incidence of corporate tax burden on labor and capital. Under the assumption that the corporate tax burden is only borne by labor and capital, they estimated the incidence

ratio on labor to be between 45% and 75%. Fuest et al. (2012) analyzed the consolidated data of employers and employees in Germany, and the tax rates imposed by the country's federal and local governments, to estimate the effect of corporate taxation on wages. They estimated the elasticity of wages with respect to marginal effective corporate tax rate at −0.18, and concluded that the effect of the corporate tax burden on wages is more significant among unskilled workers and workers with low negotiating power.

Gravelle and Smetters (2006) used an open economy general equilibrium model to analyze the incidence of corporate tax burdens in the United States. The percentage of corporate tax burdens shifted to domestic labor greatly varied between 6% and 73% depending on the mobility of capital. The changes in the rate of production factor substitution had less effect. Randolph (2006) used an open economy model to analyze the incidence of the corporate tax in the United States. The findings indicated that 32.5% to 73.7% of the corporate tax burden in the country is shifted to labor. As such, many studies using general equilibrium models also point to the conclusion that at least a certain portion of the corporate tax burdens is shifted to the labor sector.

On the other hand, Clausing (2012) estimated the effect of changes in corporate tax burdens on wages using three different approaches (correlation, regression, and VAR model approach). He used wage and corporate tax burdens (central government tax rate, central and local government tax rates, effective tax rates, corporate tax revenue to GDP ratio) data for OECD countries between 1981 and 2009. He did not find any conclusive empirical evidence that an increase in corporate tax burdens leads to wage decline. Only some of the regression and VAR model considered in his study indicated slight wage decline driven by the corporate tax burdens.

Liu and Altshuler (2013) utilized variations of marginal effective tax rates across industries in the United States, and explicitly considered an imperfect competition to analyze the incidence. They used the asset-level marginal effective tax rate estimates from Fullerton and Henderson (1985) and Mackie (2002), as well as the asset mixes across the industries, to build the industry-level marginal effective tax rates. Then, they combined them with individual characteristics and industrial concentration data for an empirical analysis. According to their findings, the wage elasticity of the marginal effective corporate tax rate was estimated to be −0.028, and the percentage of corporate tax burdens shifted to labor is at least 42%, and is generally between 60% and 80%.

2. Empirical Strategies and Regression Model

A. Empirical Strategies

The majority of previous studies empirically analyzing the incidence of corporate tax burdens use tax burden variations across countries or states. Since countries do not change their nominal corporate tax rates often, most studies identify the incidence of the corporate tax based on differences in the nominal corporate tax rates across countries or states. Felix (2007), Hassett and Mathur (2010), and Arulampalam et al. (2012) performed cross-sectional analyses based on the nominal tax rates to study the effect of corporate tax changes on country-specific wages. These studies implicitly assumed that policymakers do not change the corporate tax rates to attract internationally mobile capital to their country. However, if there exist tax competitions among countries in attempts to attract capital, a typical regression analysis that sets country-level statutory corporate tax rates as an explanatory variable will result in biased estimates. With tax competition, statutory corporate tax rates will be endogenous variables. Although there is no consensus on whether capital location decisions are significantly affected by the corporate tax rates, many studies have presented evidence that policymakers consider the tax rates of other countries when deciding their own corporate tax rates. For example, Altshuler and Grubert (2004) and Devereux et al. (2008) presented empirical findings that country-level corporate tax rates are set as a result of strategic interactions among competing countries. If such findings hold, an empirical analysis utilizing cross-country variations in the nominal corporate tax rates would produce unreliable estimates due to endogeneity problems. By the same logic, studies using cross-state variations (Gyourko and Tracy, 1989; Carroll and Prante, 2011) can also produce biased estimates if local governments strategically determine their tax rates.

Also, a cross-country approach could result in biased estimates due to measurement errors, as the way data are written could be different across countries. Typically, an empirical analysis using country-specific data utilizes country-level statutory corporate tax rates and country-specific variables that could affect corporate tax incidence as explanatory or dependent variables. If the variables included in the analyses are measured in different ways, the findings would not be highly reliable.

Liu and Altshuler (2013) also point out the fact that cross-sectional analyses across countries and states mostly assume perfectly competitive markets. As discussed in Chapter II, the market structure may affect the incidence of corporate tax. As such, an empirical analysis needs to consider the market structure of each industry.

This study analyzes the incidence of the Korean corporate tax by applying the empirical approach of Liu and Altshuler (2013), which utilized the fact that the tax burdens on marginal investments are affected by the asset mixes. Even at the same nominal tax rate, the marginal tax rate that an average firm faces in each industry may vary depending on the marginal tax rate for each asset type and the asset mix of each industry. They used these variations to analyze the incidence of corporate tax burdens. Such an approach narrows the scope of the analysis to a single country, which alleviates the problems caused by different measurement methods used in different countries, or the endogeneity problems caused by tax competition. Granted, if a marginal effective tax rate can be 'selected' by adjusting the asset types invested by firms, the marginal effective tax rate of each industry would not be a completely exogenous variable. However, each industry invests in different asset types, depending on its nature. Unless firms actively substitute between different asset types in response to taxation, it would be reasonable to regard the industry-specific marginal effective tax rate as an exogenous variable.

This study also explicitly considered the effect of imperfect competition by including industry-specific concentration levels as an explanatory variable in the regression model. The market structure is expected to directly affect the shift of tax burden to labor, while affecting individuals' wage levels. This study builds on Liu and Altshuler (2013) but differs in that it utilizes latest data from Korea, and performs additional analyses not considered in the previous study. The incidence of the corporate tax may vary depending on the capital intensity of the industry, the international openness of the economy, the skill levels of the workers or the workers' negotiating power. In a closed economy model, the incidence of the corporate tax burden on capital is expected to increase in a capital-intensive industry. In an open economy, a higher portion of corporate tax burdens may be shifted to labor even when the industry is capital-intensive, depending on the interactions with other factors. Some predict that a higher level of international openness increases the share of the tax burden falling on labor. Lastly, the empirical studies cited above (Fuest et al., 2012; Felix, 2007) present conflicting findings on the effect of workers' skill levels or negotiating power on the corporate tax incidence. All of these factors could affect the corporate tax incidence but have not been empirically tested in Liu and Altshuler (2013). This study analyzes sub-samples representing different employment types, capital intensity levels, and international openness levels to verify how these factors may change the incidence of the corporate tax burden.

B. Regression Model[3]

To empirically examine corporate tax incidence, this study considers the following individual-level regression model.

$$In(W_{ijt}) = X_{it}\alpha + \beta_1 InMTR_{jt} + \beta_2 CR_{jt} + \beta_3 (InMTR_{jt} \times InCR_{jt}) \tag{1}$$
$$+ \gamma Z_{jt} + C_j + \eta_t + \epsilon_{ijt}$$

where W_{ijt} is the wage level of an individual worker in the j industry in period t, and MTR_{jt} is the marginal effective tax rate of the j industry. The values were calculated based on the asset mix data for each industry and the marginal effective tax rates of each asset type.[4] The variables represent marginal tax rates on average investments in each industry. CR_{jt} is the market concentration level of the j industry and the individual characteristics (X) and the industry characteristics (Z) are included in the regression model as additional control variables. Individual characteristics include education, age, marital status, sex, and other socioeconomic variables that are expected to affect individual wage levels. Industry characteristics include debt-to-equity ratio, percentage of full-time workers, capital intensity, and other factors expected to affect the corporate tax incidence. The empirical analysis also considered the percentages of skilled workers and unskilled workers in each industry. Finally, C_j is the industry fixed effect and η_t is the time fixed effect.

Among the regression coefficients in Equation (1), β_1 captures the effect of corporate tax burdens in each industry on the wages of workers in the industry. This value can be used to estimate the incidence of the corporate tax on labor. If there exists no correlation between the unobserved shocks affecting individual wages and the marginal effective tax rate, market concentration level, and other characteristics of each industry, such variables can be interpreted to exogenously affect individual wages. Since wages vary at the individual level and marginal effective tax rate and market concentration level are industry-level variables, unobserved shocks to individual wages are unlikely to be correlated with these industry-level characteristics. Hence, industry-level marginal tax rates and market concentration levels can be interpreted as exogenous determinants of individual wages.

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3 This section builds on the model proposed by Liu and Altshuler (2013).

4 The data construction process is discussed in the next subsection.

Here, β_3 captures whether the market concentration level in each industry affects the effect of the marginal corporate tax rate on labor. In particular, the effect of changes in the marginal effective tax rate on wages can be expressed as follows.

$$\frac{\partial\ lnw_{ijt}}{\partial\ lnMarginal\,TaxRate_{jt}} = \beta_1 + \beta_3 lnCR_{jt}$$

Therefore, a comparison of estimates between industries with low market concentration levels and high market concentration levels shows how market competition affects tax incidence on labor.

In addition, to test the prediction that the intensity of production factors affect corporate tax incidence, the 'capital-intensive level' variable is constructed in each industry in order to define capital-intensive and labor-intensive industries.

Lastly, it is worthwhile to note that the regression model in Equation (1) may suffer from a sample selection problem. The wage levels of individuals are observed by the researcher only when the individuals work. However, the unobserved features affecting an individual's work decision are likely to be correlated with the unobserved features affecting wage levels. To account for this, the following selection equation was considered before estimating the incidence of the corporate tax.

$$work_i = \begin{cases} 1 \text{ if } \gamma_1 educ_i + \gamma_2 age_i + \gamma_3 gender + u_i > 0 \\ 0 \text{ if } \gamma_1 educ_i + \gamma_2 age_i + \gamma_3 gender + u_i > 0 \end{cases} \qquad (2)$$

Specifically, the inverse Mills ratio was calculated from the estimation results obtained from the selection equation (Equation (2)), and the ratio was then included as an explanatory variable in Equation (1).

3. Data

A. Effective Tax Rates

1) Asset-level Effective Tax Rates (Hanappi, 2018)

The industry-specific marginal effective tax rates in Korea utilized in this study are based on the effective tax rate data across asset types published by the OECD. The OECD provides

data on the average effect tax rates, marginal effective tax rates, and costs of capital across four asset types between 2017 and 2019: buildings, machinery, inventories, and acquired intangibles. These data were estimated using the methodology proposed by Hanappi (2018), who estimated the effective tax rates across different asset types in 2015 among OECD countries, based on the theoretical model of Devereux and Griffith (1999; 2003). Hanappi (2018) used the OECD Corporate Effective Tax Rate Model to estimate ten asset type-specific effective tax rates across 36 countries, and combined the taxation data (tax rates, tax expenditure programs, depreciation, etc.) with asset type information.

Two types of effective tax rates were estimated: marginal effective tax rates and average effective tax rates. The former tax rate measures how taxation changes the before-tax return required to break even, and is associated with the intensive margin of investment. On the other hand, the average effective tax rate is associated with the effect of taxation on whether to invest or not, that is, the extensive margin of investment. The cost of capital is defined as the real before-tax return that makes after-tax profit 0. The net current value of capital allowance measures how much depreciation is allowed for specific assets.

2) Industry-specific Marginal Effective Tax Rates

Based on the methodology proposed by Hanappi (2018), this study utilized the OECD marginal effective tax rate data to construct the industry-specific marginal effective tax rate data for Korea. As this study focuses on whether a firm faced with a marginal change in their tax burden shifts it to workers, the marginal effective tax rates across asset types were used. The OECD provides estimates on the asset-level marginal effective tax rates under three different macroeconomic scenarios. Each scenario assumes different levels of interest rates and inflation rates. The first scenario reflects the interest rates and inflation rates of the real economy. The second scenario is characterized by low interest rates and low inflation rates, whereas both the interest rates and inflation rates are high in the third scenario.

The industry-specific marginal effective tax rates are calculated based on the fact that the investment intensity in each asset type differs across industries. The *Survey of Business Activities* by Statistics Korea contains basic and financial information on firms employing 50 or more full-time workers and holding capital of KRW 300 million or more. The data provides information on the amount of assets acquired by those firms by asset type (land, building, machinery, vessel/vehicle transportation equipment, tangibles, and intangibles). The data starts from 2006 and as of 2018, the sample size is 13,144. The samples only include firms meeting the specified full-time employment and capital thresholds, which makes the data

suitable for analyzing the incidence of the corporate tax, as large firms bear the majority of corporate tax burdens. *Survey of Business Activities* consists of microdata of individual firms, but was aggregated to the industry level to calculate the asset mixes.

After calculating the share of investments in each asset type, the shares were used as weights to calculate the weighted average of the marginal effective tax rates across asset types, which equals the industry-specific marginal effective tax rates. Specifically, the effective tax rate for the j industry in year t is calculated as follows.

$$METR_{jt} = \sum_a METR_{at}\, W_{ajt}$$

where $METR_{jt}$ represents the marginal effective tax rate of the j industry in period t, $METR_{at}$ is the marginal effective tax rate for asset a in period t, and W_{ajt} is the share of investments in asset a against the total asset investment in the j industry (acquired assets) in year t.

The OECD provides the marginal effective tax rate data between 2017 and 2019,[5] whereas the *Survey of Business Activities* provides data up to 2018. As such, this study constructed and analyzed the industry-specific marginal effective tax rate data for 2017 and 2018. The OECD reports the marginal effective tax rate data for machinery up to 2017, but not the same data for the years 2018 and 2019. Whereas the OECD provides data on the marginal effective tax rates on inventories, investments on inventories are not reported in the *Survey of Business Activities*. As such, I used two different approaches: using the investments in buildings and intangibles as weights (Method 1), and using investments in 'tangibles' and 'intangibles' as weights.

The *Survey of Business Activities* provides data at the industry section- and industry division-level following the Korean Standard Industrial Classification (KSIC). I calculated the industry-specific effective tax rates at the lower (industry division) level, as the sample period is relatively short (two years), and sufficient industrial variations are essential for identification.

B. Market Concentrations

To understand the effect of industry market structure on corporate tax incidence, I used

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the Herfindahl-Hirschman Index (HHI) as a measure of imperfectness of market competition. The HHI measures market concentration levels. It ranges from 0 to 1, and a higher level of market concentration level means a higher HHI value. In general, if the HHI is 0.15 or lower, the market represents a lower level of concentration. The HHI is calculated as follows.

$$HHI_{jt} = \sum_{i=1}^{N} S_{ijt}^2$$

where S_{ijt} is the market share of firm i in the j industry in period t.

C. Individual Characteristics

This study is aimed at empirically examining the incidence of the corporate tax by looking into the effect of marginal corporate tax burdens on individuals' wage levels. Therefore, information on various individual features including wages and employment behaviors is essential. The analysis also requires various variables expected to affect individuals' wage levels and labor decisions because it uses individual wages as dependent variable. Moreover, the information on the business where the individuals are employed need to be reported on a similar level as the *Survey of Business Activities*. The *Regional Employment Survey* meets these requirements to a certain degree, as it offers demographic variables including sex, age, educational attainment, and marital status, as well as employment information including wage, work hours, employment type, and employment status. The Type A data in the *Regional Employment Survey* utilizes division-level industrial classifications, as does the *Survey of Business Activities*.

This study combines the Type A data for 2017 and 2018 from the *Regional Employment Survey* with the *Survey of Business Activities* data.

D. Summary Statistics

The combined data consist of industry data and individual data. The industry data mainly comes from the *Survey of Business Activities*, and include the industry-specific marginal effective tax rates based on the asset-specific marginal effective tax rate data from the OECD, the HHI for market concentration level, and other industry-specific variables. Individual data are based

on the *Regional Employment Survey*. Overall, 598,138 individual level observations were used from the combined data, after removing outliers and observations on self-employed individuals.[6]

Table 4_Summary Statistics

Variable	Mean	Min	Max	Standard deviation
Industry level variables				
Marginal effective tax rate	0.1242	0.1161	0.1413	0.0063
HHI	0.1130	0.0086	0.6877	01358
Capital intensity	3.1437	0.0012	9130.2770	22.6422
International openness	5.4332	0.0000	100.0000	21.3022
Percentage of full-time workers	0.5952	0.0154	0.9839	0.2963
Debt-capital ratio	1.7387	-375.2464	3252.5000	8.4341
Individual level variables				
Average monthly wage	243.9157	11.0000	10000.0000	159.2271
Age	47.3746	15.0000	100.0000	14.2247
Male dummy	0.4697	0.0000	1.0000	0.4991
Educational attainment	2.5434	1.0000	5.0000	1.2088
Marriage dummy	0.6950	0.0000	1.0000	0.4604
Full-time worker dummy	0.7987	0.0000	1.0000	0.4009

Notes: 1) The marginal effective tax rate data were constructed based on three scenarios (inflation rates and inflation rates based on country-level realities; low inflation rates and inflation rates; and high inflation rates and inflation rates).
2) Capital intensity is defined as total assets against revenues.
3) International openness is defined as percentage of foreign capital in total capital.
4) Educational attainment is defined as: middle school graduate or lower = 1; high school graduate = 2; junior college graduate = 3; college graduate = 4; graduate school graduate or higher = 5.
5) Full-time worker is defined as worker with work week of 36 hours or longer.
Source: Present study

4. Findings

This subsection presents the findings of the empirical analysis on corporate tax incidence based on the data constructed above. The findings are used to identify the effect of changes in marginal corporate tax rates on individual wages, and how the industry-specific market

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6 Corporate tax burdens are shifted to workers mainly when firms reduce employees' wages in response to changes in corporate tax burdens. As such, observations on self-employed individuals were excluded from the analysis.

concentration levels further affect these effects. Then, sub-samples are developed based on factors that may affect the incidence of the corporate tax, which are then separately analyzed to verify whether the theoretical predictions and empirical findings of previous studies apply to Korea. Specifically, a separate regression analysis is performed to determine whether the shift of corporate tax burdens to workers varies depending on the employment type (full-time or part-time), capital intensity, and international openness.

A. Full-sample Analysis

For the full-sample analysis, I first examined the shift of corporate tax burdens to workers by looking into the effect of changes in marginal effective tax rates on individual wage levels. I explicitly consider industry-specific market concentration levels in order to estimate the effect of imperfect competition. In addition, as the wage levels of individuals are observed by the researcher only when the individuals work, an additional selection equation was added to correct possible issues resulting therefrom. To this end, following Heckman's approach, I presented estimates based on the two-stage estimation method and the maximum likelihood estimation (MLE). In addition, the empirical findings were presented based on Scenario 1 from the OECD for its estimation of asset-specific marginal effective tax rates (interest rates and inflation rates in Korea).

In Table 5, Columns (1) and (2) presents results based on Heckman two-stage estimation. In the first-stage selection equation, the dependent variable is the individual-specific work dummy and factors that could affect individual's labor supply decision (sex, education, age) are included as independent variables. Stage 2 estimates the wage equation for individuals by including the inverse Mills ratios from Step 1. The findings confirm that firms tend to shift some of the corporate tax burden to workers by reducing their wages. However, the effect was not statistically significant. In addition, individual wage levels were lower and more of the corporate tax burdens were shifted to workers in industries with higher levels of market concentration. These two effects were found to be significant at a significance level of 5% or 10%. However, the additional industry-level control variables did not yield statistically significant results. On the individual level, educational attainment and marital status were found to have a significant effect on wages.

Using the MLE, the regression coefficient for marginal effective tax rates was also estimated to have a negative value, and was statistically significant. In other words, the findings offer empirical evidence that, when faced with marginal corporate tax burdens, Korean firms

tend to shift some of their burden to workers. Similar to the two-stage estimates above, a higher level of market concentration was significantly correlated with lower individual wages and a higher incidence of corporate tax burden on labor. These findings are qualitatively identical to the findings of Liu and Altshuler (2013), pertaining to the incidence of corporate tax based on the industry-specific effective tax rate data in the United States. However, Liu and Altshuler (2013) estimated the regression coefficient for log (marginal effective tax rate) to be −0.2183, and estimated the corporate tax for the cross-term of log (marginal effective tax rate) and log (market concentration level) to be −0.0910, which represents a larger percentage of the corporate tax burden being shifted to workers and a larger percentage of the tax burden being shifted to workers through market concentration levels.

It is noted that the regression coefficient for the log (marginal effective tax rate) did not represent a high level of statistical significance. The coefficient was not found to be statistically significant in the two-stage estimation, whereas the MLE found the coefficient to be statistically significant at a 10% or 5% significance level. I conjecture that the relatively low statistical significance comes from the fact that the industrial variations in the marginal effective tax rates in the data I used in this study is small compared to Liu and Altshuler (2013). As noted above, when constructing the industry-level marginal effective tax rates, only small number of assets were considered, due to limitations in the OECD and Korean firm-level data.

Table 5_Estimation of the Incidence of the Corporate Tax

	2-STAGE (1)	2-STAGE (2)	MLE (3)	MLE (4)
Log (marginal effective tax rate)	-0.0971	-0.068	-0.0821*	-0.0759**
Log (HHI)	-0.1001**	-0.097*	-0.1332***	-0.1294***
Log (marginal effective tax rate) × log (HHI)	-0.0476**	-0.046**	-0.0636***	-0.0626***
Debt-capital ratio	-0.0000		-0.0000	
Educational attainment	0.0985***	0.0960***	0.1436***	0.1514***
Marriage dummy		0.2683***		0.2432***
Industry fixed effect	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y
Number of observations	597,683	597,683	597,683	597,683
Censored observations	95,711	95,711	95,711	95,711
Prob. > Chi^2	0.0000	0.0000	0.0000	0.0000
Selection equation estimation				

Table 5_Estimation of the Incidence of the Corporate Tax(continued)

	2-STAGE (1)	2-STAGE (2)	MLE (3)	MLE (4)
Sex	1.1488***	1.1488***	1.1541***	1.1519***
Educational attainment	0.2771***	0.2771***	0.2774***	0.2632***
Age	-0.0270***	-0.0270***	-0.0255***	-0.0270***
Constant variable	1.4329***	1.4329***	1.3167**	1.4183***
Prob. > Chi^2	0.0000	0.0000	0.0000	0.0000

Note: ***, **, * are significance levels of 1%, 5%, and 10%, respectively.
Source: Present study

With the estimates above, the marginal effect of changes in marginal effective tax rates on individual wage levels can be calculated. Specifically, the estimates on key regression coefficients of the wage equation ($\widehat{B}_1$ and $\widehat{B}_3$ from Equation (1)[7]) and the market concentration level variable can be used to calculate the marginal effect of marginal effective tax rates on labor as follows. The economy-wide effect can be estimated from the mean of industry-specific effects.

$$\frac{\partial \, Inw_{ijt}}{\partial \, InMTR_{jt}} = \widehat{\beta}_1 + \widehat{\beta}_3 \, InCR_{jt}$$

The mean marginal effect was estimated at −0.0274, indicating that a 10% increase in the marginal effective tax rate lowers the average wage level by 0.27%. For reference, Liu and Altshuler (2013) estimated the average wage elasticity of marginal effective tax rates in the United States to be −0.0283 to −0.0382. Their findings represent a higher level of wage elasticity than the estimates on Korean data presented in this study. Although not as high as the estimates from the previous studies on the United States, the findings on Korea presented in this study also appear to be economically significant. An elasticity level of −0.0274 indicates that when the marginal effective tax rate increases from 10% to 11%, the average wage level declines by 0.27%, which is a meaningful number.

In addition, the market concentration levels are positively correlated with corporate tax incidence on labor. In the first quartile, where the market concentration level is close to perfect

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[7] Regression Equation (1) is defined as follows.
$In(W_{ijt}) = X_{it}\alpha + \beta_1 InMTR_{jt} + \beta_2 CR_{jt} + \beta_3 (InMTR_{jt} \times InCR_{jt}) + \gamma Z_{jt} + C_j + \eta_t + \epsilon_{ijt}$

competition, changes in the corporate tax burden did not result in a wage reduction. On the other hand, in the third and fourth quartiles, the wage elasticity of the marginal effective corporate tax rate was estimated to be −0.0335 and −0.0543, respectively. According to these findings, in a concentrated market (fourth quartile), a 10% increase in the marginal effective tax rate reduced individual wages by up to 0.54%.

Table 6_Corporate Tax Incidence by Market Concentration Level

Category	Market Concentration levels				
	1st quartile	2nd quartile	3rd quartile	4th quartile	Mean
Wage elasticity of marginal corporate tax rate	0.0452	-0.0220	-0.0335	-0.0543	-0.0274

Source: Present study

B. Sub-sample Analysis

In this subsection, a separate regression analysis is performed to determine whether the shift of the corporate tax burden to workers varies depending on the employment type (full-time or part-time), capital intensity, and international openness.

1) Employment Type: Full-time vs. Part-time Workers

Some researchers (Fuest et al., 2012; Felix, 2007) examined the incidence of corporate tax burden on workers depending on their skill levels, employment types, and negotiating power. When a firm shifts its corporate tax burden to workers by reducing wages, the effect may vary depending on the employment type and the status of workers. As such, I repeated the analysis discussed above on two different worker groups divided based on work hours: full-time workers and part-time workers.

When the marginal corporate tax rate increases, the wage-reducing effect was found only in the part-time worker group. The estimation coefficient for the log (marginal effective tax rate) was −0.2761, representing a significantly higher level of tax burden being shifted to workers, relative to the findings on the overall samples. On the other hand, in the full-time worker group, wage levels increased along with the marginal corporate tax rate imposed on firms. These findings suggest a possibility that Korean firms may shift their corporate tax burden to part-time workers, who have lower negotiating powers and more rooms for wage adjustment, when faced with an increase in the marginal corporate tax rate.

Table 7_Estimation of the Incidence of the Corporate Tax: Full-Time Workers vs. Part-Time Workers

	Full-time worker		Part-time workers	
	2-STAGE (1)	MLE (2)	2-STAGE (1)	MLE (2)
Log (marginal effective tax rate)	0.4717**	0.4917**	-0.2716*	-0.2761*
Log (HHI)	-0.0123	-0.0234	-0.3341**	-0.3818**
Log (marginal effective tax rate) × log (HHI)	0.0060	0.0019	-0.1259**	-0.1420**
Educational attainment	0.1072***	0.1422***	0.0920***	0.0665***
Marriage dummy	0.2304***	0.2049***	0.2910***	0.2636***
Industry fixed effect	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y
Number of observations	477,389	477,389	120,294	120,294
Censored observations	54,294	54,294	40,787	40,787
Prob. > Chi^2	0.0000	0.0000	0.0000	0.0000
Selection equation estimation				
	2-STAGE (1)	MLE (2)	2-STAGE (1)	MLE (2)
Sex	1.1907***	1.4030***	0.8909***	0.7489***
Educational attainment	0.2591***	0.2975***	0.3036***	0.22900***
Age	-0.0312***	-0.0235***	-0.0154***	-0.0202***
Constant variable	1.7596***	1.1826***	0.5573***	0.8812***
Prob. > Chi^2	0.0000	0.0000	0.0000	0.0000

Note: ***, **, * are significance levels of 1%, 5%, and 10%, respectively.
Source: Present study

2) Capital-Intensive vs. Labor-Intensive Industry

Here, I estimated the incidence of the corporate tax separately for capital-intensive industries and labor-intensive industries. Capital intensity can be measured in various ways. This study measured it by defining the capital intensity ratio (CIR) as total assets to total revenues ratio.[8] Specifically, capital-intensive industries were defined as firms in the top 25% in terms of capital intensity, and labor-intensive industries were defined as firms in the bottom 25% of capital intensity.

The findings show different patterns of incidences depending on the capital intensity

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[8]   CIR refers to the value of total assets required to generate KRW 1 in revenues. It is one of the indicators used to measure capital intensity.

levels. According to these findings, in the case of an increase in the marginal corporate tax rate imposed on a labor-intensive industry, firms reduce wages to shift a part of the increased tax burden to workers. On the other hand, in capital-intensive industries, firms increase wages when the marginal corporate tax rate increases. However, these effects were found to be statistically insignificant in the two-stage estimation for capital-intensive industries.

Table 8_Estimation of the Incidence of the Corporate Tax: Capital-Intensive Industries vs. Labor-Intensive Industries

	Capital-intensive industry		Labor-intensive industry	
	2-STAGE (1)	MLE (2)	2-STAGE (1)	MLE (2)
Log (marginal effective tax rate)	0.3997	0.4587*	-1.2205*	-1.0682**
Log (HHI)	0.2290	0.2637*	-0.1543	-0.2126*
Log (marginal effective tax rate) × log (HHI)	0.1062	0.1300**	-0.0564	-0.1062
Educational attainment	0.1378***	0.2180***	0.0936***	0.1284***
Marriage dummy	0.2911***	0.2749***	0.2778***	0.2205***
Industry fixed effect	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y
Number of observations	161,025	161,025	143,035	143,035
Censored observations	5,429	5,429	15,560	15,560
Prob. > Chi^2	0.0000	0.0000	0.0000	0.0000
Selection equation estimation				
	2-STAGE (1)	MLE (2)	2-STAGE (1)	MLE (2)
Sex	0.9072***	0.9677***	1.0172***	0.9659***
Educational attainment	0.1141***	0.1058***	0.1179***	0.1816***
Age	-0.0163***	-0.0144***	-0.0120***	-0.0091***
Constant variable	2.0300***	1.8570***	1.5850***	0.8213***
Prob. > Chi^2	0.0000	0.0000	0.0000	0.0000

Note: ***, **, * are significance levels of 1%, 5%, and 10%, respectively.
Source: Present study

3) International Openness

Theoretical studies that analyzed capital allowance incidence in an open economy commonly point to international mobility of capital as key factor determining the incidence of the corporate tax. As such, I developed a variable for international openness, and analyzed the samples by dividing them into two sub-samples: the high international openness group,

and the low international openness group. International openness was measured using two approaches: the "foreign capital to total capital ratio" from the *Survey of Business Activities*, and the ratio of imports and exports against the GDP.

In the first approach, the high international openness group consisted of samples with 0.5 or higher, and the remaining samples were classified as the low international openness group. The results indicate incidence only in the low international openness group. On the other hand, in the high international openness group, neither the log (marginal effective tax rate) nor the cross-term between the log (marginal effective tax rate) and the log (HHI) was found to be statistically significant.

In the second approach, industries where the ratio of imports and exports against GDP is less than 10% were classified as the low international openness group, and industries where the ratio exceeds 80% were classified as the high international openness group. The shift of

Table 9_Estimation of the Incidence of the Corporate Tax: Sub-Sample Analysis Based on International Openness 1

	International openness ↑		International openness ↓	
	2-STAGE (1)	MLE (2)	2-STAGE (1)	MLE (2)
Log (marginal effective tax rate)	2.1625	2.3989	-0.2524*	-0.2425*
Log (HHI)	0.3284	0.4893	-0.1870**	-0.1961***
Log (marginal effective tax rate) × log (HHI)	0.1831	0.2234	-0.0731**	-0.0735***
Educational attainment	0.1349***	0.2205***	0.0918***	0.1304***
Marriage dummy	0.2486***	0.2534***	0.2698***	0.2399***
Industry fixed effect	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y
Number of observations	96,500	96,500	369,790	369,790
Censored observations	4,118	4,118	84,597	84,597
Prob. > Chi^2	0.0000	0.0000	0.0000	0.0000
Selection equation estimation				
	2-STAGE (1)	MLE (2)	2-STAGE (1)	MLE (2)
Sex	1.0103***	1.0782***	1.1609***	1.1243***
Educational attainment	0.1914***	0.1250***	0.2833***	0.2802***
Age	-0.0065***	-0.0107***	-0.0278***	-0.0262***
Constant variable	0.0520***	1.5183***	1.3397***	1.2339***
Prob. > Chi^2	0.0000	0.0000	0.0000	0.0000

Notes: 1. International openness was measured based on the percentage of foreign capital in the total capital.
2. ***, **, * are significance levels of 1%, 5%, and 10%, respectively.
Source: Present study

the corporate tax burden to labor was not empirically found in either group.[9]

These findings contradict the theoretical predictions discussed above. According to the predictions, in an open economy, firms with high international openness may shift corporate tax burdens to labor by increasing overseas investments. On the other hand, the findings of this study indicate that, while some industries with low international openness shift some of their tax burden to workers, there was no evidence that industries with high international openness shift their corporate tax burden to workers. These seemingly counter-intuitive findings can be attributed to multiple factors, one of which may be the imperfect measurement used for international openness. Here, I used indicators that may be somewhat inaccurate due to data limitations, and different findings may be achieved by directly measuring substitution elasticity between domestic and foreign products or the international mobility of capital in each industry.

Table 10_Estimation of the Incidence of the Corporate Tax: Sub-Sample Analysis Based on International Openness 2

	International openness ↑		International openness ↓	
	2-STAGE (1)	MLE (2)	2-STAGE (1)	MLE (2)
Log (marginal effective tax rate)	0.2614	0.2060	0.3676	0.5227
Log (HHI)	-0.0333	-0.0470	0.0626	0.0972
Log (marginal effective tax rate) × log (HHI)	-0.0087	-0.0116	0.0362	0.0537
Educational attainment	0.1210***	0.1522***	0.1789***	0.2320***
Marriage dummy	0.2608***	0.2289***	0.3048***	0.2667***
Industry fixed effect	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y
Number of observations	222,881	222,881	118,250	118,250
Censored observations	14,228	14,228	2,810	2,810
Prob. > Chi^2	0.0000	0.0000	0.0000	0.0000
Selection equation estimation				
	2-STAGE (1)	MLE (2)	2-STAGE (1)	MLE (2)
Sex	1.4808***	1.6231***	0.6539***	0.8390***
Educational attainment	0.0362***	0.0861***	0.0903***	0.1342***
Age	-0.0295***	-0.0220***	-0.0187***	-0.0076***
Constant variable	2.2393***	1.5969***	2.4403***	1.5974***
Prob. > Chi^2	0.0000	0.0000	0.0000	0.0000

Notes: 1. International openness was measured based on the ratios of imports and exports against GDP in each industry.
2. ***, **, * are significance levels of 1%, 5%, and 10%, respectively.
Source: Present study

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9 Similar patterns were observed when adjusting the threshold for international openness (10%/80%).

C. Summary and Implications

The above findings empirically confirmed that Korean firms faced with an increase in the marginal effective corporate tax rate are shifting some of their tax burden to workers. Specifically, a 10% increase in the marginal tax rate reduced wage levels by 0.27%. In particular, firms shifted more of their tax burdens to workers in a market with a higher concentration level.

Additional analyses of sub-samples confirmed that the shift of the corporate tax burden is more evident among part-time workers. It suggests that a policy increasing corporate tax burden can harm more "vulnerable" workers. The analysis of labor-intensive industries vs. capital-intensive industries also showed differences in the tax burden incidence, with the former reporting a higher incidence of a corporate tax burden on labor. Lastly, I analyzed the tax incidence in sub-samples divided based on international openness, which produced findings not congruent with the theoretical predictions stating that the level of incidence on labor is higher in industries with high international openness.

These findings are significant in that they empirically confirmed that firms faced with an increased corporate tax burden may shift their tax burden by reducing wages. However, it is worthwhile to note that the study has also some limitations. The estimates on the asset-specific marginal effective tax rates obtained from the OECD are not fully reflecting the corporate tax regime of Korea. Therefore, the industry-specific marginal effective tax rates derived from this data are likely to be different from the marginal tax burdens actually faced by Korean firms. In addition, I did not utilize a sufficient number of asset types when constructing the industry-specific marginal effective tax rates in Korea. As a result, not enough industrial variations in marginal effective tax rates were shown in the constructed data.

In addition, some variables expected to affect corporate tax incidence in the theoretical studies were either incompletely measured or not explicitly incorporated. For example, many of the previous studies indicated that the corporate tax incidence is significantly affected by the rate of technical substitution between production factors (labor and capital), and the substitution elasticity between domestic and foreign products. However, these factors were not considered due to data constraints.

Lastly, I solely focused on the incidence of the corporate tax burden on workers through wage reductions and did not explicitly analyze the incidence on other economic agents. Many of the theoretical studies pointed to the channel of incidence where firms shift their tax burden to consumers by raising the price of final goods. To empirically analyze such incidences, an industry-level analysis seems to be required. However, the data on final goods prices are published for only some business types.[10] Moreover, an industry-level analysis using

industry-specific price indices as dependent variables and industry-specific marginal effective tax rates as explanatory variables may suffer from endogeneity problems. This is because, differences in industry-specific marginal effective tax rates originate from industry-specific asset mixes, which may be affected by unobserved industry characteristics. These unobservables are likely to be correlated with industry-specific marginal effective tax rates and a failure to consider this correlation will result in biased estimates.

IV. Conculsion

The corporate tax is one of the main tax items in Korea and represents high likelihood of discrepancy between taxpayers and those who actually bear tax burdens. In Korea, the corporate tax revenue to the total tax revenue or GDP ratio is high compared to most OECD countries. Moreover, the Korean government recently raised the nominal tax rate and cut down expenditures to increase corporate tax burdens. Such reform is not aligned with the international trends of lowering corporate tax rates. The gap warrants an empirical analysis of the economic effect of the Korean policy. Numerous theories and empirical studies have been proposed and published regarding the incidence of corporate tax burdens. However, consensus as to how much tax burdens are shifted to labor has not been reached. I expect that the findings of this study will serves as a useful reference point to corporate tax policy designs in the future, as they are based on the latest data from Korea.

This study reviewed previous studies on corporate tax incidence, and the findings from these studies suggest that the shift of corporate tax burdens on labor may vary depending on the level of competition in the market, closed or open economy assumptions, the capital intensity of the relevant industry, the international openness of capital, and the employment status of workers.

In order to test these predictions empirically with Korean data, I followed the approach proposed by Liu and Altshuler (2013). In particular, unlike previous studies relying on country or state-level data, I utilized changes in marginal tax burdens in each industry, so as to mitigate the endogeneity issue and measurement errors. I also explicitly included industry-specific market concentration levels in the empirical analysis, in order to verify the findings of Davidson and Martin (1985), who suggested that the shift of corporate tax burdens on labor

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10 Korea publishes consumer price index statistics based on the nature of items (or the purpose of expenditures) only for some items.

may be affected by the market structure of the relevant industry. As such, I verified changes in the incidence of corporate tax burdens by analyzing sub-samples using variables predicted to affect incidence in previous studies, including employment status, capital intensity, and international openness.

The findings indicate that Korean firms faced with marginal tax burden increase shift a part of the burdens to workers by reducing their wages. Specifically, a 10% increase in the marginal effective tax rate lowers the average wage level by 0.27%. The findings confirm that the pattern of corporate tax burden incidence on labor varies depending on the market concentration level. In a low-concentration market close to perfect competition, an increase in corporate tax burden does not lead to wage reduction. However, in a high-concentration market, the absolute value of the wage elasticity of marginal effective corporate tax rate increases. In a highly concentrated market, a 10% increase in the marginal effective corporate tax rate reduces individual wages by up to 0.54%.

Also, the incidence of corporate tax on labor was more evident for part-time workers than full-time workers. In addition, a labor-intensive industry reports a higher incidence of corporate tax burdens on labor. Lastly, this study analyzed tax incidence in sub-samples divided based on international openness, which produced findings not congruent with the theoretical predictions that the level of incidence on labor is higher in industries with high international openness.

The above findings confirm at least part of corporate tax burdens are passed onto workers through wage reduction. The shifting of the tax burden was most evident for part-time workers and workers in labor-intensive industries. As such, the recent increase in corporate tax burdens in Korea may have undermined the well-being of these workers.

The corporate tax is known to have large efficiency per a dollar of additional tax revenue. However, the corporate tax takes up high percentages in tax revenues of most countries. In particular, it is known to causes less tax resistance than other taxes. Nevertheless, if corporate tax burdens are largely shifted to other economic agents as suggested by the findings of this study, careful consideration is required to determine whether increasing corporate tax burdens through tax reforms is a desirable course of action. If the increased tax burdens imposed on large firms are partially shifted to part-time workers, this may not be consistent with the original purpose of increasing the tax burdens. Granted, the economic effect of the corporate tax is not limited to the shift of tax burdens to workers. Specific policy should be preceded by a comprehensive and careful review of all of its effects. However, this study significantly contributes to the literature by empirically verifying the theoretically predicted incidence of the corporate tax on labor.

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Public Policy Evaluation Using Machine Learning

Jaehyun Jung*

I. Introduction

Machine learning is a method of improving work performance by using data-based learning tools. It specializes in reducing errors in predictions, relative to analyses based on existing models. For example, spam filtering is one area in which machine learning is frequently used. Spam filtering involves determining whether a new email is a spam email. Spam filtering performance can be measured based on the percentage of emails that the system actually classifies as spam. In this context, machine learning refers to a process in which the system learns from training data that contains emails that have already been determined to be regular email or spam, in order to increase the percentage of new emails being successfully identified as spam.

Advancements in big data technologies and computing power have widened the potential applications of machine learning. Computing power is now so advanced that even personal computers can be used for machine learning, and user-friendly statistics packages are widely available. In addition, access to both administrative microdata and high-level data such as satellite photographs and social network data are becoming more accessible than ever. These factors have resulted in a large body of studies that are applying machine learning to empirical analyses. Now, machine learning is being considered for applications that affect evaluations and policy designs.

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This study reviews the basic concepts and key components of machine learning in order to help readers better understand the methodology. In machine learning, a program learns data without predetermined rules. As such, there exists a wide array of approaches to machine learning. This study focuses on two frequently used approaches: decision trees and random forests.

In terms of organization, Chapter 2 discusses a policy effectiveness evaluation that is based on machine learning, as well as improvements to Korean tax policies. Chapter 3 then explores how machine learning can be used to complement the existing effectiveness analysis for special taxation policies, and demonstrates how useful it is relative to the existing analysis method. Specifically, the chapter shows how machine learning analyses provide better outcomes for heterogenous treatment effects compared with existing research methods pertaining to the causality between policies and their effects. Among the evaluations of the special taxation policies conducted in 2019, this study focuses on the special taxation policy for tax-exempt general savings, in order to show how machine learning provides better estimates of policy effectiveness over a linear regression analysis. The special taxation for tax-exempt general savings is designed to help the elderly, people with disabilities, social security beneficiaries, and other vulnerable groups save money.

The conventional approach used data from the Survey of Household Finances and Living Conditions to analyze the effectiveness of the policy, and concluded that the policy does not have statistically significant effect on tax-exempt general savings or asset formations/ transfers. This study examines whether the effectiveness estimation for the policy can be improved by exploiting the ability of machine learning to combine more diverse feature variables for the treatment effect analysis. In addition, this study examines the causal effect of the special taxation policy for tax-exempt general savings using causal forest, one of the latest machine learning methods capable of assessing the causal effect between policy implementation and effects when a randomized controlled experiment or quasi-experiment is not applicable.

II. Machine Learning and Big Data: Overview

1. Machine Learning

A. Big Data and Machine Learning

Big data and artificial intelligence (AI) are regarded as two of the key areas of the Fourth

Industrial Revolution. Advances in these technologies have been driven by three breakthroughs: the accumulation of a massive amount of data; advances in AI analysis technologies such as machine learning and deep learning; and the advances in the computing power required for big data development and analysis. Experts are still divided over the clear definition of machine learning and deep learning. However, for now, we can safely assume that AI is the broadest concept that contains machine learning, and that deep learning is central to machine learning. Machine learning enhances work performance by having a computer learn from the volume of data. Deep learning is a machine learning method that utilizes artificial neural networks that resembles human neurons, including input/output layers and multiple hidden layers.[1]

B. Machine Learning in Empirical Analyses

Advances in machine learning have prompted a broad swathe of economic studies that utilize the technique to be conducted.

Computing power is now so advanced that even personal computers can be used for machine learning, and user-friendly statistics packages are widely available. In addition, access to administrative microdata and high-level data such as satellite photographs and social network data are more accessible than ever. These factors have resulted in a large body of studies applying machine learning to empirical analysis. Another theme actively discussed in recent years is whether machine learning can completely replace conventional methods including regression analysis, or it will be merely an analysis method specializing in big data.

Machine learning has been attracting attention from many economists in recent years, not a small part due to its superb capability to solve 'prediction' problems, which have been largely neglected by conventional economic analyses (Athey, 2017; Mullainathan and Spiess, 2017). Machine learning enables the use of algorithms capable of drastically improving the accuracy of response variable estimations by using feature variables, even without the inclusion of specific assumptions about the analysis model. Linear regressions and other conventional econometric methodologies typically rely on pre-modeling relationships between feature variables and response variables in order to estimate key parameters ($\hat{\beta}$). On the other hand, the main goal of machine learning is to improve the accuracy of the response variable

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[1] Some researchers understand deep learning as being a mere overlap of machine learning, and do not classify it as a separate category.

estimation.

Granted, linear regressions and other model-based estimation methods can show decent prediction performance. One can predict response variables by choosing a linear model, finding the model's parameters that minimize loss using the given samples, and use the resulting linear regression equation to predict the response variables y for new data x. However, machine learning provides vastly improved algorithms over the conventional linear models, as shown in Table 1.

As an example, Mullainathan and Spiess (2017) combined randomly extracted housing price data (training data) in the United States using 150 feature variables, including house floor area and the number of rooms, to create a housing price prediction model. The model was analyzed using the ordinary least square method (OLS), and trained by three machine learning algorithms. Then, the model's prediction performance was compared using 41,808 new samples (test data). According to Table 1, the random forest technique showed around a 9% improvement over the conventional OLS method in analyzing the test sample. In addition, the ensemble method, which combines the three machine learning algorithms (decision tree, least absolute shrinkage and selection operator, and random forest) demonstrated an even further improved prediction performance over each of the three approaches.

Table 1_Machine Learning Algorithms and Prediction Performance

Learning Algorithms	Prediction Performance (R^2)	
	Training Data	Test Data
OLS	47.3%	41.7% [39.7%, 43.7%]
Decision Tree	39.6%	34.5% [32.6%, 36.5%]
LASSO	46.0%	43.3% [41.5%, 45.2%]
Random Forest	85.1%	45.5% [43.6%, 47.5%]
Ensemble	80.4%	45.9% [44.0%, 47.9%]

Notes: 1. The ensemble method uses the average of predictions from the three machine learning techniques.
　　　2. The test data figures in brackets represent the 95% confidence interval using bootstraps.
Source: Present study, based on Mullainathana and Spiess (2017), Table 1.

Machine learning still needs overcome numerous challenges before it can be considered as the most widely used analysis technique. However, even in its current state, its outstanding prediction performance can definitely contribute to the empirical analyses Mullainathan and Spiess (2017) proposed for a range of applications, which can be summarized as follows.

First, machine learning is specialized for handling big data. Here, the term 'big data' does not simply mean a large number of samples. It refers to a massive amount of data that includes high-level data such as images and texts. For example, in the case of a developing country with

no sufficiently reliable economic statistics, machine learning can be used to analyze satellite photographs having a vast amount of pixel information in order to produce quite reliable proxy variables, including annual agricultural production. Machine learning can be also highly useful in analyzing texts from social networks, discovering hidden correlations in large-scale administrative microdata such as census data, and then classifying the microdata based on the correlations.

Second, machine learning is useful for the prediction process that is explicitly or tacitly included in parameter estimations. For example, the first stage of the two-stage least squares (2SLS) using instrument variables is essentially a prediction stage, as endogenous variables are regressed to the instrument variables and the other explanatory variables of the model. As such, in recent years, some researchers performed empirical analyses to resolve the 'weak instrument' issue using the one-stage LASSO.

Third, machine learning is an excellent choice for resolving the 'policy prediction problem,' that is, predicting the effects of a policy and 'who' are the most appropriate targets of the policy. Machine learning is capable of proposing improved solutions for issues such as 'which' teachers to employ (Chalfin et al., 2016), 'which' defendants should be granted bail (Kleinberg et al., 2018), and 'which' youths should be targets of delinquency prevention programs (Davis and Heller, 2020).

Machine learning also serves as a useful tool for policy effect predictions because it is highly proficient in determining the 'heterogeneous effects' of policies. Conventional linear models add cross terms between treatment variables and feature variables of the experiment group in order to identify policy effects on different groups that share similar features, whereas machine learning can predict policy effects at an individual level by flexibly combining the features of the experiment group (Athey and Wager, 2018). In addition, a recent study proposed a machine learning method that is combined with the randomized control trial (RCT) method. This method is capable of identifying heterogeneous effects of policies and the features causing such effects (Chernozhukov et al., 2018).

2. Machine Learning Methodology

A. Overview

Machine learning can be divided into supervised learning and unsupervised learning. Supervised learning uses training data, one or more features, and desired answers for each

input sample (response variables). The supervised learner then predicts the response variables based on features of the new data. Classification is one of the most widely used applications of machine learning. For example, a spam classification program identifies spam emails based on information such as senders and texts included in subjects. Supervised learning algorithms include regression analyses, support vector machine (SVM), decision trees, random forests, and neural networks. In unsupervised learning, or autonomous learning, only the feature variables are provided to the training algorithms, with no response variables. One example of unsupervised learning is a clustering analysis, in which the algorithm discovers similarities among data on its own and classifies them into several clusters.

Economists are interested in the use of machine learning for predicting continuous variables and classifications using feature variables. Therefore, the discussions in the following paragraph focus on supervised learning.

B. Prediction Issue in Machine Learning

One of the reasons behind the rise of machine learning as a new analysis method for economics is its ability to provide improved predictions over conventional linear models. For example, Suppose that we collected the price information of n houses (response variables y_1), and we know the size, number of rooms, and other feature variables ($x_i = (x_{i1}, x_{i2}, ..., x_{ip})^T$) of each house. The relationship between housing price and the feature variables can then be summarized as $y_i = f(x_i) + \epsilon$. Other than the parts that can be explained by the feature variables (f), we may have error terms that the feature variables do not explain (ϵ). Here, our goal is to create an estimation function capable of predicting housing prices using n housing price-feature variable pairs ($\{(x_1, y_1), (x_2, y_2), ..., (x_n, y_n)\}$). $\hat{f}$ In this analysis, we are interested in 'predicting' housing prices that correspond to newly provided feature variables that were not used in the training. Granted, we need a model with a high prediction power for the training dataset. However, in this scenario, we are not interested in how close the training predictions $\hat{f}(x_1), \hat{f}(x_2)..., \hat{f}(x_n)$ are to $y_1, y_2, ..., y_n$. We want know how close $\hat{f}(x_0)$ is to y_0 of the new data that has not been used in training (x_0, y_0). In other words, we are interested in the generalization performance of the model.

Therefore, in order to assess the performance of machine learning in handling given data, we need to quantify how close the predicted response values are to the actual response values. The most widely used measure in regression analyses is the mean squared error (MSE).[2] Let us suppose that we used the housing price sample mentioned above as training data for the

prediction model, and calculated the MSE between the housing price predictions and the actual housing prices. The resulting MSE is then referred to as the training error rate. However, as mentioned above, machine learning is mainly used for predictions, which means that we are interested in improving the accuracy of the prediction by using a new test set that was not used in training, rather than improving the prediction performance for the training data. As such, finding the optimal machine learning method is akin to finding the learning method that minimizes the test-error rate.

C. Key Concepts of Machine Learning

1) Overfitting and Regularization

Machine learning models are trained to lower the test-error rate. However, a low training error rate does not guarantee a low test-error rate. This can be understood as an issue of the trade-off between variance and bias. Variance is the change in $\hat{f}$ when making estimations using different training data. Bias refers to the error caused by approximating a real-world issue when using a much simpler model.[3] As the flexibility of the model increases, the training error rate may decline when the mode fits the training data too well (low bias), but it might then lack in generalization. This is called overfitting, which means that $\hat{f}$ varies too much depending on the training data, resulting in a high variance. In other words, high flexibility lowers bias, and increases variance. For example, even if a quadratic polynomial regression model fits the training dataset A better than a linear regression model, there is no guarantee that the first model will display a high prediction performance for the new dataset A'. Conversely, a non-linear structure f might not be accurately predicted by using an estimation based on a linear regression.

Therefore, a model needs to be restricted to avoid overfitting and to find a balance between the bias and variance. Such restriction is called regularization, a key consideration for machine learning. The amount of regularization to be applied during learning is determined by the regulatory mediating variables. The pre-training determination of the regulatory mediating

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[2] The MSE can be expressed as follows: $MSE = \dfrac{1}{n}\sum_{i=1}^{n}(y_i - \hat{f}(x_i))^2$

[3] The expected error test MSE for a given value x_0 can be expressed as the sum of variance, squared bias of $\hat{f}(x_0)$, and the variance of error term ϵ: $E(y_0 - \hat{f}(x_0))^2 = Var(\hat{f}(x_0)) + [Bias(\hat{f}(x_0))]^2 + Var(\epsilon)$ (James et al. 2016)

variables is thus a crucial part of the machine learning algorithm training. Mullainathan and Spiess (2017) propose the machine learning algorithms and related regularization methods shown in Table 2.

Table 2_Machine Learning Algorithms and Regularization Methods

Machine Learning Algorithm	Regularization Methods and Parameters
Linear model	Subset choice $\|\beta\|_0 = \sum_{j=1}^{k} 1_{\beta_j \neq 0}$
	LASSO $\|\beta\|_1 = \sum_{j=1}^{k} |\beta_j|$
	Ridge $\|\beta\|_2^2 = \sum_{j=1}^{k} \beta_j^2$
	Elastic net $\alpha\|\beta\|_1 + (1-\alpha)\|\beta\|_2^2$
Decision tree	Depth, nodes and leaves, leaf size, information acquired at each cutpoint
Random forest	Number of trees, number of feature variables used in each tree, bootstrap sample size, complexity of each tree
Nearest neighbors	Number of neighbors
Kernel regression	Kernel bandwidth
Deep learning, neural network, etc.	Number of levels, number of neurons per level, neuron connectivity
Spline	Number and order of knots, etc.

Source: Present study, based on Mullainathana and Spiess (2017), Table 2.

2) Test Error, Cross-Validation, and Bootstrap

A machine-learning algorithm is trained using training data, and response variables are predicted by applying the feature variables of the validation data into the fitted model. Ideally, we want to choose a machine learning method that has a low test-error rate. The test-error rate can be easily calculated when a test set is designated. However, as a test set is rarely designated various estimation methods have been proposed in attempts to minimize the test-error rate. Examples include: the validation set approach, which uses a part of the given observations as a hold-out set; the k-fold cross-validation, which divides observations into k subsets and uses one of them as a test set; and bootstrap, which sets given samples as the population and then randomly extracts samples through replacements.

3. Decision Tree and Random Forest

In this study, we use the random forest method to explore the effectiveness of policies. Random forest is one of the most widely used machine learning methods. Before delving into the analysis, the following paragraphs provide an overview of the concept and configuration method of decision trees, which constitute one of the key components of the random forest method.
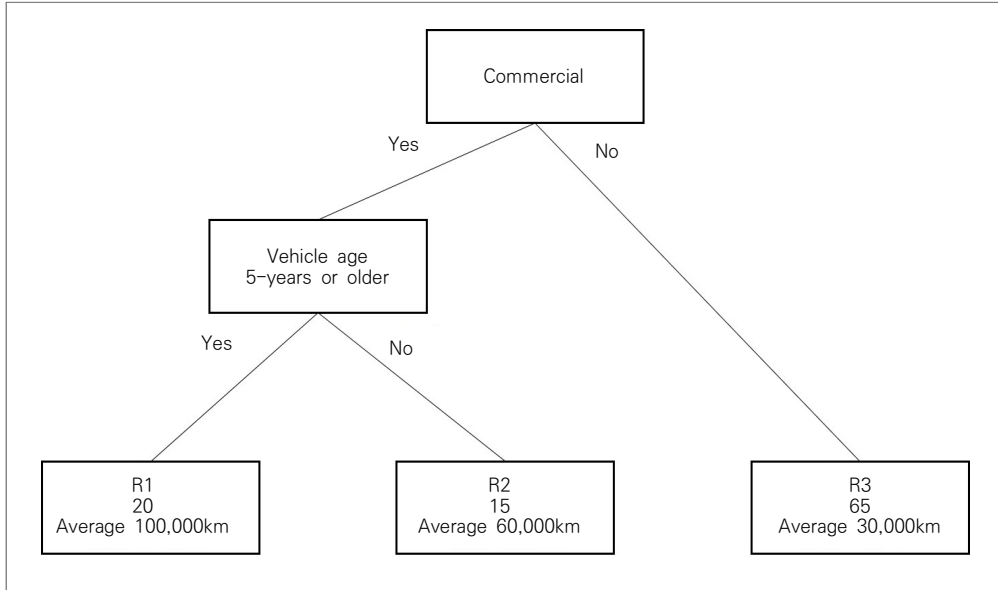
A. Decision Tree

The decision tree is one of the most widely used machine learning methods for classification and regression. It is an algorithm that adds certain conditions to feature variables and then classifies data using yes or no questions. Benefits of the decision tree method include: it allows researchers to flexibly explore non-linear relationships and interaction term relationships between explanatory variables, as it does not presuppose linearity; it is easy to visualize; and it does not require the pre-treatment of data, as it applies conditions that fit each feature variable. The method has a number of drawbacks, however, including a high propensity for overfitting, which should be addressed with appropriate regularization. This chapter examines the basic structure, training methods, and regularization methods for decision trees.

B. Basic Structure

This section explains the basic structure of decision trees by using the hypothetical scenario shown in Figure 1, where we need to predict the mileage of 100 randomly selected cars. Classification begins at the root node with a depth of 0 on the top, by asking whether a vehicle is a commercial vehicle. If not, we move onto the child node on the right with a depth of 1. If the vehicle is a commercial vehicle, another classification is performed based on the vehicle's age, which results in three terminal nodes (or 'leaves'): R1, R2, and R3. The decision tree offers the same predictions for all observations in area R_j. If the response variable of R_j is a continuous variable, the average of the training observations is presented as the predicted value (that is, the mileage of non-commercial vehicles is predicted as being 30,000 km, obtained by averaging the mileage of 65 vehicles in R3). In the case of classification, the mode is presented as the predicted value.

Figure 1_Sample Decision Tree for Vehicle Mileage Prediction

Source: Present study

C. Decision Tree Algorithm and Prevention of Overfitting

In a regression tree, the purpose of a decision-tree training algorithm is to find the residual sum of squares (RSS).[4] In the case of classification, the purpose is to identify the areas R_1, R_2,..., R_j that minimize the impurity of the Gini index,[5] entropy, etc.[6] However, it is impossible to consider all possible combinations of feature variables x_1, x_2,..., x_p and the

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[4] In $\sum_{j=1}^{J} \sum_{i \in R_j} (y_i - \widehat{y_{R_j}})^2$, $\widehat{y_{R_j}}$ represents the average response variable value for the training observations in the j th area.

[5] The impurity of the Gini index is defined as follows: $G_i = 1 - \sum_{k=1}^{n} p_{i,k}^2$, where $p_{i,k}$ is the percentage of samples falling under category k among the training data in the i th node. If all samples of a node fall under category k, the Gini index for the node is 0.

[6] Entropy can be defined as follows: $H_i = -\sum_{k=1, p_{i,k} \neq 0}^{n} p_{i,k} \log_2 (p_{i,k})$. If all samples of a single node fall under the same category, the entropy is 0.

cutpoint of each variable. Therefore, we use a 'greedy' algorithm, that is, an algorithm that produces the feature variable-cutpoint combination that produces the best segmentation, which only considers the current stage, without calculating future stages. In a regression classification, the process is repeated until the RSS is minimized.[7] Then, the tree is developed until a certain stopping criteria is satisfied, which will be covered later.

As mentioned above, the decision tree method tends to be over fitted because there exists little restriction to the training data. Regulatory mediating variables for restricting this vast flexibility of the decision tree method include the following: maximum depth; the minimum number of samples that a node should have for segregation; the minimum number of samples that a terminal node should have; and the maximum number of leaf nodes. The overfitting of a decision tree can be also prevented by 'pruning' unnecessary nodes that provide little significant statistical contribution to lowering the impurity.

D. Concepts and Characteristics of Random Forest

Improved prediction performance can be expected by collecting and combining multiple machine learning predictions, as it results in trade-offs between biases and variances. This approach is called 'ensemble learning,' and an ensemble of decision trees is called a random forest. For example, we can think of a method that trains decision trees using different datasets randomly extracted from a single training dataset to calculate the prediction of each tree, and then calculating the average of the predictions.

The flexibility of the decision tree method makes it vulnerable to overfitting, however, as well as highly sensitive to variations in the training data. Therefore, in order to reduce the variance of these predictions (in other words, to generalize them), we can create random subsets of the training dataset and train decision trees with different subsets. One of the most widely used approaches is bootstrap aggregating, or bagging, which creates arbitrary training datasets by allowing replacement (bootstraps), trains each tree with the bootstrap, and then combines the predictions from the trees by calculating their average or mode. This approach improves the prediction performance of machine learning by reducing variances while maintaining the prediction performance of each tree.

The random forest method goes a step further; it adds arbitrariness by selecting the feature

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[7] It means finding the values for the explanatory variables x_j and s that minimize the equation:

$$\sum_{i\,:\,x_i \in R_1(j,s)} (y_i - \widehat{y_{R_1}})^2 + \sum_{i\,:\,x_i \in R_2(j,s)} (y_i - \widehat{y_{R_2}})^2$$

variables to be considered by each node. Among p feature variables, only m variables[8] are selected as candidate variables for segregation. Each segregation uses one of the m feature variables for segregation. This approach reduces the correlation among decision trees, and the random forest then does not sensitively respond to variations in the training data, which improves the stability of the prediction performance. The accuracy of the model also improves as the number of trees (forest size) increases, and overfitting can thus be avoided because the generalization error converges to a specific value. In addition, each decision tree is trained using randomly extracted from all data, which reduces the effect of noise and outliers. As such, this method is suitable for projects requiring learning from, and predicting, a vast amount of existing data and a large number of independent variables. In addition, the random forest method has demonstrated the best prediction power when applied to binary classifications with imbalanced frequencies (Kim et al., 2016).

E. Implementation of Random Forest

To prevent overfitting and improve the prediction performance, in the random forest method, we can set the parameters for each decision tree, as well as the parameters required for controlling the ensemble. Key parameters include: forest size (number of leaves); the maximum allowed depth of each tree; and the number of feature variables to be considered for node segregation. Importantly, a low number of trees in a forest reduces the generalization power, resulting in a higher test-error rate. A forest with a large number of trees produces a lower error rate, but requires more time for training and testing. In terms of feature variables, looking for cutpoints from randomly selected feature variable candidates can increase the test-error rate of each tree. However, it allows the researcher to train better models that then reduce the variances and the test-error rates of the forest.

The random forest method uses a large number of decision trees, and it is difficult to visualize how predictions are presented. Therefore, feature importance is used to roughly understand the prediction process of a forest. Feature importance measures the extent to which a node with certain features lowers the impurity across all trees in a random forest. A variable with a high feature importance score is more important for the response variable prediction than a variable having a lower importance score.

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8 For classifications, the number of feature variables considered in each segregation (m) is close to the root square of p.

III. Policy Efficacy Evaluation Using Machine Learning

1. Policy Efficacy Evaluation

A. Policy Efficacy Evaluation

A government policy can be measured in terms of its effect through evaluations, and evaluation results are then fed back into improving the policy design. In this study, evaluation refers to a process for identifying whether a policy is effective, and how effective it is. For example, the government adopted a special taxation for tax-exempt general savings designed to help the elderly, people with disabilities, social security beneficiaries, and other vulnerable groups save money. The special taxation for tax-exempt general savings refers to tax exemption for the interest income or dividend income earned by residents 65 and older, people with disabilities, people who contributed to Korea's liberation from the Japanese Occupation and their bereaved families, wounded veterans, basic living welfare beneficiaries, defoliant (e.g., napalm) victims, and people injured during the May 18 Democratic Uprising in Gwangju, Korea.

The policymakers expect that their policy will help these vulnerable groups to build assets for a stable life. To this end, the policymakers would want to know how much the policy contributed to the asset building of these vulnerable groups. The policymakers can use any findings pertaining to this effectiveness to then develop efficient ways to operate the policy, and use the evaluation data to inform decisions on additional budgets for a possible sunset extension.

However, a strict effectiveness evaluation is not easy to achieve. To determine the effectiveness of a policy, we need to first consider the outcomes for the groups who benefit from the policy, as well as the outcomes for other groups. However, caution is required when using a simple comparison between a beneficiary group and a non-beneficiary group, because purchasing a financial product is a matter of personal choice. If only financially affluent members of the beneficiary group purchased tax-exempt financial products, the observed difference between the beneficiary group and the non-beneficiary group actually represents the combination of the outcome from the policy and the differences in individual competency that existed before the policy. If the latter factor outweighs the former factor, a simple comparison between the two groups may subsequently result in over- or under-estimation of the policy's effectiveness.

In the example, measuring the effectiveness of a policy is not an easy task, despite its importance in understanding the outcomes of the policy. We thus need a theoretical understanding of the overall policy evaluation. The following paragraphs will examine the framework of policy evaluations using the example explained above.[9]

Here, an individual considering the purchase of a tax-exempt general savings plan is represented by a lowercase i, and the outcomes of the policy when the individual purchases such a plan are represented by Y_i^T (e.g., saved amount), and the outcomes when the individual does not purchase the plan is represented by Y_i^C. In addition, (Y_i^T, Y_i^C) represents the potential outcome of the beneficiary i, which has a predetermined value. Only one of the two values is observed as the realized outcome Y_i for the individual i. Then, in order to calculate the effect of the policy on the individual i, we need to subtract the outcome when the individual purchases a plan Y_i^T from the outcome when the individual does not purchase a plan Y_i^C. The individual only has two options: purchase a plan, and not purchase the plan. Therefore, the researcher cannot observe the two potential outcomes (purchase / non-purchase) at the same time. As such, it is realistically impossible to calculate the influence of the policy on the individual. This dilemma is called the 'fundamental problem for causal inference.'

The same issue occurs when calculating the average effectiveness of the policy. The effects of the policy may vary depending on individual differences, notably in terms of assets and financial affluence. For policymakers, the average effectiveness $E[Y_i^T - Y_i^C] = E[Y_i^T] - E[Y_i^C]$ of the policy holds greater importance. However, because of the fundamental problem for causal inference, the average effectiveness cannot be calculated using only the observable data. To understand why this is impossible, let us define a dummy variable that has a value of 1 for an individual who purchases a plan, and 0 for an individual who does not. The average of the outcomes for purchasers is thus a conditional average $E[Y_i^T | D_i = 1]$ that is likely to be different from the average of the policy outcomes for all individuals $E[Y_i^T]$. Likewise, the average of the outcomes for non-purchasers is a conditional average $E[Y_i^C | D_i = 0]$, which is typically different from $E[Y_i^C]$. Therefore, there is no way to estimate the average effectiveness of the policy $E[Y_i^T - Y_i^C]$ by only using the observable data.

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9   The following descriptions of the policy evaluation framework are based on Oh et al. (2015).

Then, what is the result of subtracting the average outcome for non-purchasers from the average outcome for purchasers obtained using only observable data? The difference can be expressed as follows:

$$E[Y_i^T|D_i = 1] - E[Y_i^C|D_i = 0] = (E[Y_i^T|D_i = 1] - E[Y_i^C|D_i = 1]) \\ + (E[Y_i^C|D_i = 1] - E[Y_i^C|D_i = 0])$$

According to this expression, the difference between the averages that we can calculate using observable data is equal to the sum of two items. The first item is the average treatment effects for the treated (ATT), which is defined here as the policy effectiveness for purchasers only. The second item is the value calculated by subtracting the average outcome for non-purchasers $E[Y_i^C|D_i = 1]$ from the average outcome for purchasers if they did not purchase a plan $E[Y_i^C|D_i = 0]$. This value represents the inherent difference in policy outcomes between the purchaser group and the non-purchaser group that exists regardless of their purchaser status. This item is defined as 'selection bias,' which may have a negative, positive, or zero value. If the purchasers of tax-exempt general savings plans are inherently better at building assets than non-purchasers, the second item will have a positive value.

Without the second item (selection bias), the average outcome of the purchaser group subtracted by the average outcome of the non-purchaser group represents the average policy effectiveness for the purchaser group. If the potential outcome for an individual is unrelated to whether the individual purchased a plan, the same value is the average of the policy effectiveness, which is equal to the policy effect that we intend to identify (Angrist et al., 1996).

$$E[Y_i^T - Y_i^C] = E[Y_i^T] - E[Y_i^C]$$

In addition, the value of the regression equation estimated using the OLS method is equal to the average outcome for the purchaser group less the average outcome for the non-purchaser group.

$$\hat{\beta} = \hat{E}[Y_i^T|D_i = 1] - \hat{E}[Y_i^C|D_i = 0]$$

However, the estimate is equal to the average policy effectiveness only if the selection bias does not exist. Therefore, an accurate measurement of the policy outcome requires a way to

eliminate such bias, which is the inherent outcome difference between the purchase group and the non-purchaser group. In other words, we need to break the correlation between the purchaser status and individual features. One possible option is to randomly assign the purchaser/non-purchaser status to individuals and achieve (statistical) balance between the treated group (purchasers) and the comparison group (non-purchasers). By creating these random groups, we can eliminate the inherent difference between the treatment group (beneficiary group) and the comparison group. This approach is referred to as a randomized controlled trial (RCT). It is considered one of the golden standards of causal inference. In addition, a recent study proposed a machine learning method that is combined with the RCT method. This method is capable of identifying heterogeneous effects of policies and the features causing such effects (Chernozhukov et al., 2018).

B. Heterogeneous Treatment Effect

Due to the fundamental problem for causal inference mentioned above, the effectiveness of the policy is difficult to determine at an individual level. Most researchers prefer estimates capable of identifying the average treatment effect of individual effects. However, in many cases, the determination of the average effect is restricted by the heterogeneity of treatment effect across subgroups, or better implications for the policy design or evaluation can be achieved by focusing on the individual treatment effect for each subgroup.

Granted, most effectiveness evaluations focus on the average effects on beneficiaries. Such average effects are considered as key elements that determine the success/failure of a policy. However, in cases where certain subgroups report negative (−) effects and others report positive (+) effects, a linear analysis may estimate a net zero effect because it calculates the average effect across the group. In addition, if a group expected to report positive effects actually report negative effects, we may improve the effectiveness of the policy design by identifying the group and its features. For example, we can identify which features exert the most influence on an individual's purchasing decision for a tax-exempt general savings plan, which feature-sharing group reports the highest purchase rate, and which group reports the highest savings or asset building outcomes.

Machine learning serves as a useful tool for policy effect predictions, as discussed above, because it is highly proficient in determining the 'heterogeneous effects' of policies. Conventional linear models add cross terms between treatment variables and feature variables of the experiment group in order to identify policy effects on different groups sharing similar

features, whereas machine learning can predict policy effects on the individual level by flexibly combining the features of the experiment group (Athey and Wager, 2018). However, it should be mentioned that the heterogeneity of treatment effects can be accounted for by using conventional linear regression methods as well. A conventional method selects subsamples that satisfy certain conditions in order to identify treatment effects and then utilize the overall sample. This can be achieved by adding cross terms between feature variables and treatment variables and then determining the statistical significance of the interaction term coefficients. For example, subsamples can be created or included as cross terms by assuming the amount of existing financial assets is the feature variable having the largest effect on the decision as to whether to purchase a tax-exempt general savings plan.

However, such heterogeneity assessments using a linear model have two significant drawbacks. First, a linear model can effectively determine the statistical significance of each feature variable and interaction term coefficients. However, when determining the treatment variable in a subsample created by flexibly combining multiple feature variables, the number of parameters to estimate may exceed the number of observations. For example, if there are five feature variables and a single treatment variable, we need to estimate 64 coefficients in order to determine the heterogeneous effects that depend on the feature variables. For this reason, researchers typically select only a part of the feature variables that are considered to have greater effect on the heterogeneous treatment effects, in which the researchers' assumption regarding the treatment effects might intervene. In an empirical analysis based on a theoretical model, most researchers perform the analysis by selecting the variables that they 'expect' will produce heterogeneous effects. Therefore, more likely than not, the feature variable that produces the largest heterogeneous effect may not be included in the researchers' assumption.

As such, a linear regression model is restricted in its ability to analyze heterogeneous effects, which is why machine learning is being hailed as an alternative in accurately identifying heterogeneity effects. Machine learning provides a method to efficiently select feature variables that show the heterogeneity of treatment effects without requiring any prior information—including assumptions of the researchers. For this reason, the causal forest method provides an intuitive insight into feature importance, which refers to the extent of the effect on the treatment effect.
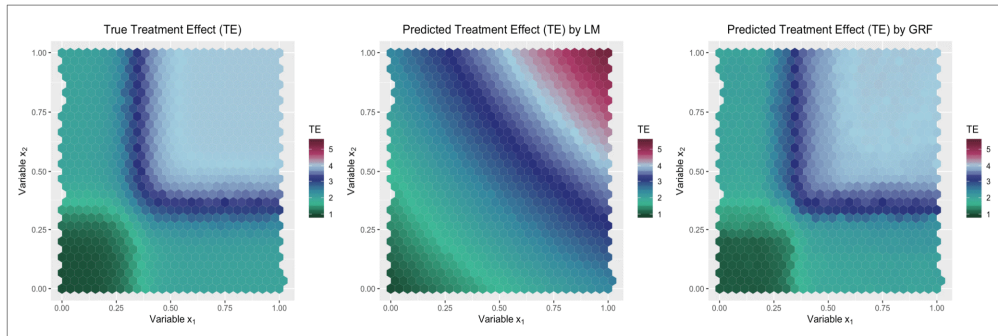
C. Features of Causal Forest

In recent years, a continued inflow of research articles emerged that have focused on the exploration of causal effects using machine learning or, to be more precise, the exploration of heterogeneous treatment effects using machine learning methods. One of the methods is the causal forest method discussed by Athey, Tibshirani, and Wager (2018). The causal forest method uses the random forest approach, that is, repeatedly creating individual decision trees and then generating a motel that integrates and represents those trees. However, instead of calculating the average of each tree, each tree is assigned a different weight for further exploration of the causal effects.

Notably, in estimating the heterogeneous treatment effects, the features of the causal forest method can be summarized into two parts. First, in the case of regression classification, the random forest method involves growing individual decision trees in a way that minimizes the RSS in each area. On the other hand, the causal forest approach performs the classification in a way that maximizes the treatment effect calculated as the difference in the variable of interest (y) between the treatment group and the treatment group in each area. Second, what separates the provision of predictions from the calculation of causal treatment effects is the need to provide the statistical significance of the treatment effects. To address this issue, Athey, Tibshirani, and Wager (2018) proposed the honest tree approach. On the premise that the same observations cannot be used to both grow decision trees and calculate the treatment effects at the same time, the honest tree approach randomly divides the existing training data once again into the splitting subsample and the estimating subsample. The splitting subsamples are used to grow individual trees, and the estimating subsamples are used for generating predictions for the treatment effects.

This process can be understood in its use to achieve statistical balance between the treatment group and the comparison group, and in creating an RCT that minimizes the influence of the selection bias. In this sense, the treatment effect estimated by a causal forest can be understood as being a consistent estimator. Figure 2 shows the outstanding performance of the approach in predicting heterogeneous treatment effects.

The diagram on the left side of Figure 2 shows a hypothetical cases where variables x1 and x2 are combined in various ways, and each combination has a different treatment effect. A single observation may represent greater policy effect (red) or lower policy effect (green) depending on the x1–x2 combination. The figure shows the performance of the two prediction models in predicting the policy effect for each unit. The diagram in the middle

Figure 2_Comparison of Heterogenous Treatment Effect Estimations Between Linear Regression and Causal Forest

Source: STATWORX Blog, "Machine Learning Goes Causal II: Meet the Random Forest's Causal Brother," https://www.statworx.com/ch /blog/machine-learning-goes-causal-ii-meet-the-random-forests-causal-brother/, accessed on December 10, 2020.

shows the individual treatment effects calculated using a linear model. The prediction for each treatment effect is significantly different from the actual heterogeneous treatment effect (diagram on the left), which can be understood as being a result of the model's limitation (only linear combination between feature variables x1 and x2). On the other hand, the diagram on the right shows the treatment effect predicted for individuals using the causal forest approach. The diagram is highly similar to the diagram on the left, which means the model predicted the treatment effects are quite close to the actual effects, and was obtained by flexibly combining the feature variables.

2. Tax Policy Effectiveness Evaluation: Special Taxation for Tax-Exempt General Savings

A. Overview

This study performed a causal forest analysis on one of the policies included in the special taxation evaluation in 2019, which is the special taxation for tax-exempt general savings (Article 88-2 of the Restriction of Special Taxation Act). The purpose of the analysis is to determine whether machine learning analyzes policy effectiveness better than the conventional linear regression methods, and is then used to identify policy implications for a more effective policy design.

The special taxation for tax-exempt general savings is designed to help the elderly, people

with disabilities, and social security beneficiaries and other vulnerable groups save money. The beneficiaries of the policy include residents 65 and older, people with disabilities, people who contributed to Korea's liberation from the Japanese Occupation and their bereaved families, wounded veterans, basic living welfare beneficiaries, defoliant (e.g., napalm) victims, and people injured during the May 18 Democratic Uprising in Gwangju, Korea. As of the end of 2018, residents 65 and older accounted for 92.5% of the 4.27 million beneficiaries. Under the policy, the beneficiaries are exempt from taxes imposed on their interest or dividend income from tax-exempt general savings, which refer to the savings plans offered by financial institutions and six designated mutual aid cooperatives (including trusts, insurance, and mutual aid) that beneficiaries purchase by applying for the tax exemption. According to the Mandatory In-depth Evaluation of Special Taxation for Tax-Exempt General Savings Report (Jung et al., 2019), the policy serves a valid purpose of helping the elderly, people with disabilities, low-income earners, and other vulnerable groups build their assets. However, the report pointed out the possibility that high-income earners and people with large assets may enjoy better access to the benefits of the policy, which may thereby undermine the vertical equity of the policy. The report highlighted the need for various ways to address this risk. In fact, an analysis of the purchasers of tax-exempt savings plans based on the National Tax Service (NTS) data shows that individuals who purchased other tax-exempt/tax-reduction financial products were more likely to apply for the special taxation. Overall, only 3% of people in the five lower income brackets were found to have purchased tax-exempt general savings, whereas 69% of people in the top five income brackets purchased them. The financial income from the tax-exempt general savings purchased by the top three income brackets accounted for 91% of the income from tax-exempt general savings, across all income brackets.

The 2019 report (Jung et al., 2019) indirectly estimated the effect of the policy using a quasi-experimental method in which the minimum eligible age was increased in the 2014 amendment to the Act (from 60 to 65), and the eligibility conditions were exogenously determined. A subsequent analysis using the Survey of Household Finances and Living Conditions data found the following. First, the average effect of the special taxation policy on savings, asset transfer, and asset building across all beneficiaries was not statistically significant. Second, despite the lack of significant effect across all beneficiaries, the authors of the report decided that the policy should be further tested for the possibility of significantly affecting specific subgroups. For this task, the authors divided the beneficiaries into households with employment or business income and households with neither income.

The analysis did not find any statistically significant coefficients in either of the household

groups. Third, the report analyzed the effect of the special taxation policy for the top asset quintile and the fifth asset quintile. As a basic goal of the policy is to contribute to the savings and asset building of low-income groups, the authors decided that they needed to assess the possibility that the policy may primarily affect low-income earners. Households having large assets were also considered because these households are financially affluent, and tend to benefit more from the policy. However, similar to the findings cited above, no statistically significant results were found in either household group, in terms of savings, asset transfer, or asset building. Granted, these findings may indicate that the average effect of the policy is not significant. However, it should be also noted that the conventional methodology is limited in its ability to understand policy effects on an individual level.

The next section focuses on the latter possibility, and explores how machine learning improves effectiveness estimations by combining various feature variables, and how the technique helps evaluators estimate heterogeneous treatment effects across different groups of beneficiaries.

B. Analysis Method

This section discusses the usefulness of machine learning in analyzing the heterogeneous effectiveness of a policy. In brief, this section utilizes the empirical analysis method proposed in an in-depth report (Jung et al., 2019). The main beneficiaries of the special taxation policy consist of the elderly. In 2014, the age eligibility criteria was exogenously changed by an amendment, which increased the minimum eligible age from 60 to 65 in one-year increments per year. As a result, a person born in 1954 (aged 60 in 2014) became eligible for the benefit in 2014. However, a person born in 1955 (aged 59 in 2014) did not make the cut, and was not eligible for the same benefit until 2019. The in-depth report (Jung et al., 2019) measured the effectiveness of the tax-exempt general savings policy by comparing the saving behaviors of the two groups that were divided based on of the exogenous change in the eligibility criteria.

Specifically, based on the reasonable assumption that people born in 1954 and those born in 1955 are similar in all aspects except for their eligibility status, the authors compared the changes in saved amount, saving types (financial assets or tangible assets), and asset building after turning 60 between the two groups, using the difference-in-difference method. In other words, in the 2014~2019 period, people born in 1954 were in the treatment group, and those born in 1955 were defined as the control group.

The in-depth report attempted to determine the effectiveness of the policy using a variety

of indicators, including effects and asset effects. This study, on the other hand, proposes examples of determining heterogeneous effects. As such, this study focuses on the savings effect likely to show the greatest change, that is, changes in the amount of installment savings.

This study used the 2014~2019 data from the Survey of Household Finances and Living Conditions. Those who turned 60 in 2014 and became eligible for purchasing a tax-exempt general savings plan were defined as the tax-exempt general savings, and those who turned 59 in 2014 were assigned to the control group. This study analyzed a total of 4,290 samples, of which the treatment group and the control group accounted for 43.7% (1,875) and 56.3% (2,415), respectively. The causal forest analysis considered feature variables that could reasonably be assumed to have been determined before the amount of savings was determined. The feature variables included: the sex of the household head; the number of household members; the educational attainment of the household head; cohabitation status; place of residence; the job and industry of the household head; the job type of the household head; the marital status of the household head; and the income quintile of the household head.

Table 3_Key Variables

Feature variable	Description
Personal features of the household head	Sex, number of household members Cohabitant status (single-member household; lives with other members; does not live with other members (job); does not live with other members (study)) Marital status (unwed, married, widowed, divorced) Place of residence (Seoul Capital Area, Others)
Educational attainment	None, elementary school, middle school, high school, college (3-year or lower), university (4-year or higher), graduate school
Household head job	Manager, professional and practitioner, office worker, service worker, sales worker, skilled agricultural/fishery worker, technician and technical worker, equipment/machine operator and assembly worker, manual worker, military personnel
Household head job type	Full-time worker, temporary worker/day laborer, employer, self-employed, unpaid family worker, others (commission-based insurance planner, chauffeur, visiting teacher, etc.), others (unemployed, home manager, student, etc.)
Household head industry	Agriculture, forestry, and fishery; mining and quarrying; manufacturing; power, gas, steam, and water services; retail; transportation; hotel and restaurant; publication and visual content; broadcasting and information service; finance and insurance; real estate and lease; professional, science, and technology service; business facility management and business support; public administration, national defense and social security administration; education service; healthcare and social welfare service; art, sport, and leisure service; association and organization; repair and other personal service; family employment and other unclassified production for self-consumption; international and foreign organization
Household head income quintile	Current income quintile

Source: present study, based on Survey of Household Finances and Living Conditions Codes (household, master).

The eligibility for purchasing a tax-exempt general savings plan is determined by age. However, the savings amount may change as the holder's gets holder. Therefore, this study analyzed the residual after controlling for the fixed effect of age. The analysis was performed with R, which provides a variety of machine learning packages, and the causal forest analysis used the GRF package.

C. Findings

Table 4 presents the results of the linear regression analysis.[10] The dependent variable is the residual of the savings amount after controlling for the fixed effect of age, and the treatment variable was whether the sample is eligible for purchasing a dependent variable (born in 1954).

Table 4_Regression Analysis Results

(unit: KRW 10,000)

Feature variable	Response variable: Total savings amount (residual)
Eligibility (born in 1954)	-0.0000445 (560.7847)

Source: Present study, based on the Survey of Household Finances and Living Conditions data.

As for Jung et al. (2019), the findings show negative coefficients and the measurements are not deemed to be statistically significant. The findings indicate that, compared to non-eligible individuals (born in 1955), the average treatment effect of the eligibility for the special taxation was not statistically significant. Another linear regression analysis was then performed with additional feature variables, as listed in Table 4. Table 5 lists the feature variables with statistically significant measurements, along with the treatment variable.

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[10] The linear regression equation is defined as follows: $y_{it} = \alpha + \beta D_{1954} + X^{'}\gamma + \tau_t + \epsilon_{it}$, and y_{it} represents the savings amount, D_{1954} represents the eligibility for purchasing a tax-exempt general savings plan, X is each individual's feature variable, and τ_t represents the fixed effect of age.

Table 5_Regression Analysis Results For Feature Variables

(unit: KRW 10,000)

Feature variable	Response variable: Total savings amount (residual)
Eligibility (born in 1954)	296.8 (527.5)
Number of household members	-704.9** (331.9)
Household head's educational attainment	1,774*** (224.6)
Place of residence (Seoul Capital Area)	1,127* (579.2)
Household head job (manager)	13,324*** (3,424)
Income quintile (1st)	-15,628*** (1,156)
Income quintile (2nd)	-12,712*** (990.4)
Income quintile (3rd)	-11,191*** (947.0)
Income quintile (4th)	-9,159*** (937.3)
Observations	4,290
R-squared	0.153

Note: *, **, *** are significant at a statistical significances of 10%, 5%, and 1%, respectively.
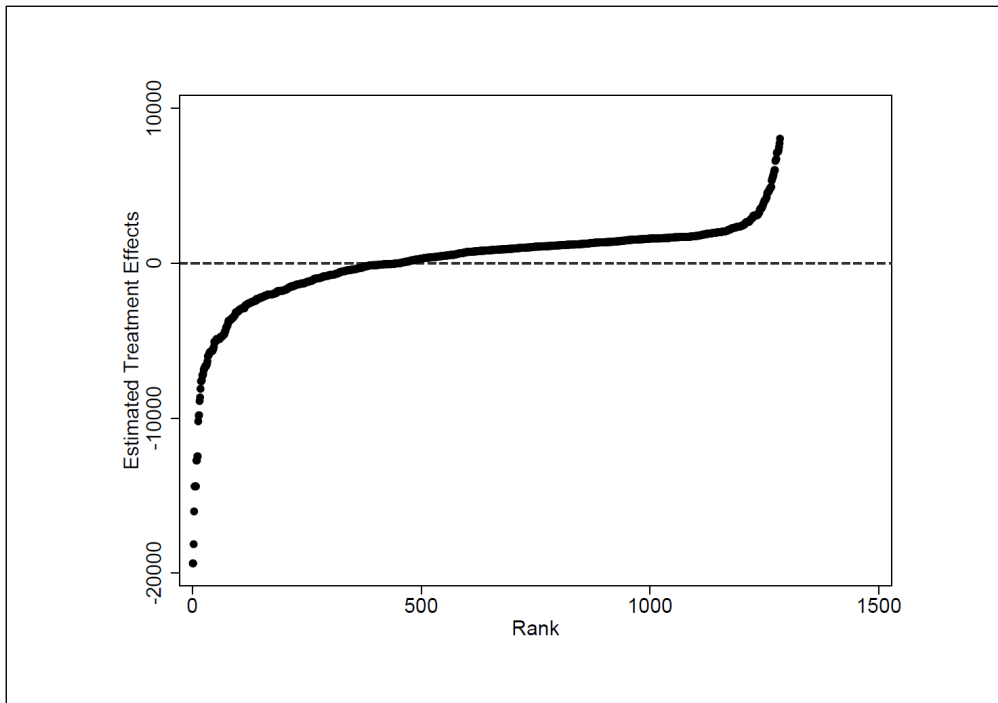Source: Present study

Despite the differences in coefficient sizes and directions, the findings remain statistically insignificant. However, with these findings, we can now compare whether certain feature variables (number of household members, educational attainment, place of residence, job, and income) can be correlated with the savings amount. A household with more members and less income saving reports a lower savings amount. A household with higher educational attainment, residing in the Seoul Capital Area, and is a household head working as a manager deposits more money in the general savings account.

However, neither linear regression analyses provided sufficient data to conclude that the treatment variable, that is, the savings amount, is not 0. Granted, the average effect of a policy constitutes the main factor in determining its success. However, in cases where certain subgroups report negative (–) effects and others report positive (+) effects, a linear analysis may estimate a net zero effect, as it calculates the average effect across the group. In addition,

if a group expected to report positive effects actually report negative effects, we may improve the effectiveness of the policy design by identifying the group and its features. For the tax-exempt general savings plan, it is important to determine which feature is shared by the group reporting the highest savings or asset building results.

The causal forest analysis provides a useful way to determine the existence of heterogeneous treatment effects. The causal forest method can predict the treatment effect for each observation. Figure 3 shows the treatment effect predictions arranged in the ascending order. With most of the predictions indicating a zero effect, the dots on the left side represent negative treatment effects, and those on the right side represent positive effects. In other words, among individuals who became eligible for the special taxation policy, some individuals reported lower savings amounts than the average, whereas others reported higher amounts.

Figure 3_Heterogeneous Effects of Tax-Exempt General Savings Estimated Using the Causal Forest Method

Source: Present study, based on the Survey of Household Finances and Living Conditions data.

The following sections explore the key explanatory variables for these heterogeneous treatment effects. The findings of this analysis can be used to inform decisions as to which group should be given higher priority in order to improve the effectiveness of the policy.

One of the causal forest analysis tools can calculate the relative importance of feature variables affecting response variables (variable importance). Table 6 lists the top five variables, which can be understood as being key determinants affecting individuals' decisions as to whether to increase savings amounts when they become eligible for purchasing a tax-exempt general savings plan.

Table 6_Feature Importance Variables

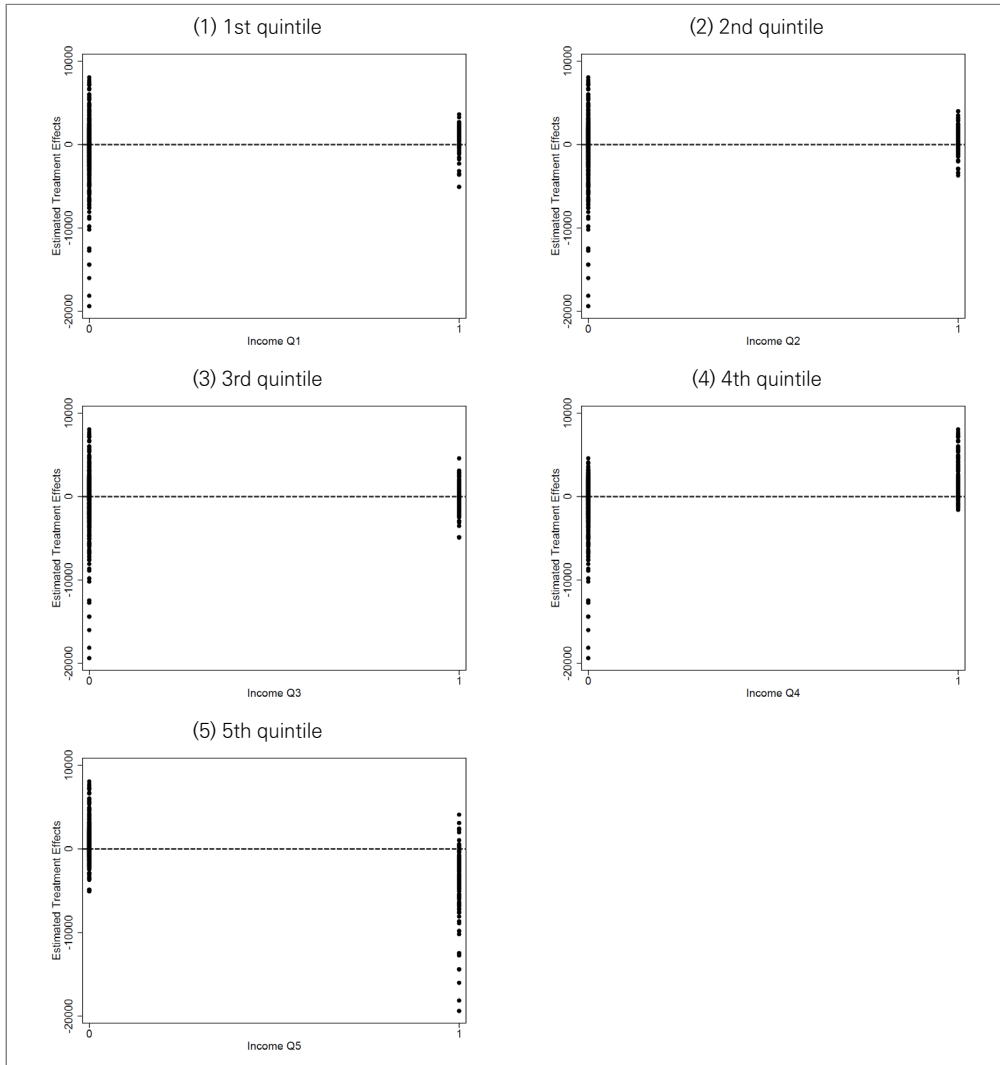| Feature variable	Description
quint_inc_Q5	Income quintile
hhh_educ	Household head's educational attainment
hhh_indu_F	Household head's industry (construction)
hhh_job_2	Household head's job (professional or practitioner)
hhh_jtype_7	Household head's job type (others: unemployed, home manager, student, etc.)

Source: Present study, based on the Survey of Household Finances and Living Conditions data.

The list shows that income exerts the greatest influence on determining the savings amount, followed by household heads' educational attainment, industry, and job.

The variable importance analysis indicates the possibility that the effect of the eligibility for the special taxation varies depending on the income level. Indeed, the above analysis identified key feature variables that are correlated with the heterogeneous treatment effects. Figure 4 summarizes the policy effect of the eligibility across income quintiles.

The in-depth report (Jung et al., 2019) discussed the possibility that the benefits of the special taxation may be concentrated on individuals with high levels of income or assets. Figure 4 supports the prediction that the eligibility for purchasing a tax-exempt general savings plan affects the amount of the savings in the fifth quintile.

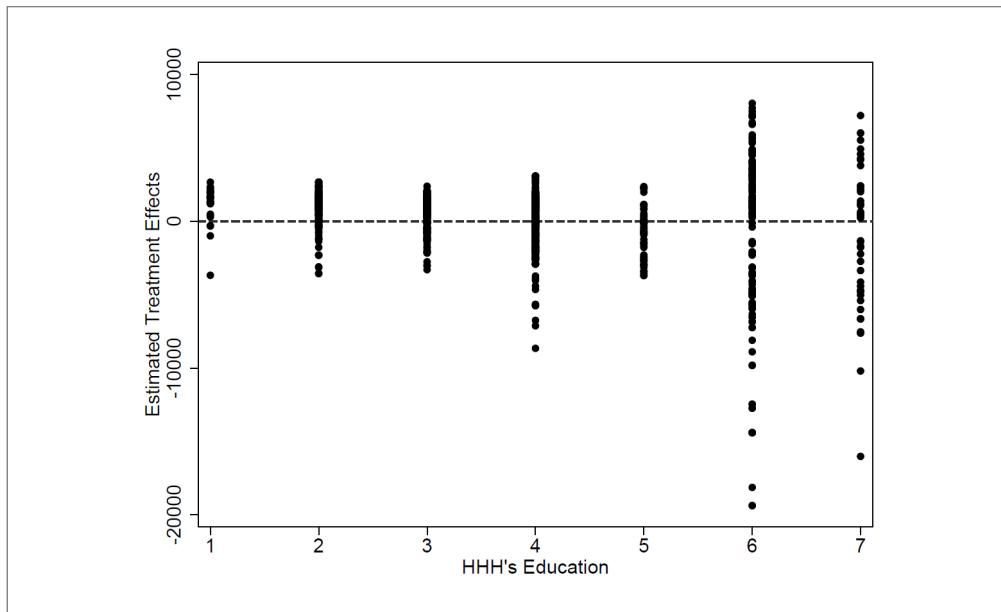**Figure 4_Estimation of Heterogeneous Treatment Effects Across Income Quintiles**

Source: Present study, based on the Survey of Household Finances and Living Conditions data.

Each graph predicts the individual-level treatment effects (changes in savings amounts) of becoming eligible for the special taxation in the relevant quintile (Income Qx=1). The first four graphs confirm that the eligibility had no treatment effect on most individuals in the

relevant quintiles. On the other hand, in the fifth graph, most individuals in the fifth quintile (Income Q5=1) reported savings amounts below the average (that is, their individual treatment effects are below zero). It should be also noted that some individuals in the fourth quintile reported positive treatment effects, unlike in the other quintiles. As such, further analysis is required in order to understand why the eligibility affects savings amounts differently. However, the very ability to examine the extent and direction of individual treatment effects in each quintile is one of the key benefits of machine learning analyses over conventional linear analyses.

Figure 5 shows how the eligibility for purchasing a tax-exempt general savings plan affects savings amounts across different levels of educational attainment. The figure shows seven levels of attainment: 1 = no education; 2 = elementary school graduate; 3 = middle school graduate; 4 = high school graduate; 5 = college (3-year or shorter); 6 = college (4-year or longer); and 7 = graduate school. Most individuals reported zero change in their savings amounts. However, individuals who graduated from college (4-year or longer, 6) and graduate school (7) reported different savings amounts, depending on their eligibility status.
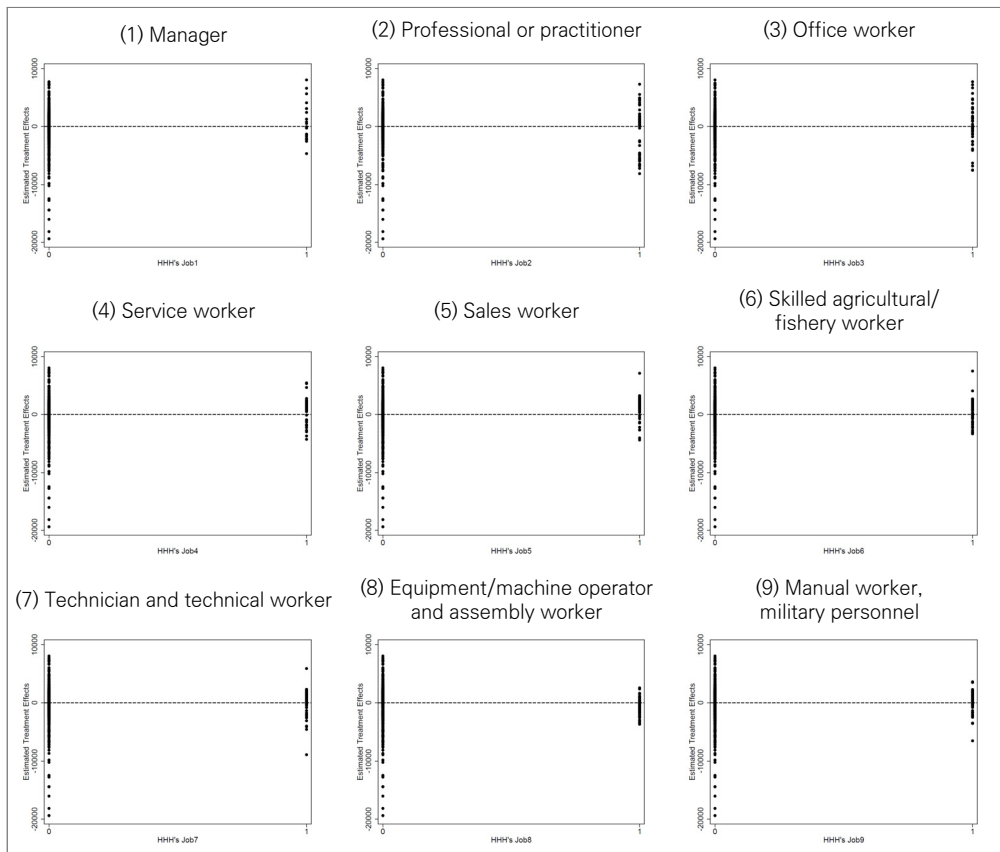
Figure 5_Estimation of Heterogeneous Treatment Effects Across Educational Attainment Levels

Source: Present study, based on the Survey of Household Finances and Living Conditions data.

Figure 6 shows how the eligibility for purchasing a tax-exempt general savings plan affects savings amounts across different jobs. The job classifications considered for this analysis include: 1 = manager; 2 = professional and practitioner; 3 = office worker; 4 = service worker; 5 = sales worker; 6 = skilled agricultural/fishery worker; 7 = technician and technical worker; 8 = equipment/machine operator and assembly worker; 9 = manual worker, military personnel Across most jobs, the effect of special taxation eligibility on individuals' savings amounts measures at zero. However, professionals (2) and practitioners and office workers (3) reported different savings amounts depending on their eligibility status. Consistent with the findings above, heterogeneous treatment effects are observed in the professional/

Figure 6_Estimation of Heterogeneous Treatment Effects Across Jobs
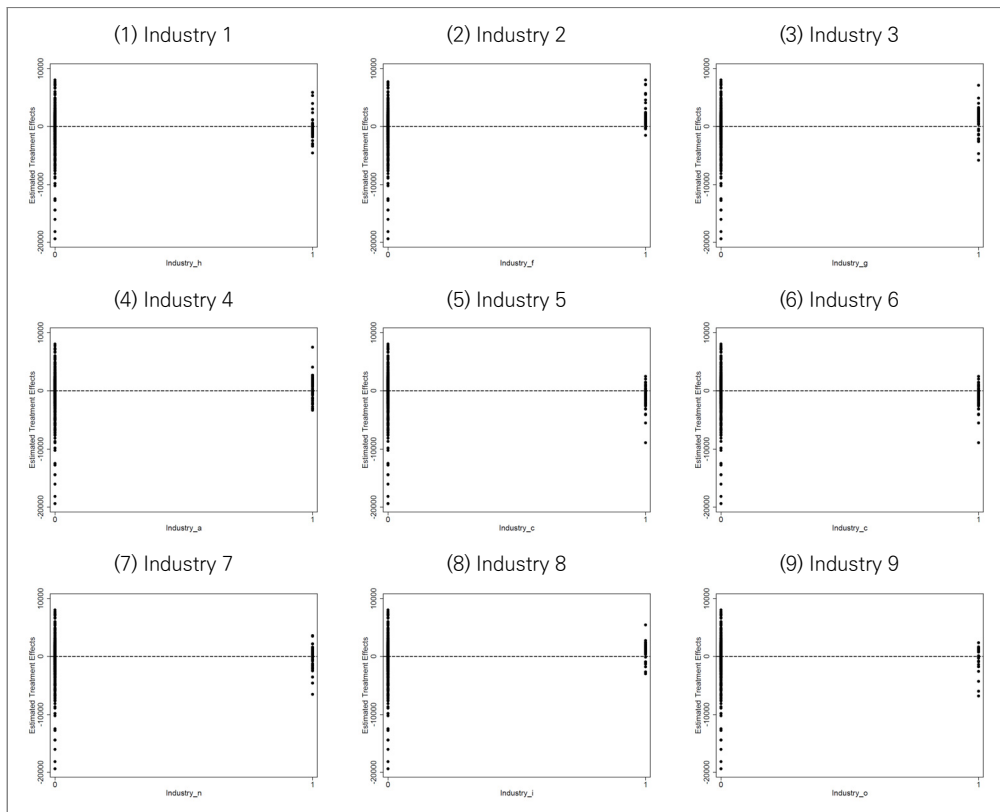

Source: Present study, based on the Survey of Household Finances and Living Conditions data.

practitioner group (2) and the office worker group (3), who are likely to earn a higher income and be more financially affluent.

Figure 7 shows how the eligibility for purchasing a tax-exempt general savings plan affects savings amounts across different industries. The industries include: 1 = transportation; 2 = construction; 3 = wholesale and retail; 4 = agriculture, forestry, and fishery; 5 = manufacturing; 6 = real estate and lease; 7 = business facility management and business support services; 8 = hotels and restaurants; 9 = public administration, national defense, and social security administration. Across most jobs, the effect of special taxation eligibility on individuals' savings amounts was measured to be zero. However, households with household heads working in construction reported different savings amounts depending on their eligibility status.

Figure 7_Estimation of Heterogeneous Treatment Effects Across Industries

Source: Present study, based on the Survey of Household Finances and Living Conditions data.

To summarize the findings, the eligibility for purchasing a tax-exempt general savings plan was found to affect savings amounts only among individuals having high income and assets, who are financially affluent even after retirement. In other words, while the special taxation policy is designed to encourage vulnerable groups to save money, the findings suggest the possibility that the benefits of the policy may go to financially affluent individuals already having high income and assets (college graduates, office workers, etc.).

From the above findings, machine learning has provided a way to analyze treatment effects on specific groups that are not readily discernible using conventional linear analyses, and to analyze group-specific effects and behavioral changes brought on by certain policies. These findings will subsequently enable policymakers to design more insightful policies and assess their effectiveness.

IV. Conclusions and Policy Implications

This study provided an overview of machine learning, and why it is being widely hailed by those who evaluate and design policies. In particular, this study focused on two machine-learning algorithms: decision trees and random forests.

Taking note of the outstanding ability of machine learning to examine the heterogeneous effects of policies, this study focused on the special taxation policy for tax-exempt general savings evaluated in 2019. By analyzing the policy's effectiveness using the causal forest approach, this study sought to show how machine learning can provide better estimates of policy effectiveness over linear regression analyses. Notably, however, as with the conventional linear analysis the findings of the machine learning analysis did not determine statistically significant changes in saving behaviors. However, the machine learning approach enabled the prediction of heterogeneous treatment effects on an individual level, and revealed the possibility that the benefits of the tax-exempt general savings policy may be primarily enjoyed by financially affluent beneficiaries.

In recent years, Korea has seen a rise in social costs caused by tax and fiscal policies implemented without sufficient preparation. If the recent controversy over determining the beneficiaries of the COVID-19 relief fund is any indication, a policy must be well-targeted in order to maximize the intended effect of the policy. In this regard, the use of machine learning can provide better outcomes than can be obtained using conventional approaches. Globally, there exist numerous examples, such as the tax refund program in Italy, the suicide prevention

policy for the elderly, and the effectiveness evaluation of the tax-exempt general savings policy, in which the effects of a policy can be maximized by utilizing the available administrative data to select the groups expected to benefit the most from the policy, and focusing resources on the identified groups.

With enhanced access to administrative microdata or social network data, machine learning is emerging as a useful tool for proposing solutions to complex issues that go beyond the scope of the conventional analysis methods. Experts are still debating on how much machine learning will change or replace conventional analysis methods. However, at the least, this approach has proved to be proficient at predicting policy effects, which brightens its prospect as one of the main tools for improving policy evaluations and designs in Korea.

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A Study on the Cigarette excise tax Rate System for Enhanced Corrective Function

Dawoon Jung*

1. Purpose and Characteristics

This foundational study examines the effect of cigarette excise tax reform that enhances its corrective function. Korea's current cigarette excise tax regime implicitly provides corrective function. So far, Korea has implemented the policy based on the expectation that the demand for cigarette can be suppressed by increasing the cigarette excise tax and other charges. An increase in the cigarette excise tax usually results in price increase by cigarette suppliers, which suppresses the demand for cigarette.

This study examines a cigarette excise tax regime that explicitly considers the costs of smoking. Its primary purpose is to examine a tax structure that takes account of the socioeconomic costs of smoking and its external costs. Previous studies on Korea's cigarette excise tax structure largely focused on the tax rate. Studies on the corrective function of the cigarette excise tax have been lacking. In particular, to my knowledge, this is the first study that explicitly consider nicotine and tar content in cigarettes to study the cigarette excise tax rate structure focusing on its corrective function.

This study is a foundational study, which is different from a policy study in some respects. The findings of this study are not readily applicable to actual policies. However, the author

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expects that the findings can be widely used in discussions on corrective function and tax rate systems in the future. The findings are also applicable to taxes other than the cigarette excise tax, including the liquor tax, the fuel tax, and the sugar tax. Foundational discussions on these taxes need to be encouraged for the following reasons. Products mentioned in discussions on corrective function have been targets of social controversy on account of the various costs caused by their use, and it is highly likely that we will not have sufficient financial resources to address the issues. New ideas and efforts are required to deal with those issues, and this study seeks to contribute its own ideas. This researcher hopes that this study will be followed by more studies examining corrective function and tax rate structures based on a wider range of data.

2. Summary

This study estimates the demand function of cigarette based on a number of methodologies, including the widely used ordinary least squares (OLS), individual fixed effects extracted from panel data, and combination of fixed effects and instrument variables.

In addition, unlike previous studies, this study considers nicotine and tar content in the estimation. This study also estimates the heterogeneity of the price elasticity of the demand for cigarette across different levels of nicotine and tar content. The price elasticity of cigarette is generally low. The price elasticity of individuals who consume high nicotine/tar cigarettes reported particularly low price elasticity.

As mentioned above, the primary purpose of this study was to examine a tax structure that takes account of the socioeconomic costs of smoking and its external costs. To that end, this study used the data on cigarettes actually consumed by smokers. Nicotine and tar content varies depending on the cigarette product, which means that different smokers inhale different amounts of nicotine and tar. According to previous studies in medicine and healthcare, nicotine and tar contents are positively correlated with the health-related costs incurred by smokers and the damage caused by second-hand smoking. This study examines how the corrective function of the cigarette excise tax can be enhanced, assuming that nicotine and tar content determine the external costs of cigarettes. Smokers who smoke high-nicotine cigarettes incur more external costs than those who consume low-nicotine cigarettes. As such, it makes theoretical sense to impose a higher tax rate on the former group. According to the empirical analysis on the demand for cigarette mentioned above, high-nicotine smokers were less sensitive to prices than low-nicotine smokers. Therefore, the smoking behaviors of

low-nicotine smokers can be suppressed by relatively small price increase. The same does not apply to high-nicotine smokers.

Additionally, this study compares a fixed tax rate structure that considers nicotine content, and a differential tax rate structure that also takes account of tar content. The findings suggest that the differential tax rate structure can be more efficient for the society as a whole. Given the fact that both nicotine and tar content are key components that generate social costs, a tax rate reform that considers both substances is bound to offer higher efficiency. Compared to the current cigarette excise tax structure that does not explicitly take account of external costs, a tax rate structure that considers external costs would be more efficient.

3. Policy Implications and Suggestions for Future Studies

The cigarette excise tax structure proposed in this study is but one of many policy options for correcting smoking behaviors. If the primary goal of policymakers is reducing the external costs of smoking, there are other alternatives than the corrective tax.

Examples include restricting cigarette sales in specific ways, and reinforcing activities that warn the public of the danger of smoking. However, researchers and policymakers need to consider the possibility of reinforcing the corrective function of the cigarette tax and lowering external costs with the new tax rate structure.

The tax rate structure proposed in this study poses an issue that warrants further examination. The data analyzed in this study suggest that people with lower income and lower educational attainment tend to consume higher-nicotine products. Then, a tax rate increase based on nicotine content, like the one proposed in this study, may result in a regressive tax rate structure, which is partially linked with the existing controversy over the regressive nature of the excise tax. However, imposing taxes based on nicotine content does not necessarily result in a regressive tax structure. If such a tax structure reduces the individual and socioeconomic costs of smoking among low-income earners, the tax structure may actually reduce the amount of costs borne by a low-income smoker. A definite answer to this issue will require further studies on tax rate structures based on nicotine content.

Several suggestions for future studies on this issue can be drawn from this study First, an incorrect estimation of the socioeconomic costs of smoking may result in significant estimation errors. In this study, we used the external costs estimated in previous literature, and the estimates were from a single year. The accuracy of these estimates affects the corrective tax proposed in this study. However, despite the possibility of biased estimates, the political

implications of our findings still persist, as the theoretical and empirical findings are intuitively consistent. Secondly, the subject matter of this study needs to be examined further using a wider range of data. For example, even though the Korea Finance Panel Survey data used in this study include information on what products smokers consume, and how often they smoke, the data do not contain information on the intensity and duration of a single smoking event, Data that provide information on these factors will be highly useful for future studies on the subject matter. Lastly, the researcher hopes that this study will pave the way to more discussions on the taxation structures on goods that generate external costs. For example, future studies can discuss the tax on liquors and alcoholic beverages. Korea recently adopted a liquor tax structure based on the amount of alcohol. However, the new structure cannot be identified as a structure designed to explicitly consider external costs. In this regard, it would be interesting to study liquor tax reforms to take account of liquor types and the alcohol content.

Griffith et al.(2019) proposed a tax rate reform plan based on liquor type and alcohol content. We believe that their insight is applicable to the Korean setting. Similar approaches can be taken to devise a tax rate structure for the sugar tax, which considers the sugar content in products to control obesity. This researcher hopes that this study will lead to further studies on corrective taxes that explicitly consider external costs in various aspects.

I. Introduction

A corrective tax, also called a Pigouvian tax, is a tax imposed in order to achieve certain policy objectives. Prime examples of a corrective tax are taxes imposed on the consumption of certain products in an attempt to cause negative externalities to discourage their consumption. This type of tax includes the cigarette excise tax, which is the subject matter of this study, as well as the liquor tax, and the fuel tax imposed on the consumption of gasoline or diesel. The excessive consumption of cigarettes or liquor may incur additional social costs. If consumers' health is negatively correlated with the consumption of such products, an increase in their consumption is likely to increase the consumers' healthcare expenses. In Korea, given the high percentage of healthcare costs covered by the National Health Insurance, cigarette or liquor consumption may negatively affect the healthcare finances of the country. In addition, if an increase in the consumption of a product increases the expenses incurred by people other than the consumers of the product, its consumption is highly likely

to result in an even greater increase in social costs. For this reason, the government is justified in its efforts to 'correct' the behaviors of those who consume such products. The case of the fuel tax provides a good analogy. The consumption of gasoline and diesel causes various negative externalities such as traffic congestion and environmental pollution. Imposing a fuel tax may reduce such externalities by discouraging consumers from using too much fuel. The government imposes taxes on gasoline and diesel because, if the consumption of these products inflicts harm on the society, correcting the demand for these products may result in an increased utility for society as a whole.

As such, a corrective tax is often referred to as a 'sin tax.' The term implies that the tax is imposed not because the consumption of the product is a statutory crime, but because the consumption is a 'sin,' that is, a behavior deemed undesirable by society's norms. As discussed above, the sin taxes imposed today presuppose that the consumption of the relevant products may increase social costs. However, there exists no absolute criteria for social undesirability, and what constitutes a sin may vary depending on the social context. This is why it is difficult to ascertain the products subject to sin taxes, and why we constantly hear discussions on the appropriate level of corrective taxation, even despite the consensus on its necessity and justifiability.

To determine the optimal level of corrective taxation, we need to consider three major points: whether the tax at issue is capable of achieving the policy goal to the extent that justifies its existence; what is the appropriate level of corrective taxation when considering the additional tax revenue and the costs of collecting it; and whether the tax is regressive, given the fact that most corrective taxes are indirect taxes. A corrective tax imposed without these considerations is less likely to achieve its policy objectives. Increasing the tax rate imposed on a product subject to a sin tax is likely to increase taxpayers' motivation to avoid taxation, and even lead to the formation of an illegal underground market for the product. In addition, the percentage of cigarette and liquor users is likely to be higher in lower income groups, which means that increasing the tax rate on these products disproportionately increases the tax burden of lower income groups.

The fundamental reason for the ongoing controversy over the optimal level of corrective taxation pertains to the difficulty of reaching an agreement on what is the 'socially optimal' level of consumption. Corrective taxation presupposes the gap between the individually optimal consumption and the socially optimal consumption, and the need to address such a gap. A corrective tax would not be logical if it is imposed without clear criteria regarding the socially optimal level of consumption. For this reason, in economic discussions on the optimal

rate for a corrective tax, we need to keep in mind the following: an 'optimal' level for the society does not necessarily mean 'the best' level for the society.

Another crucial issue regarding corrective taxation is its scope. If corrective taxation is solely aimed at correcting the non-optimal demands for certain products, there would be no reason not to extend corrective taxation to products other than cigarettes and liquor. One of the most controversial issues regarding the scope of corrective taxation is the sugar tax, otherwise referred to as the obesity tax. In 2016, the World Health Organization (WHO) launched full-fledged discussions for the adoption of the sugar tax in an attempt to stem the increase in the number of diabetic and obese patients. Those discussions encouraged other countries to adopt the tax, and the body of academic work on this issue has been growing. For example, Allcott et al. (2019) claims that the adoption of a sugar tax is mainly aimed at reducing health deterioration caused by carbonated beverages and deterring the resulting cost increase. In addition, as with liquor, cigarettes, and other 'temptation goods,' carbonated beverages are more likely to be consumed by lower income earners, and the researchers suggested a further need for correcting their consumption behaviors.

In light of these issues, we aim to determine the excise tax rate for enhancing the corrective function of the cigarette excise tax. Specifically, we analyze the corrective tax rate system for cigarettes that considers the external costs of smoking. We first assume that nicotine and tar consumption is the main cause of the external costs of smoking, and we then explore a system that varies tax rates depending on the consumption of these two substances. Given the small number of studies that exploring this type of corrective tax in Korea, we hope that this study will lead to active discussions on the issue.

II. Cigarette excise tax and its Corrective Function

1. Status

The Korean cigarette excise tax is explicitly designed as a corrective function. However, its tax rate determination process does not clearly consider the negative externalities of smoking, because of the inherent difficulty of externality estimation, and includes a long list of other considerations—including the political landscape. It does not necessarily mean that the current cigarette excise tax regime is defective; a complex tax rate structure that considers all those factors to correct externalities would be inefficient. However, we do need to assess

the corrective function of the current cigarette excise tax regime, and then attempt to devise a more efficient system. In fact, healthcare costs caused by cigarette consumption affect the soundness of Korean healthcare finances. Unfortunately, few researchers have explored possible options for a tax rate structure that enhances the corrective function. However, one of the upsides is the substantial body of works on the estimation of demand functions, including those studying the price elasticity of cigarettes. These studies form the basis of studies and proposals on the tax rate structure for the product.

The emergence of new types of cigarettes (liquid e-cigarettes being the foremost example) has brought more attention to issues regarding the cigarette excise tax rate. Table 1 overviews how the cigarette tax rate changed in Korea, and Table 2 shows the taxation structure for different types of e-cigarettes. The price of cigarettes has increased by 66%, driven by the increase in taxes and levies in 2005. Another rapid increase in taxes and levies pushed the standard cigarette price by 80% to KRW 4,500. Granted, both more expensive and cheaper products exist, and the sales prices below represent the standard price.

Table 1_Changes in Cigarette Taxes and Levies

(Unit: Won)

Year	1996	1997	1999	2001	2002. 1.	2002. 2.	2005	2008	2015
Cigarette excise tax	460	460	460	510	510	510	641	641	1,007
Local education tax	184	184	184	255	255	255	320.5	320.5	443
Value added tax			100	118.2	118.2	136.4	227.27	227.27	409
Public health promotion fund		2	2	2	2	150	354	354	841
Special excise tax									594
Waste disposal charge	4	4	4	4	4	4	7	7	24.4
Tobacco production stabilization fund						10	10	15	5
Sales price	1,000	1,100	1,100	1,300	1,300	1,500	2,500	2,500	4,500

Source: Hong (2015), p. 51 <Table 2>

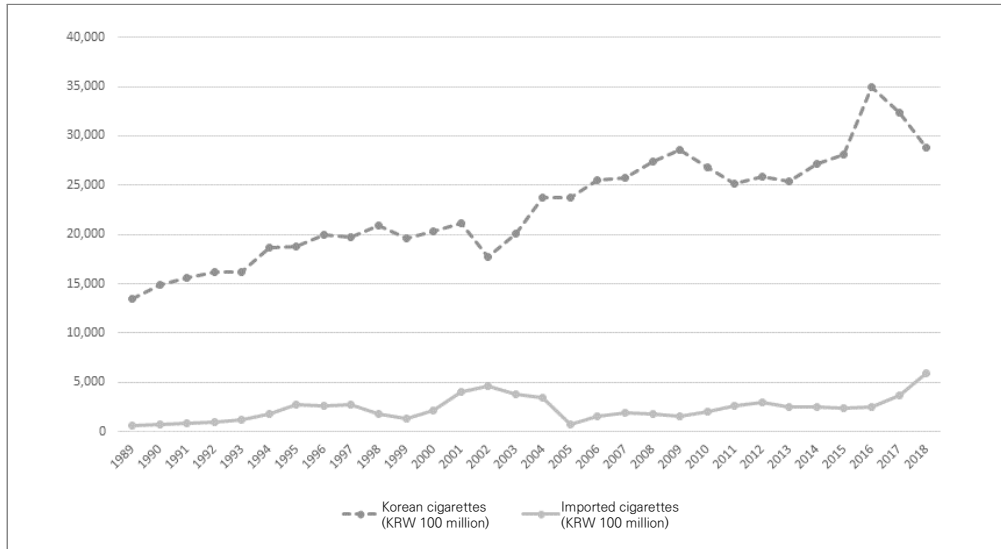**Table 2_Changes in Taxation Structure By E-cigarette Type**

(Unit: Won)

Type		2011. 1.	2011. 12.	2015. 1.	2017. 1.	2017. 5.
Nicotine solution (per ml)	Cigarette excise tax	400	400	628	628	628
	Local education tax	200	200	276	276	276
	Public health promotion charge		221	525	525	525
	Special excise tax			370	370	370
	Waste disposal charge	7	7	24.4	24.4	24.4
	Sub total	607	828	1823.4	1823.4	1823.4
Solid tobacco (per g)	Cigarette excise tax				88	88
	Local education tax				38.7	38.7
	Public health promotion charge					73
	Special excise tax					21
	Waste disposal charge					
	Subtotal				126.7	220.7

Source: Choi et al. (2017), p. 4 <Table II-1>

Figure 1 shows the tax revenues from Korean cigarettes and imported cigarettes from 1989 onward. The tax revenue from Korean cigarettes recorded a steady increase, whereas the revenue from imported cigarettes did not increase significantly. A noteworthy change occurred in 2015, when the tax revenue from Korean cigarettes increased, following a large cigarette excise tax increase. In 2018, the Korean government collected KRW 2,880 billion from Korean cigarettes, but a mere KRW 594 million from imported cigarettes. The key takeaway from the figure below is that the cigarette excise tax steadily increased, and at a higher rate for Korean cigarettes.

Figure 1_Cigarette excise tax Revenue

(Unit: 100million)

Source: Ministry of the Interior and Safety, Local Tax Statistics, http://kosis.kr/statHtml/statHtml.do?orgId=110&tblId=TX_11007_A721 &conn_path=I3. Accessed on February 28, 2020.

III. Assessment of the Corrective Function of the Cigarette excise tax

This section estimates a demand function of cigarette in order to estimate the product's price elasticity, and to then assess the corrective function of the cigarette excise tax. The Korean cigarette excise tax serves the purpose of corrective function by discouraging cigarette consumption and contributing to public health. As discussed in Chapter II, Korea has increased the taxes and levies on cigarettes including new taxes and quasi-taxes and as well as tax rate increase. The underlying idea is to lower cigarette consumption by increasing its prices. The corrective function of the cigarette excise tax can be assessed by examining changes in the demand for cigarette caused by tax rate increase and price increase. The basic assumption is that not all burden caused by cigarette tax increase is borne by suppliers. At least some of the burden is transferred to consumers in the form of cigarette price increase. Therefore, in order to assess the corrective function, we first need to estimate the demand function of cigarette. As discussed in Chapter II, an expansive body of academic works on the price elasticity of cigarettes exists. Korean researchers put the price elasticity of cigarettes between

–0.6 and –0.1.

In this chapter, we estimate the demand function of cigarette by taking a number of different approaches, and assess the corrective function of the cigarette excise tax increase, especially with regards to the tax increase in 2015 and the following years.

1. Estimation of the Demand Function of Cigarette

In this section, we apply different methods to estimate the demand function of cigarette. Most previous studies on the function put the price elasticity of the product in the lower range, suggesting that cigarettes are non-elastic to price. The estimation in this study differs from previous literature in a number of respects. In addition to the standard estimation in which we analyze the general demand function by assuming the heterogeneity of cigarette products (Model 1), we use the Korea Finance Panel Survey data to track changes in the demand for cigarette and price by year (Model 2). We believe that the second part of the analysis will add a significant contribution to the current situation, as few researchers have attempted to estimate the demand function of cigarette using panel data. Despite the use of the panel data, however, we still need to control the endogeneity of the cigarette price. Otherwise, we will see bias in the demand function estimation. To address this issue, we use the policy changes made during the cigarette excise tax reform in 2015 as an instrument variable, and use the Panel-IV model to estimate the demand function (Model 3). Lastly, we estimate the demand function that takes account of the heterogeneity of cigarettes. To our knowledge, none of the previous studies used a discrete selection model to analyze the annual panel data. As such, we believe that this study will be a meaningful addition to the existing body of work (Model 4). The primary purpose of the estimation discussed above is to see whether estimates significantly vary across different models, and to provide reliable elasticity values for the demand for cigarette. In particular, given the relatively small amount of studies that have estimated the cigarettes demand function using data from 2015 and the following years, the demand function estimation in this section offers its own contribution.

Based on the discussion above, the demand function of cigarette can be estimated as follows. In order to estimate the demand function, we first need to determine cigarette price variations. In Korea, most cigarettes are sold at KRW 4,500. However, some variations exist across specific products. As mentioned above, the Annexed Table lists the types and prices of cigarette products chosen by the respondents.

In this study, we estimate the demand function using three models: the model used in

previous literature; the model using the Korea Finance Panel Survey data; and the discrete choice model. All models use the same samples, and the periods of analysis are as follows. We analyze data from 2013 to 2018, which encompasses three years before and after the cigarette excise tax reform in 2015 (Year 6 to 11). We used the balanced data in 2015 to balance the data before and after the 2015 reform. As mentioned above, questions pertaining to the demand for cigarette in the Korea Finance Panel Survey ask about the demand for cigarette in the preceding year. Therefore, the cigarette demand data for 2015 are found in the 2016 survey. In addition, we only analyze respondents found throughout the analysis period. We restricted the scope of the sample in order to prevent the sample from affecting the estimation results, and have acquired reliable findings by comparing estimates across different models. In addition, we consider the type of cigarettes, as well as the nicotine and tar contents of each type. Therefore, we only considered the respondents who reported the types of cigarettes that they smoke.

To move on to the main part of the analysis, the first model (Model 1) estimates the price elasticity of cigarettes using a simple regression equation. Specifically, this model estimates the relationship between cigarette demand and price using a log-log regression equation. The equation used in Model 1 is presented below.

$$\log Q_{it} = \alpha + \beta \log P_{it} + \gamma Nicotine_i + \delta Tar_i + X_{it} + \epsilon_{it} \qquad \text{(Model 1)}$$

Model 1 does not use the Korea Finance Panel Survey data. It analyzes the data from each year by considering them as cross-sectional data. Here, Q_{it} is the respondent's cigarette demand in year t (analysis period: 2013~2018; survey period: 2012~2017). P_{it} is the actual price of the cigarette that the respondent purchased in year t. For the elasticity estimation, the two variables are converted to log variables. We use Model 1 to calculate the elasticity values. We also used clustered standard errors to consider the correlation among various factors within each respondent. In order to control the factors that may affect the demand for cigarette, we controlled for the following factors: household income; fixed age effect; annual household healthcare cost (a proxy for healthiness); and fixed academic attainment effect (X_{it}). We also added the trend of the demand for cigarette across the years. The model used in this study is distinguished from those used in previous studies by the explicit inclusion of nicotine content and tar content. We use this model to verify the effect of nicotine and tar content on the price elasticity of the demand for cigarette.

Table 3 lists the findings from Model 1. To compare the findings with those from studies that do not take account the nicotine and tar content, we remove the nicotine/tar content variables from Model 1 and only use the price variable and other control variables. The findings indicate a low level of price elasticity at −0.078, at a statistical significance level of 1%. The following paragraphs examine the price elasticity of cigarettes after controlling for nicotine and tar content. In Column (2) in Table 3, the price elasticity does not vary significantly across different levels of nicotine and tar content. The elasticity value is −0.087, at a statistical significance level of 1%. Therefore, nicotine and tar are not deemed to significantly affect the demand for cigarette.

According to Model 1, cigarette prices affected the demand for the product at a statistical significance level of 1%. Findings of Model 1 confirm the low price elasticity of cigarettes. Despite the addition of nicotine and tar content to the analysis, we arrived at similar findings as those obtained in previous studies.

Model 1 has been frequently used in previous studies, and produced significant elasticity estimates in this study. However, this model suffers from the endogeneity issue with the price variable. Even when controlling for variables potentially affecting the demand for cigarette, we cannot rule out the possibility that the elasticity of the demand for cigarette (β) can be biased. To address this issue, we will analyze two models that have not been widely used in previous studies.

Model 2 estimates a demand function of cigarette that takes into account the panel data. A smoker may smoke the same cigarette product every year, or change their consumption pattern. Possible reasons for changing one's consumption behavior include price variation or changes in preference in terms of nicotine and tar content. Other variables may also affect the demand for cigarette. For example, an increase in household income may reduce the need for cigarettes. Model 2 uses the same variables as Model 1. However, Model 1 does not take into account the possibility that the unobserved characteristics and preferences of individuals may affect the demand for cigarette, which may bias the estimates from the simple log regression equation. Model 2 addresses this possibility by considering variations in the individual fixed effect (ν_i) of respondents. This allows us to control for observable or unobservable variables that do not change over time. Granted, there is no perfect control for variables that change over time. However, as was the case in Model 1, Model 2 controls for trend variables in order to minimize variations over time.

$$\log Q_{it} = \alpha + \beta \log P_{it} + \gamma Nicotine_i + \delta Tar_i + X_{it} + \nu_i + \epsilon_{it} \qquad \text{(Model 2)}$$

The findings are shown in the Model 2 section of Table 3. The elasticity estimates from Model 2 are slightly larger than those from Model 1. In Column (3), the price elasticity of the demand for cigarette was estimated at −0.1 when not controlling for nicotine and tar content, at a statistical significance level of 1%. Column (4) shows the price elasticity after controlling for the nicotine and tar content, which is seen to be quite similar to the estimate in Column (3). To summarize, findings from Model 2 also point to the low price elasticity of the demand for cigarette, even after controlling for the endogeneity issue.

Lastly, we use Model 3 to estimate the price elasticity. Model 2 is more deemed to be reliable than Model 1 because it considers the individual fixed effect in order to address the endogeneity issue. However, as mentioned above, the model still faces the possibility of price elasticity being biased due to unobservable variables that change over time. Model 3 is designed to address this issue.

$$\log P_{it} = \alpha + \eta\, T_i + \gamma Nicotine_i + \delta\, Tar_i + X_{it} + \nu_i + \epsilon_{it} \qquad \text{(Model 3)}$$
$$\log Q_{it} = \alpha + \eta\log P_{it} + \gamma Nicotine_i + \delta\, Tar_i + X_{it} + \nu_i + \epsilon_{it}$$

Model 3 uses the policy changes (T_i) brought on by the cigarette excise tax reform in 2015 as an instrument variable. The policy variable is a dummy variable of which value is 0 before 2014, and 1 in 2015 and the following years. Estimates using Model 1 were found to suffer from the issue of estimate bias. Model 2 reduces the likelihood of estimate bias by using the individual fixed effect, but its estimates may be still biased due to the endogeneity of the price variable. To address this issue, we use the panel data from Model 2 along with an instrument variable, that is, the cigarette excise tax rate before and after 2015. We use the instrument variable to predict the price changes in the first stage. We then use this prediction to estimate the price elasticity of the demand for cigarette in the second stage. In other words, this model uses a fixed-effect instrument variable that controls for the individual fixed effect as in Model 2 (fixed effect IV estimation).

The findings are shown in the Model 3 section of Table 3. The elasticity estimates from the model are highly similar to those from Model 2. Without controlling for the nicotine and tar content, the price elasticity of the demand for cigarette was −0.095 at a statistical significance level of 1%. Controlling for the nicotine and tar content also produced significant estimates at the 1% significance level.

Table 3_Estimation of the Demand Function of Cigarette (Year 6 to 11)

Log cigarette demand	Model 1		Model 2		Model 3	
	(1)	(2)	(3)	(4)	(5)	(6)
Loc cigarette price	-0.078*** (0.027)	-0.087*** (0.029)	-0.100*** (0.026)	-0.101*** (0.028)	-0.095*** (0.022)	-0.096*** (0.025)
Nicotine (mg)		0.246 (0.153)		0.103 (0.137)		0.107 (0.133)
Tar (mg)		-0.026** (0.013)		-0.010 (0.012)		-0.010 (0.012)
No. of observations	1,716	1,716	1,716	1,716	1,716	1,716
No. of individuals analyzed	286	286	286	286	286	286
First stage F-statistics					57,464	46,878

Note: P value in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
Source: Present study, based on the Korea Finance Survey data.

One noteworthy aspect of Model 3 (fixed-effect instrument variable) is that the instrument variable in the first stage had a statistically significant effect on the endogenous variable. In other words, in Korea, the cigarette excise tax reform had a great effect on the cigarette price. In fact, the basic statistics indicate that there was a cigarette price surge caused by the cigarette excise tax reform, as suggested by the large F value in the first stage. Another crucial point for the instrument variable estimation is that the estimation should satisfy the following assumption: when the instrument variable affects the dependent variable of interest (the demand for cigarette), the effect must be exerted only through the endogenous variable (price). In other words, it must satisfy the exclusion restriction of the instrument variable. If the cigarette excise tax reform coincided with other policy changes, or if other potential factors affecting the demand for cigarette are affected by the reform, the estimates for the instrument variable will be biased as well. While we cannot test this possibility, there was no significant policy change implemented at the time that may affect the demand for cigarettes, and it is difficult to think of any other reason that the potential factors affecting the demand for cigarette should change at the time of the reform. Therefore, it appears that the estimates from Model 3 are not likely to be biased.

In the next model, we consider the heterogeneity of the price elasticity of the demand for cigarette. Few researchers have estimated the price elasticity of the demand for cigarette using the discrete choice method with appropriate variables. In this regard, this study is distinguished from previous studies by its use of a discrete analysis, which constitutes one of its main contributions to the field. In particular, in this study, we analyze the heterogeneity of

the price elasticity across various levels of nicotine and tar content. Furthermore, we also estimate the price elasticity of smokers' demand for cigarette based on income levels and healthcare costs.

For the heterogeneity analysis, we use the three models developed above. Previous studies did not fully consider the importance of nicotine and tar content. Even when the prices are the same, the price elasticity of smokers' demand for cigarette may vary depending on whether they smoke high/low nicotine cigarettes or high/low-tar cigarettes. Such a demand analysis is important for reviewing the new tax rate structure that will be discussed later. If the price elasticity of the demand for cigarette varies depending on the nicotine and tar levels, we may be able to develop an efficient tax rate structure by adopting a corrective tax that considers the nicotine and tar content.

Table 4 analyzes the three models for different nicotine levels. We divide the respondents into two groups: respondents who smoke cigarettes with nicotine content exceeding the median nicotine content of the cigarette products analyzed in this study (high-nicotine group); and respondents who smoke cigarettes with nicotine content lower than the median content (low-nicotine group). The low-nicotine group reported a price elasticity of −0.137 at a statistical significance level of 1%. The same phenomenon is observed when including nicotine content and tar content in the regression equation. From Column (2), compared with the findings without controlling for the nicotine and tar content, the price elasticity of the demand for cigarette was slightly lower at −0.12, also at a statistical significance level of 1%. On the other hand, without controlling for nicotine and tar content, the high-nicotine group reported a price elasticity of −0.50. When controlling for the two control variables, the elasticity level stood at +0.014. It should, however, be noted that the estimates from both columns were not deemed to be statistically significant.

The same phenomenon is observed with Models 2 and 3 that control for the endogeneity of the price variable. In Model 2, the price elasticity value of the low nicotine group is −0.181, which is higher than the Model 1 estimate, at a statistical significance level of 1%. The figures did not significantly change in Colum (2), where the nicotine and tar content were used as the control variables.

In Model 1, the high-nicotine group reported price elasticities of −0.011 and −0.059, which is far lower than the low nicotine group. What is more, as was the case in Model 1, these values were not deemed to be statistically significant.

The findings from Model 3 do not significantly differ from those of Models 1 and 2. In Model 3, the price elasticities of the cigarette demand of the low nicotine group were −0.15

and −0.135, at a 1% significance level. On the contrary, the price elasticities of the high-nicotine group shown in Columns (3) and (4) were very low at −0.065 and −0.036, which were not deemed to be statistically significant.

To summarize, the high-nicotine group reported lower price elasticity levels. The findings were not significant, however, which means that they do not even tell us whether the cigarette demand of the group is affected by the cigarette price. The findings are intuitively consistent with our understanding that nicotine is highly associated with cigarette addiction. If cigarettes with high nicotine content are addictive, the demand for these cigarettes is bound to be less affected by a price increase. Supporting this fact, according to Benowitz and Henningfiled (2013), smoking and cigarette addiction are significantly correlated with nicotine content.

Table 4_Estimation of the Demand Function of Cigarette (by Nicotine Content) (Years 6 to 9)

Log cigarette demand	Model 1			
	Low nicotine (below median)		High nicotine (above median)	
	(1)	(2)	(3)	(4)
Loc cigarette price	-0.137*** (0.039)	-0.120*** (0.041)	-0.050 (0.042)	0.014 (0.049)
Nicotine (mg)		-1.623 (2.278)		0.565** (0.268)
Tar (mg)		0.172 (0.218)		-0.041** (0.016)
	Model 2			
Loc cigarette price	-0.181**** (0.037)	-0.183*** (0.038)	-0.011 (0.043)	-0.059 (0.050)
Nicotine (mg)		-0.055 (2.179)		-0.378 (0.310)
Tar (mg)		-0.002 (0.210)		0.014 (0.018)
	Model 3			
Loc cigarette price	-0.150*** (0.045)	-0.135*** (0.048)	-0.065 (0.047)	-0.036 (0.056)
Nicotine (mg)		-1.457 (2.564)		0.525** (0.241)
Tar (mg)		0.155 (0.244)		-0.039** (0.016)
First stage F-statistics	33,392	30,259	8,056	5,774
No. of Observed Values	939	939	777	777

Note: P value in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
Source: Present study, based on the Korea Finance Survey data.

Lastly, we introduce a new assumption to estimate the demand function of cigarette. To this point, we assumed that cigarettes are homogenous. In Model 4, we consider the heterogeneity of cigarette products. Model 4 provides an important backdrop for the discussion on the tax rate adjustment later. The basic design of the model is as shown in Equations (1) to (4). Respondent i from the Korea Finance Panel Survey consumes s cigarettes (Cigarette Product j), for which the respondent pays p_{js}. Here, the respondent chooses the type of the cigarette product and its quantity (j, s). For a non-smoker, the values of the choices are $(0, 0)$. X_{jst} represents the nicotine and tar content of the product, which reflects the respondent's preference. It is assumed that ϵ_{ijst} follows the i.i.d Type 1 extreme value distribution. Here, the elasticity levels are estimated using the discrete choice model. It is different from both the basic analysis and the heterogeneity analysis in that it considers non-smokers as well.

Based on these assumptions, the conditional probability of a consumer consuming s cigarettes (Cigarette Product j) can be expressed as Equation (2). Equation (3) represents the expected utility of the consumption, and Equation (4) represents the payoff function for each consumer. Cigarette consumers are divided into five brackets depending on their smoking levels (d). The payoff function represents the price of the cigarette product when a consumer consumes s cigarettes (Cigarette Product j), and w_j and z_{js} are the tar and nicotine content of the product, respectively. We use $\gamma_{d(i)}$ to take into account each consumer's preference based on their smoking level. We also control for $\xi_{d(i)j}$ in order to consider the product's unchanging characteristics that reflect the consumer's preference. In addition, we consider the preference of each consumer by using random coefficients such as α_i and β_i.

$$u_{ijst} = \nu(p_{jst}, X_{jst}; \theta_i) + \epsilon_{ijst} \tag{1}$$

$$q_{ijst} = \frac{\exp\left(\nu(p_{jst}, X_{jst}; \theta_i)\right)}{1 + \sum_{j' > 0, s' > 0} \exp\left(\nu(p_{j's't}, X_{j's't}; \theta_i)\right)} \tag{2}$$

$$\nu_{it}(p_t, X_t) = \ln \sum_{j > 0, s > 0} \exp \nu(p_{jst}, X_{jst}; \theta_i) + C \tag{3}$$

$$\nu_{it} = \alpha_i p_{jst} + \beta_i w_j + \gamma_{d(i)} Z_j + \gamma_{d(i)} Z_{js}^2 + \xi_{d(i)j} + X_{d(i)jt} \tag{4}$$

We use the tax rate changes (before and after 2015) as an instrument variable. For the estimation of Equation (5), we divided the consumers depending on their smoking levels, and each group is estimated by using the maximum simulated likelihood. The likelihood function can be expressed as Equation (5), where we consider the cases in which Consumer i chooses (j_t^*, s_t^*).

$$l_i = \ln \int \Pi_{t = (1, \dots T_i)} q_i j_t^*, s_t^* dF(\theta) \tag{5}$$

The responses analyzed in this study are comprised of 156 cigarette products. Nicotine and tar levels vary depending on the product. For a simpler calculation, we group these products based on price, nicotine content, and tar content. For example, The One consists of seven products, including The One Green, The One Blue, and The One Etipac. We categorize these products as the The One group, and calculate their average price, nicotine content, and tar content. We apply the same approach to Dunhill products and calculate their average price, nicotine content, and tar content. With this approach, however, it is difficult to take into account the respondents' choices within the same product group. However, we can consider differences in price, nicotine, and tar content among products. Subsequently, we categorized the cigarette products into ten groups. We also divided smokers into a heavy smoker group and a non-heavy smoker group in order to take into account the respondents' characteristics.

Table 5 shows the estimation results of the demand function of cigarette obtained using Model 4. According to the table, the findings of the discrete choice model are not different from the results with the first three models. In this study, we used the discrete choice model model for the heterogeneity analysis. However, the small sample size restricted our ability to use the model for the estimation. As such, we were not able to attempt the analyses discussed above while us Model 4.

Table 5_Estimation of the Demand Function of Cigarette (Discrete Choice Model)

Loc cigarette price	-0.0003 (0.000)
Nicotine (mg)	3.8547** (1.551)
Tar (mg)	-0.6119*** (0.1204)

Note: P value in parentheses *** p<0.01, ** p<0.05, * p<0.1.
Source: Present study, based on the Korea Finance Panel Survey data.

In this chapter, we used four models to estimate the demand function of cigarette, and discussed the implications of the findings. Despite the limitations of each model, the findings were quite similar across all models. It is also worth noting that high-nicotine and high-tar cigarettes showed a lower price elasticity than the low-nicotine and low-tar cigarettes. These findings suggest that it is difficult to correct instances of excessive smoking or the consumption of high-nicotine/tar cigarettes by using the current cigarette excise tax regime. In the next chapter, we will discuss an optimized corrective tax regime that considers the external costs of nicotine and tar consumption. We will then combine the theoretical discussions and empirical data to determine an optimal rate for the corrective tax.

IV. Empirical Analysis of the Corrective Function of the Cigarette excise tax

The tax rates for cigarettes and liquor are determined through a process that is more complicated than for general goods. First, cigarettes and liquor are inherently different from general goods. They are addictive, and their consumption causes individual and social costs. For example, consumers of cigarette products may maximize their utility by smoking cigarettes, even when considering the financial costs incurred by the purchase and the costs on the individual's health. However, it would not be the best choice for society as a whole, considering the external costs that secondhand smoking imposes on non-smokers. In fact, the consumption of cigarettes and liquor may not be the best option to maximize the individual's utility, not to mention the social externalities that it entails, because the individual themselves is not equipped to accurately assess the personal costs of smoking and drinking. These characteristics explain the need for active discussions on the optimal tax rate for these products.

Park and Min (2009) aptly summarized the theoretical discussions on the optimal tax rate for addictive goods. The most widely accepted theories include: the optimal taxation theory; the securing of tax sources and revenues; excise taxes that take account of correction; political considerations; and the securing of national finances.[1] Most empirical analyses have been performed against the backdrop of these theories. In this study, we estimate the optimal tax rates that take into account the corrective function of these taxes, and compare the social welfare levels across different tax rate structures.

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[1] For further discussion on the issue, see Park and Min (2009).

1. Optimal Taxation: Correcting Externalities

In Chapter III, we explained that the price elasticity of the demand for cigarette may greatly vary even among smokers. As mentioned in the Introduction, according to the Ramsey rules, varying the tax rates depending on the price elasticity may increase the economic efficiency. Furthermore, if heavy smokers and light smokers incur different socioeconomic costs, varying the cigarette tax rate depending on their cigarette consumption level may boost the economic efficiency while enhancing its function as a corrective tax. In other words, if the external costs caused by heavy smokers are different from those caused by light smokers, we may be able to determine the optimal tax rates for the respective groups by changing the tax rate structure of the cigarette excise tax. However, it is difficult for researchers and policymakers to distinguish between the two groups. Indeed, there is no data available on the smoking levels and frequencies of all smokers, which makes it impossible to determine tax rates based on this data. Therefore, we need a way to divide smokers into different groups depending on the external costs that they cause. In this chapter, in addition to the discussions above, we define the external costs caused by smokers in order to then set the background for the discrete tax rate structures that will be discussed alter.

A. External Cost Function

In this study, we assume that heavy smokers create more external costs than light smokers. This assumption appeals to our intuition. While heavy smoking is not the only cause of certain diseases, when all the other conditions are identical, heavy smokers are more likely to incur greater socioeconomic costs, including healthcare expenses, than non-smokers.

In this study, we consider the nicotine and tar content of cigarette products because: 1) Smoking high-nicotine/tar cigarettes is likely to cause more socioeconomic external costs. Smoking high-tar/nicotine cigarettes has been closely associated with cancer and other diseases (Sanner and Grimsrud, 2015; Meyers et al., 2017; Shimatani et al., 2020). Granted, such observations assume that there is no difference in the inhalation strength (puff) between high-nicotine/tar cigarettes and low nicotine/tar cigarettes, or difference in how much smokers use of a single cigarette. 2) Smokers consuming high-nicotine/tar cigarettes are likely to smoke more frequently. A higher level of cigarette addiction may result in a higher preference for high-nicotine/tar cigarettes. These can be verified by the data from the Korea Finance Panel Survey that we analyze in this study. Using this data, we can compare how much money the respondents spent on cigarettes and the average nicotine/tar content of the
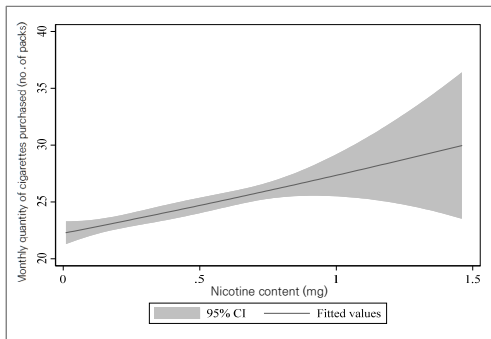
cigarettes that they consumed (Figures 2 and Figure 3). Figure 2 nonparametrically shows the relationship between the quantity of cigarettes purchased per month and the nicotine content of the cigarettes. The graph indicates a weak positive correlation between the quantity of cigarettes purchased by the respondents per month and the nicotine content of the cigarettes that they smoked. The confidence interval is quite large, due to the small number of respondents who smoke high-nicotine cigarettes. Figure 3 similarly represents the relationship between the quantity of cigarettes purchased per month and the tar content of the cigarettes. Similar patterns can be found in Figure 3 as well. Granted, the findings on the correlation between tar content and the quantity of cigarettes purchased per month are highly inaccurate; nevertheless, we can see a weak positive correlation between the two variables.

For this reason, we explicitly included nicotine and tar content in the function of external costs caused by smokers. In other words, a tax rate structure aimed at enhancing the corrective function requires explicit consideration of nicotine and tar content. Here, we assume that smokers consuming cigarettes with high-nicotine/tar content generate more external costs. We also designed the external cost function around the total nicotine content in the cigarettes consumed by smokers. The external cost function is assumed to be a convex function, which means that smoking cigarettes with higher nicotine content is likely to generate more external costs (Equation (6)).

$$\varphi(Z_{it}) = \varphi_0 Z_{it} + \varphi_1 Z_{it}^2 \tag{6}$$

Figure 2_Nicotine Content and Monthly Quantity of Cigarettes Purchased
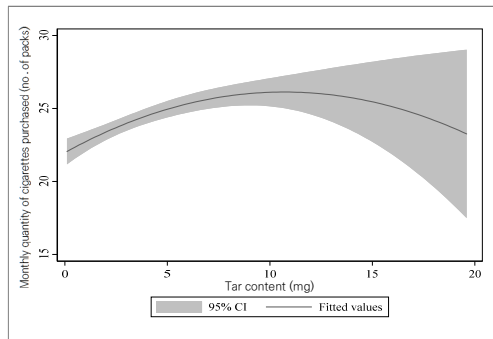
(unit: number of packs)

Source: Present Study, based on the Korea Finance Panel Survey data.

Figure 3_Tar Content and Monthly Quantity of Cigarettes Purchased

(unit: number of packs)

Source: Present Study, based on the Korea Finance Panel Survey data.

The externalities and socioeconomic costs of smoking may include the following elements: healthcare costs for the smokers themselves; healthcare costs for others affected by secondhand smoking; and the costs associated with an increased risk of fire. In this study, we estimate the parameters (φ_0, φ_1) based on the following literature. Park et al. (2008) estimated the annual socioeconomic costs incurred by smokers in 2007 to be between KRW 2.6 trillion and KRW 3.2 trillion. The estimate only considers the costs of direct smoking. In a more recent study, Lee et al. (2016) used 2015 data to estimate the socioeconomic costs of smoking, drinking, and obesity. The socioeconomic costs of smoking was estimated to be KRW 7,125.8 billion.

By gender, the socioeconomic costs of male smokers and female smokers were estimated to be KRW 5,973.4 billion and KRW 1,152.3 billion, respectively. Although lower than the estimated costs of drinking in the United Kingdom in 2011 (GBP 7.2 billion; or KRW 12.3 trillion based on the 2011 exchange rate of KRW 1,700), the figures are still significant.

Here, we first estimate the parameters for the external cost function (φ_0, φ_1). For this task, we use the findings from Lee et al. (2016) and Park et al. (2008), along with the data from the Korea Finance Panel Survey used in the empirical analysis in the previous chapters. As discussed above, we divided the respondents into a heavy smoker group and a light smoker group. Given the fact that the two groups can incur different amounts of external costs and that the external cost function is assumed to be a convex function, we considered the possibility that heavy smokers may generate larger external costs. We then divided the two groups based on the quantity of cigarettes purchased per month. Though there is no data available for the quantity of cigarette purchase per se, we do have data pertaining to the amount spent on cigarettes per month, and the price of the cigarettes consumed by the respondents. We used this data to estimate the monthly quantity of cigarettes consumed by the respondents.

If the marginal costs incurred by smokers remain constant, and the heavy smoker group consumes 40% of the total nicotine, it means that heavy smokers generate 40% of the total external costs. In this case, the external cost function will take the form of a linear function. In the Korea Finance Panel Survey data, heavy smokers comprise around 80% of the total nicotine consumption, which means that these smokers cause 80% of the total external costs. Along the same line of logic, the external cost function takes the form of a linear function. If heavy smokers generate more than 80% of the total external costs, the external cost function would be a non-linear function (a quadratic form of Equation (6)). The higher percentage of the total external costs the heavy smoker group accounts for, the more convex

the function will become. In other words, if heavy smokers take up a higher percentage in the total external costs, the external cost function becomes more convex, which means that the costs generated by cigarette consumption exponentially increases with the nicotine content of the cigarettes. Therefore, in this study, we estimate the parameters (φ_0, φ_1) needed to explain the external cost estimates by varying the percentage of heavy smokers in the total external costs from 80%, 85%, 90%, to 95%.
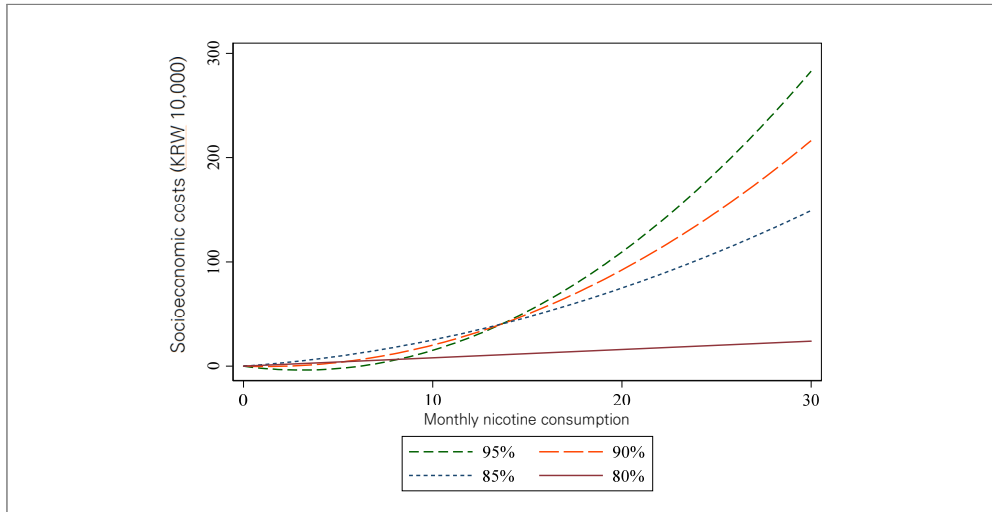
Figure 4 represents the external cost function of nicotine consumption. To calibrate the function, we used the socioeconomic costs of smoking estimated by Lee et al. (2016). As mentioned above, they estimated the socioeconomic cost to be KRW 7,128.5 billion. By gender, the socioeconomic costs of male smokers were estimated to be KRW 5,973.4 billion. The 99% of the sample used in this study are men. Therefore, we can use the socioeconomic cost estimate for men, KRW 5,973.4 billion, for the external cost function estimation. Figure 4 shows the external cost function based on the estimated parameters at different percentages of external costs generated by heavy smokers. We can then estimate the external cost function by varying the percentage of heavy smokers in the total external costs from 80%, 85%, 90%, to 95%. We began with 80% for the following reason. The monthly nicotine consumption of the smokers classified as heavy smokers in this study was 80% of the nicotine consumption of all smokers. Then, if the external costs caused by heavy smokers is 80% of the total external costs of smoking, the external cost function will be linear. If the percentage exceeds 80%, the function will take a different form.

From Figure 4, at higher percentages, the external cost function becomes more convex. For example, if the external costs incurred by heavy smokers take up 95% of all external costs, it would mean that a respondent who consumes 30 mg of nicotine per month generates more than twice the amount of a smoker who consumes 20 mg of nicotine per month. If the external costs incurred by heavy smokers comprise 90% of all external costs, it would mean that a respondent who consumes 30mg of nicotine per month generates around twice the amount of a smoker who consumes 20 mg of nicotine per month.

In the Korea Finance Panel Survey, an average smoker purchased 30 packs of cigarettes per month. An average cigarette pack contains 0.3 mg of nicotine, which puts the monthly nicotine consumption of an average smoker at around 9 mg. Then, according to Figure 4, if the external costs generated by heavy smokers account for 95% of the total external costs, a smoker with a monthly nicotine consumption of 30 mg would incur around 30 times as much external costs as a smoker whose monthly nicotine consumption is 9 mg. As nicotine consumption increases, external costs increase at a faster rate.

Figure 4_External Cost Function of Nicotine Consumption

(Unit: KRW10,000)

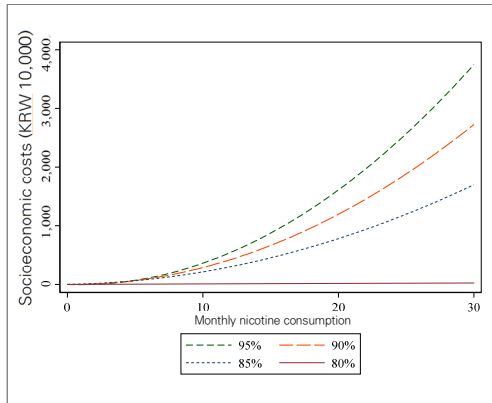Source: Present Study, based on the Korea Finance Panel Survey data.

We use the same method as shown in Figure 4 to estimate the external cost functions for high-tar products and low-tar products, respectively. Even when separating heavy smokers from light smokers based on tar content, the Korea Finance Panel Survey data show that heavy smokers still consume 80% of the total nicotine consumed by smokers. Therefore, as shown in Figure 4, we can estimate the parameters (φ_0, φ_1) used to explain the external cost estimates by varying the percentage of heavy smokers in the total external costs from 80%, 85%, 90%, to 95%.

Figure 5 represents the findings of the external cost function for nicotine consumption from low-tar products. Similar to Figure 4, if the external costs caused by heavy smokers exceed 80% of the total external costs, the external cost function takes a convex form. The convexity increases as the percentage increases.

The same pattern can be observed in Figure 6. Figure 6 applies the same method to estimate the external cost function for high-tar products; we estimate the parameters (φ_0, φ_1) used to explain the external cost estimates by varying the percentage of heavy smokers in the total external costs from 80%, 85%, 90%, to 95%. The pattern shown in Figure 6 is highly similar to those observed in Figures 4 and Figure 5. As the external costs incurred by heavy smokers increase, the amount of external costs caused by nicotine consumption increases at a faster rate.

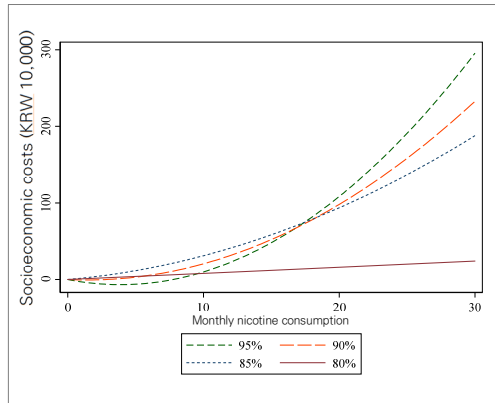**Figure 5_External Cost Function for Nicotine Consumption from Low-Tar Products**

(Unit: KRW10,000)

Source: Present study, based on the Korea Finance Panel Survey data.

Figure 6_External Cost Function for Nicotine Consumption from High-Tar Products
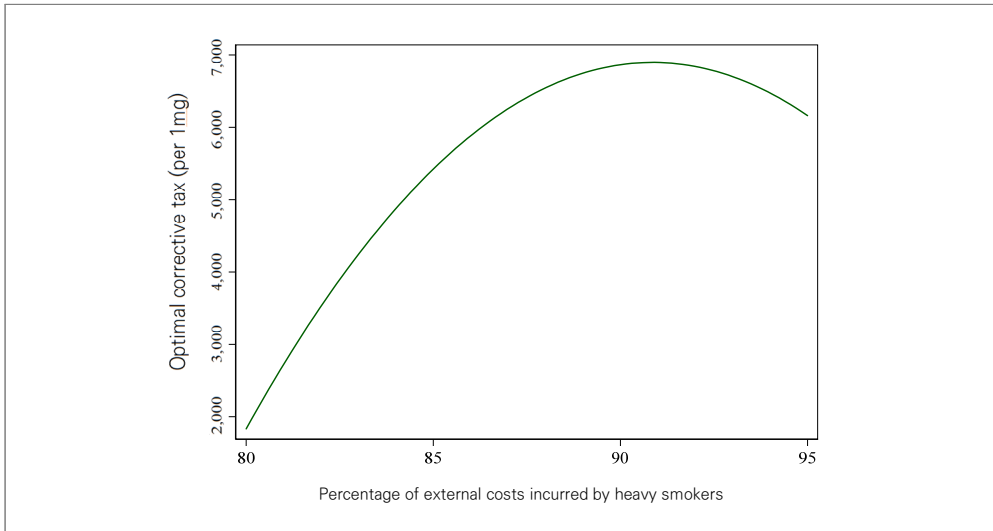
(Unit: KRW10,000)

Source: Present study, based on the Korea Finance Panel Survey data.

B. Optimal Tax Rate for Corrective Function

In this chapter, we estimate and propose an optimal tax rate structure based on the external cost function that was estimated in the previous chapter. Figures 7 and Figure 8 represent the optimal corrective tax rates for the flat tax rate structure and the differential tax rate structure, respectively.
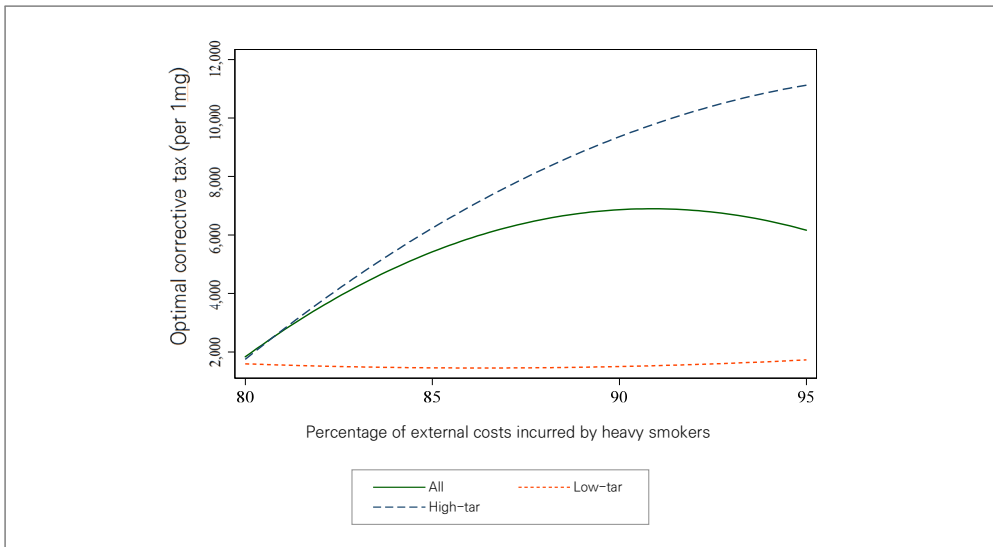
Figure 7 estimates the change of the optimal flat corrective tax rate changes depending on the percentage of external costs caused by heavy smokers. Similar to the previous analyses, a heavy smoker refers to a smoker who consumes more than 30 packs of cigarettes per month, which is the average cigarette consumption level from the Korea Finance Panel Survey data. As mentioned above, in the Korea Finance Panel Survey data, heavy smokers are estimated to account for 80% of the total nicotine consumption. If the external costs incurred by the heavy smokers take up 80% of the total external costs, the external cost function will be linear. Therefore, in Figure 7, we determine the optimal corrective tax and corrective tax rate only in cases where the percentage of external costs caused by heavy smokers is 80% or higher.

Figure 7_Optimal Corrective Tax Rate Per Nicotine Content (1 mg) (flat tax rate)

Source: Present study, based on the Korea Finance Panel Survey data.

Figure 8_Optimal Corrective Tax Per Nicotine Content (1 mg)
: High-Tar and Low-Tar Products

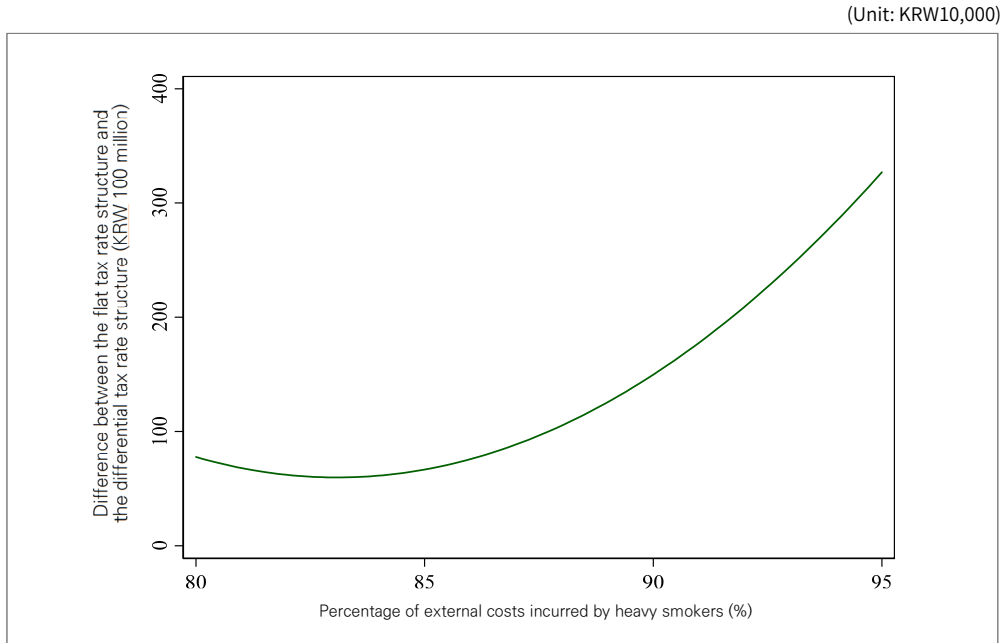Source: Present study, based on the Korea Finance Panel Survey data.

C. Comparison of Well-being Level

In this section, we compare the flat tax rate structure per 1mg of nicotine with the differential tax rate structure that applies different rates to high-tar and low-tar products. The purpose of the analysis is to verify changes in social welfare caused by the transition to a tax rate system taking account of external costs.

Typically, well-being levels are calculated by adding the consumer surplus and tax revenue, and then subtracting the socioeconomic costs of smoking, that is, the external costs estimated in the previous section.

Using statistical data, we compare the social welfare levels between the flat tax rate structure and the differential tax rate structure. The social welfare level of the differential tax rate structure was calculated by adding the social welfare level estimated for high-tar products and the social welfare level estimated for low-tar products. Then, we compare the estimates with the flat tax rate structure. The findings are represented in Figure 9.

Figure 9_Social Welfare Levels Between the Flat Tax Rate Structure and the Differential Tax Rate Structure

(Unit: KRW10,000)

Source: Present study, based on the Korea Finance Panel Survey data.

The difference in social welfare levels was calculated by subtracting the social welfare level for the flat tax rate structure from the social welfare level for the differential tax rate structure. In the figure, as the percentage of external costs incurred by heavy smokers increases, the social welfare gap between the two tax rate structures grows larger. Therefore, a tax rate structure that takes into account the external costs can increase the social welfare levels more than the flat tax rate structure based on nicotine content. In fact, these findings are to be expected. As the purpose of the cigarette excise tax is to minimize the external costs of smoking, a tax rate that takes into account the external costs would be more efficient and socially desirable.

Ⅴ. Conclusion and Implications

In this study, we explored the possibility of creating a new tax rate structure for the cigarette excise tax. The Korean government has waged repeated reforms in attempts to improve the cigarette excise tax regime, and to ultimately reduce smoking in Korea. The primary purpose of this study was to examine a tax structure that takes into account the socioeconomic costs of smoking and its external costs. To that end, we reviewed and compared tax rate structures based on nicotine content. As far as we know, no researcher has yet examined the cigarette excise tax structure based on nicotine content. The contribution of this study thus lies in the fact that it represents the first attempt to build a tax rate structure that explicitly considers the external costs of smoking, such as increased healthcare and health insurance expenses. It is important that this study is followed by further studies on tax structures, based on even more data and information.

The cigarette excise tax structure proposed in this study is but one of many policy options that are being proposed to correct smoking behaviors. If the primary goal of policymakers is to reduce the external costs of smoking, there are alternatives other than a corrective tax. Examples include restricting cigarette sales in specific ways, and reinforcing activities that warn the public of the danger of smoking. However, researchers and policymakers need to also consider the possibility of reinforcing the corrective function of the cigarette tax and lowering external costs by using a new tax rate structure.

The data analyzed in this study suggest that people with lower income and lower educational attainment tend to consume higher-nicotine products. In this case, a tax rate increase based on nicotine content, similar to the one proposed in this study, may result in a

regressive tax rate structure, which is partially linked to the existing controversy over the regressive nature of excise taxes. However, imposing taxes based on nicotine content does not necessarily result in a regressive tax structure. If such a tax structure reduces the individual and socioeconomic costs of smoking among low-income earners, the tax structure may actually reduce the amount of costs borne by low-income smokers. A definite answer to this issue, however, will require further studies on tax rate structures based on the nicotine content.

This study is limited by a number of factors. First, an incorrect estimation of the socioeconomic costs of smoking may result in significant estimation errors. In this study, we used the external costs estimated in previous literature, and the estimates were only from a single year. The accuracy of these estimates affects the corrective tax that is proposed in this study. However, despite the possibility of biased estimates, the political implications of our findings remain, as the theoretical and empirical findings are intuitively consistent. Second, we hope that this study will lead to more discussions on the taxation structures on goods that generate external costs, such as for liquor. Korea recently adopted a liquor tax structure based on the amount of alcohol consumed. However, the new structure cannot be identified as a structure designed to explicitly consider external costs. In this regard, it would be interesting to study liquor tax reforms to take into account both the liquor type and the alcohol content. Previously, Griffith et al. (2019) proposed a tax rate reform plan based on liquor type and alcohol content. We believe that their insight is applicable to the Korean setting. Similar approaches can thus be taken to devise a tax rate structure for a sugar tax, which would consider the sugar content in products in an attempt to control obesity. Overall, we hope that this study will lead to further studies on corrective taxes, especially those that will explicitly consider external costs in various aspects.

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Fiscal Policy Framework Reforms for Proactive Fiscal Management*

Nowook Park**

I. Research Background

1. Uncertainties During the COVID-19 Crisis

The ongoing COVID-19 crisis has prompted an unprecedented accumulation of government expenditures and debts. As of January 2021 (International Monetary Fund (IMF) Fiscal Monitor), to fight COVID-19, governments across the world have spent 7.4% of the global GDP on fiscal expenditures (including tax expenditures), and 6.1% of the GDP on liquidity supports. Developed countries have spent 12.68% and 11.3% of their GDP on fiscal expenditures and liquidity supports, respectively. Among the developed countries, the ratios of fiscal expenditures and liquidity supports against GDP are far lower among European Union (EU) member states, at 3.8% and 6.8%, respectively. Korea spent 3.4% and 10.2% of its GDP on the same.

The COVID-19 fiscal policies that drove these spending initiatives have also increased government debts. Among developed countries, the ratio of average government debt against GDP increased by more than 20%p from 105.3% in 2019 to 125.5%, as of October 2020 (IMF Fiscal Monitor). With economic normalization nowhere in sight, and additional support policies

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* This article is based on a section from *Fiscal Expenditure Policies for Growth* (Park, Yoon, and Kim, 2020).
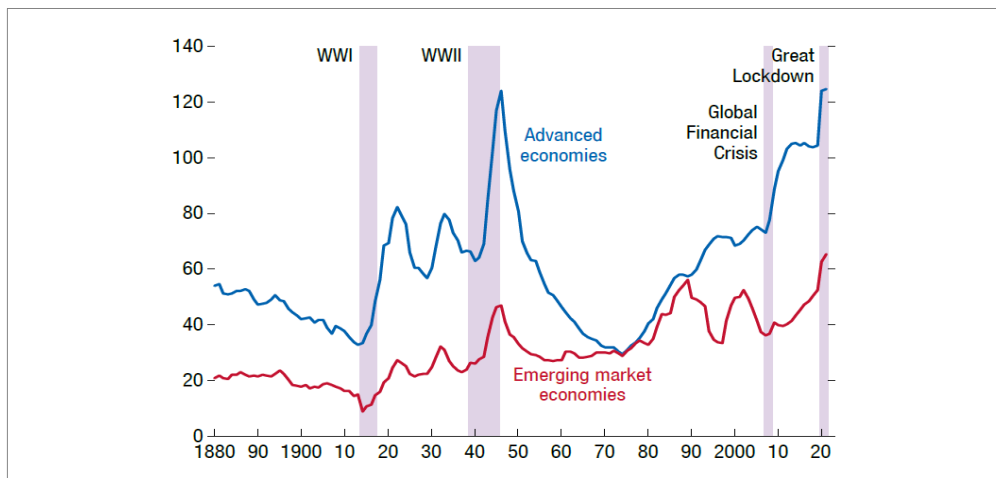** Nowook Park, Senior Fellow, Korea Institute of Public Finance

being implemented by national governments, government debts are expected to further increase in 2021. As shown in Figure 1, given the continuation of fiscal responses in 2021, government debts are expected to reach new heights, beyond the level seen immediately after World War II. Uncertainty is increasing, especially as to how such a rapid debt increase will be resolved after the COVID-19 crisis. Recently, driven by liquidity expansion, recovered demands, and supply delays, the United States treasury bond rate is increasing again along with possible inflation.

The unprecedented fiscal responses to the recent crisis are associated with the fiscal expansion trend encountered after the global financial crisis in the late 2000's.

After the financial crisis, despite the expansionary financial and fiscal policies established, the interest rates, price indexes, and growth rates remained low, which posed new issues regarding the roles and scope of fiscal policies. The scope and effectiveness of traditional monetary policy, which controls inflation by managing the interest rate, was weakened, and low interest rates lowered the burden from government debts. As a result, fiscal policies faced increasing demands to undertake proactive roles as a means of countercyclical economic policies. However, no consensus formed among researchers and policymakers in this regard, with different commentators offering competing arguments. It was during these chaotic times that the COVID-19 outbreak occurred, which critically increased uncertainties and risks surrounding fiscal policies.

Figure 1_Historical Patterns of General Government Debt

(unit: percent of GDP)

Source: Figure 1.2 from Chapter 1, IMF Fiscal Monitor (IMF, Oct. 2020), p. 2.

2. Weakening of Fiscal Policy Framework

In Korea, along with the changes in economic policies surrounding fiscal policies, changes in the framework for the establishment and operation of fiscal policies are ongoing. Until recently, the Korean National Assembly has exercised its constitutional budgetary power to draft budgets and ensure that the fiscal authorities in the executive branch comply with fiscal discipline. However, the advancement of democracy in the country increased the National Assembly's budgetary power.

Therefore, the overall fiscal policy framework now needs to be reviewed and overhauled in light of these political and economic changes. Korea urgently requires reforms in its fiscal policy framework in order to enhance the role of fiscal policies in the rapidly changing economic environment, democratize fiscal policies, and respond to fiscal risks exacerbated by the COVID-19 crisis and demographic changes. Recent practices regarding budgets and supplementary budgets, long-term fiscal projections, National Fiscal Management Plans, and preliminary feasibility study findings highlight concerns that the current fiscal policy framework may not be working properly.

Korea's National Fiscal Management Plan, which serves as the country's medium-term fiscal plan, provides a good example. Each National Fiscal Management Plan sets out goals regarding fiscal balance and government debts for a five-year period, which includes the year of publication. In other words, the plan defines Korea's fiscal management plan for the four years following the current year. Even though the goals are not mandatory, for the fiscal authorities, these goals represent the aggregate targets for their fiscal management efforts. The authorities are required to submit the goals to the National Assembly.[1]
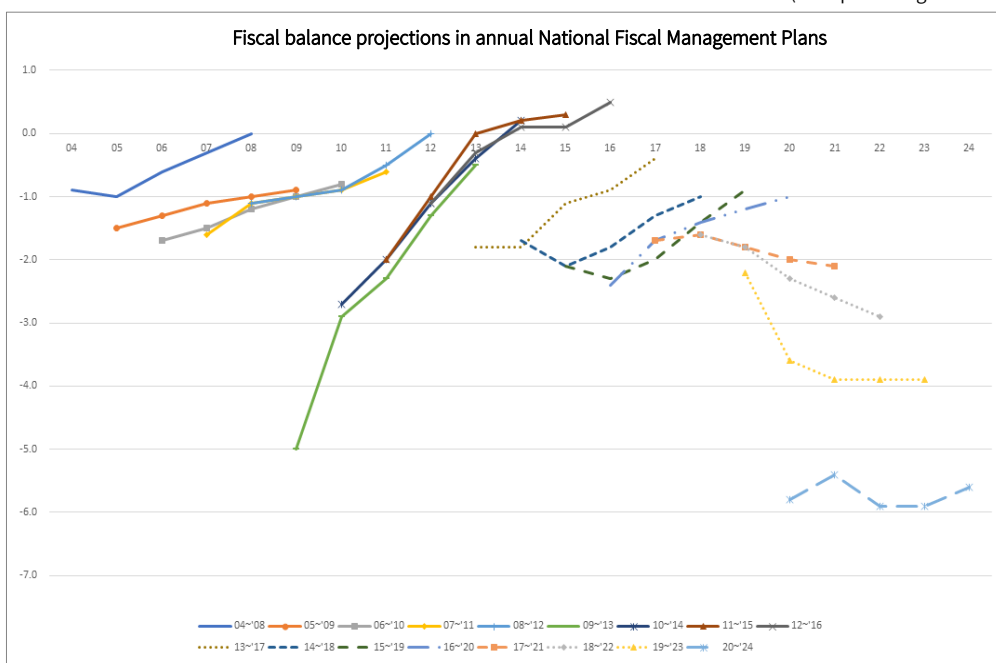
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1 This requirement is one of the elements stated in the comprehensive fiscal reform policies in the mid 2000's comprehensive fiscal reforms, an unprecedented look into the budgetary process. Some European countries with stricter fiscal disciplines establish medium-term aggregate fiscal targets when a new coalition government is formed. Those goals form the foundation of the new government. On the other hand, the fiscal management plan serves as a document by which the fiscal authorities express their political commitment to medium-term fiscal management. In 2010, Article 7(8) was newly inserted into the National Finance Act, which required the fiscal authorities to report the fiscal size, fiscal balance, resource distribution, and other details of the national fiscal management plan to the relevant standing committees at the National Assembly, by 30 days prior to the submission of the plan. Even though the authorities are not required to consult the National Assembly in advance regarding the direction of fiscal management, they should at least provide the National Assembly with the relevant information. These changes reflect the increasing influence of the National Assembly in the budgetary process.

Between 2004 and 2020, a total of 17 National Fiscal Management Plans were established. These plans set out their respective fiscal balance targets, though most were ultimately too optimistic and thus were not achieved. As for the targets set out for the following year in each plan, the authorities exceeded the targets in two of the ten plans, and just met the targets in five of them. In other words, in some years, the authorities failed to achieve even the base targets for the following year.

A more troubling trend is that the medium-term fiscal balance targets are shifting toward the red. The medium-term trajectory of fiscal balance was consistent across the four plans between 2005 and 2008. The trend continued between 2009 and 2012, a period immediately following the global financial crisis that occurred in the late 2000's. However, starting in 2013, the fiscal balance targets in the plans began to shift toward the red, and their medium-term trajectories became no longer consistent. The plans between 2013 and 2016 included targets for decreasing the fiscal deficit at least in the medium term. However, the plans for 2017 and the following years included medium-term targets that increased or maintained fiscal deficits.

Figure 2_Fiscal Balance Goals in Annual National Fiscal Management Plans

(unit: percentage of GDP)

Source: Present study, based on the National Fiscal Management Plans (Ministry of Finance and Economy), 2004~2020.

The following sections compare Korea's level of compliance regarding its medium-term fiscal plans with select European countries having good fiscal discipline. Specifically, the paragraphs compare Korea's level of compliance regarding the fiscal balance targets for the 2017~2019 period with the level of compliance with the 2017~2019 medium-term fiscal balance plans of Sweden, the Netherlands, Germany, Denmark, and Austria, as reflected in the 2016 Stability Program. All of the five European countries overachieved their goals during this period, whereas Korea failed to meet most of its targets—except for the 2017 targets. In contrast, except for Austria in 2017, all of the European countries recorded a fiscal surplus during the period.

Table 1_Compliance with Fiscal Balance Targets in Medium-Term Fiscal Plans

(unit: percentage of GDP, %)

	(t+1)	(t+2)	t+3
5 European countries[1]	2.1	1.7	2.0
Korea	0.0	-0.2	-1.0

Note: 1) Arithmetic means for Sweden, the Netherlands, Germany, Denmark, and Austria.
Source: Sweden, the Netherlands, Germany, Denmark, and Austria: (1) 2016 Stability Programmes/Convergence Programmes, European Commission; (2) Eurostat, "Government deficit/surplus, debt, and associated data" (accessed on January 21, 2021).
Korea: 2016~2020 National Fiscal Management Plan (Ministry of Economy and Finance).

Despite the high uncertainties driven by the ongoing COVID-19 crisis, the following paragraphs compare the medium-term fiscal balance targets or projections in October 2020 with selected European countries. The comparison uses the General Government Overall Balance announced by the IMF, which represents estimates based on information regarding medium-term fiscal plans for each country. The Korean fiscal balance projections are based on the integrated fiscal balance targets stated in the National Fiscal Management Plan for the 2020~2024 period. As the plan does not set out the 2025 targets, this study assumes that the projections for 2024 will be maintained.

The five European countries represented in Table 2 greatly increased their fiscal deficits in response to COVID-19. However, they plan to substantially reduce the deficits afterwards. Germany plans to return to the black in 2022, and Sweden set the target year for its return to surplus as 2023. Austria, Denmark, and the Netherlands also plan to gradually reduce deficits and restore fiscal balance over the long term. On the other hand, even though its fiscal deficit is smaller than other countries dealing with the pandemic, its fiscal projections do not show significant a reduction in fiscal deficits. The fiscal balance targets set out by the 2020~2024 National Fiscal Management Plan is to have a 5.8% deficit in 2020, 5.4% in 2021, 5.9% in 2022

and 2023, and 5.6% in 2024. It can be understood as a sign that the country does not have clear direction for fiscal management after the COVID-19, or the country's National Fiscal Management Plan is lacking in substance.

Table 2_2020~2025 General Government Overall Balance

(unit: percent of GDP, %)

	2020	2021	2022	2023	2024	2025
Austria	-9.9	-3.9	-2.3	-1.8	-1.2	-0.5
Denmark	-4.0	-3.0	-1.5	-0.2	-0.1	0.0
Germany	-8.2	-3.2	0.6	0.8	1.0	1.0
Korea	-3.2	-2.3	-2.7	-2.7	-2.5	-2.5
Netherlands	-8.8	-4.9	-2.0	-1.1	-0.4	0.2
Sweden	-5.9	-2.0	-1.5	0.3	0.3	0.3

Source: IMF, *IMF Fiscal Monitor* (Oct 2020), Table A.9.

The recognition underlying this study is that the fiscal policy framework must be fundamentally changed according to the ongoing changes in the political and economic environment after the COVID-19 outbreak. The global financial crisis in the late 2010's and the COVID-19 crisis call for fiscal policies that serve as economic policy measures for economic boost and growth, whereas some have argued that the continued low interest trend limits these fiscal risks. Along with economic changes, the advancement of democracy in Korea has increased the influence of the political sphere, represented by the National Assembly, on the establishment and management of fiscal policies. Such changes can prevent the fiscal policy framework from achieving the intended goals, and make it difficult to play active roles in responding to the changes.

This study presents policy issues and implications in two areas. First, this study critically reviews the argument that, on account of the economic changes characterized by low interest rates, low price indexes, and low growth, expansionary fiscal policies can be implemented as economic policy measures without worrying about the possibility of fiscal risks. In response to those arguments, this study highlights that the possibility of sudden fiscal risks still persist, even if the low interest rate trends continue in the near future, and that the fiscal policy framework must be fundamentally changed so that fiscal policies can serve as economic policy measures.

Second, this study stresses the need for fundamental changes within the fiscal policy framework to secure the accountability and sustainability of the framework in the current

situation, in which the administration-led fiscal policy framework is no longer viable. In this regard, this study briefly benchmarks the experiences of the Netherlands and Sweden, and presents implications for Korea. The two European countries ensure fiscal sustainability with strict fiscal discipline, while achieving the strongest social safety net in the EU and promoting innovative growth based on an open economy. This study then suggests that, in a situation where the National Assembly fundamentally affects the establishment and operation of fiscal policies, fiscal discipline should be internalized in the political process in order to ensure accountability, and that expertise and independence should be guaranteed in functions that produce, monitor, analyze, and diagnose information essential for the establishment and operation of stated fiscal policies. In addition, a financing regime based on social solidarity and automatic stabilization mechanization should be established in order to reinforce the social safety net, which will only grow in significance during and after the COVID-19 crisis.

II. Fiscal Policy Issues Posed by Changes in the Economic Environment

1. Can Fiscal Policies be used as Main Economic Policy Measures?

The argument for using fiscal policies as the main economic policy measure is predicated on the reduced space and efficacy of monetary policies. Since the 1990's, Korea mainly relied on monetary policies that focused on interest rate control, with fiscal policies taking on auxiliary roles. The country's policies focused on ensuring fiscal sustainability and stability. However, the global financial crisis in the late 2000's resulted in prolonged periods of low interest rates, low price indexes, and low growth, which undermined the space and efficacy of monetary policies. The situation required active use of fiscal policies as economic policy measures. Despite these policy needs, we still need to ask whether fiscal policies can properly serve as counter-cyclical economic policies for economic growth. In fact, fiscal policies have seldom been used as an economic policy measure because of their inherent limitations in managing fiscal policies.

The function of using fiscal policies as counter-cyclical policies has been limited because, technically, it is difficult to develop fiscal policies that are timely, targeted, and temporary. Budget formulation and execution cannot be performed by the push of a button. Decision-making takes time, with additional time then required for execution. Budgets may not be aligned with their purpose due to excessive political influence, and the counter-cyclical

expansion of spending is then likely to be prolonged rather than temporary.

In addition, fiscal policies are limited in terms of their ability to promote economic growth. In the case of expanding fiscal investments to promote growth using debts, there are numerous issues to resolve in order to ensure that the expenditure operates in a way that serves its purpose.

Limitations of fiscal policies in economic growth can be summarized into two ways. First, expansionary fiscal expenditures should be implemented in a way that ensures fiscal sustainability. However, the act of budget formulation itself poses a common pool problem, and displays a deficit bias that is caused by time-inconsistent political inducements.

Second, fiscal expenditure programs should be developed and executed to contribute to growth. However, the process of developing fiscal expenditure programs and organizing the budget are political by nature, which means there are other factors in play, they are not based simply on efficiency. Apart from political factors, fiscal expenditures are highly likely to be aligned with organizational interests of government ministries, public institutions, and local governments, rather than the need to solve problems and to actually promote growth.[2]

In other words, even when the space and efficacy of monetary policies are undermined, it is difficult for fiscal policies to save the day. To do that, the government first needs to tackle numerous challenges. For the active operation of fiscal policies, we need to consider the institutional elements that are required in order to pursue monetary policies as economic policies. Monetary policies pose a risk of inflation when they go through the political decision-making processes. In fact, monetary policies have come to serve as rational economic policy measures only after an institutional reform aimed at securing the independence of the central bank in the mid 1990's. Many factors contributed to the low price trends that persisted in the 1990's and the following years, and independent monetary policies were one of them.

On account of inherent limitations in the decision-making and execution processes involving fiscal policies, some researchers have argued that fiscal policies cannot readily serve as economic policies, and that monetary policies need to be reconsidered in order to determine whether there is no longer more room for them before replacing them with proactive fiscal policies (Rogoff, 2017; 2019).[3] All researchers seem to agree that a fundamental reform of the

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2　For example, when a trade conflict broke out with Japan in 2019, the Scientists and Engineers' Association of National Research Institutes announced a statement (August 31, 2019) that listed five cautionary points. The first point was the need for internalizing strategies to pool innovative capabilities. This statement also raised an issue with project structures centered around individual government ministries and bureaucratic staff rotation.

decision-making and execution processes involving fiscal policies needs to be carried out in order for fiscal policies to serve as key economic policy measures.

2. Does the Current Economic Situation Lower Fiscal Risks?

The second grounds for the argument for the proactive use of fiscal policies as economic policy measures is that expansionary fiscal policies are highly unlikely to cause fiscal risks, because the cost of debt is low when the interest rate is persistently low. As such, we need to examine whether continuous low interest rate trends, where the growth rate (g) exceeds the interest rate (r) (r-g<0), fosters conditions that lower the need to consider the risks caused by using debts to expand fiscal expenditures. Blanchard (2019)[4] argues that, in Europe and the United States, the growth rate continuously exceeded the interest rate over the last decade, especially after the global financial crisis, and that the trend is likely to continue for a prolonged period.

Blanchard's argument invited reviews and criticisms from various perspectives. By providing a brief overview of the key points raised by these reviews and criticisms, this study seeks to prove that such trends do not constitute a reason for under-evaluating the risk of financial risks caused by expansionary fiscal management.

First, the growth rate has exceeded the interest rate for longer than the last decade. The growth rate exceeded the interest rate, even before the government debt crises. Mauro and Zhou (2019)[5] arrived at this conclusion after analyzing the government debt data of 55 countries over the last two centuries. In most cases, a crisis occurs when the marginal cost of borrowing rapidly and abruptly increases. We need to pay attention to the possibility of fiscal risks rather than concluding that the low interest rate trends in the past and the present indicate a low likelihood of crisis in the future. Countries with open economies that are highly reliant on the global market must, in particular, pay attention to these risks.

Government debts, which rapidly increased after the global financial crisis, have been increasing at an even higher rate during the pandemic, and there exists significant uncertainties

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3 Rogoff (2017; 2019) is skeptical about the potential of using monetary policies as main counter-cyclical policy measurepolicy measure. He also argues for the possibility of monetary policies aimed at a negative interest rate.

4 Blanchard, Olivier, "Public Debt and Low Interest Rates," *American Economic Review*, 109(4), 2019, pp. 1197 ~1229.

5 Mauro, Paolo and Jing Zhou, "r-g<0: Can we Sleep More Soundly?," IMF Working Paper, 2019.

as to how this sudden debt growth will be resolved. On a global level, the debt increase after the global financial crisis represented the 'fourth debt wave.'[6]

Three out of the four debt waves were associated with economic crises, which signals a need to pay attention to post-pandemic situations. Lian et al. (2020) theorizes that an increase in government debt is correlated with an increase in 'r-g,' and suggests a possibility for 'r-g>0.' In addition, he points out that the interaction between debt increase and 'r-g' increase may have a serious impact on the economy, and even result in another crisis after the pandemic.[7] Rogoff (2020) advocates the need for forward-looking fiscal management, due to the rapid debt increase, if risk factors include private and public debt accumulation, political and economic insecurities, and increased natural disasters driven by climate change.[8]

Second, researchers have raised criticisms regarding the baselines for interest and growth rates when discussing a dynamic efficiency under ' r-g<0' conditions. Barro (2020)[9] argues that the interest rate should be understood as a return on investment in the stock market, rather than as the government bond interest rate. He also claims that the growth rate should be understood as the average growth rate of the real GDP. Based on these understandings, the r-g>0 condition is satisfied in most periods in the past, which indicates a dynamic efficiency. Other critics have pointed out that, in order to assess future fiscal risks based on the relationship between interest rates and economic growth rates, the assessment should be based on marginal interest rates, rather than on the average interest rates of safe assets as argued by Blanchard (2019).

Rogoff (2020) also reported that the current market interest rate (r) may be affected by an incorrect perception regarding the size of the government debt. In other words, when a private sector entity buys government bonds, it expects that the bonds held by private entities will be honored before other debts that the government owes. These 'other' debts include implied or expressly stated payment obligations, including those associated with social insurance programs such as pension and health insurance. However, such expectations may

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6   The first debt wave is associated with the two world wars, the second debt wave with the Great Depression, the third with the Great Accumulation between the 1970's and the mid-2000's. The fourth wave is linked with the recession following the global financial crisis, to which the pandemic has had an additional debt-increasing impact (Eichengreen, Barry et al., "Public Debt Through the Ages," IMF Working Paper, 2019).

7   Lian, W. A. F. Presbitero and U. Wiriandinata, "Public Debt and r-g at risk," IMF Working Paper 20/137, 2020.

8   Rogoff, Kenneth, "Falling Real Interest Rates, Rising Debt: A Free Lunch?," *Journal of Policy Modeling,* 42(4), 2020, pp. 778~789.

9   Barro Robert, "r minus g," NBER Working Paper No. 28002, 2020.

not be realized during a time of crisis, and this risk factor is not reflected in the current market interest rates. In other words, it would be risky to assume that the current interest rates will be maintained during a time of crisis.

Third, even when r-g<0, through debt financing, the government should generate income exceeding the cost of debt in order to maintain expansionary fiscal policies.

The argument for expanding fiscal investments by issuing government bonds at low interest rates is predicated on the possibility that the government can make productive investments with the additional financial resources. The Western scholars who support this argument stand on the premise that Europe and the United States have demands for investments in deteriorated infrastructure, as well as clear needs for more investments in education. Korea, on the other hand, has made significant investments for economic growth both in terms of the amounts and percentages.[10] However, the country entered a low-growth phase in 2010. As such, the country may need to enact policies to improve the efficacy and efficiency of fiscal investments, more than it needs to expand its fiscal investments. Expanding fiscal expenditures in a country suffering from structural issues may only perpetuate the issues. Even when the r-g<0 condition continues for a considerable period, the causes of the low r and g should be identified in order to come up with appropriate solutions.

Fourth, the actual debts of a government may be larger than those reflected in official statistics. Therefore, it is dangerous to rely on fiscal spaces calculated based on the debts reflected in official statistics. The global financial crisis has proved that a financial crisis caused by debts in the private sector may become a fiscal crisis. In other words, in a crisis, the factors that add a fiscal burden to the government may be greater than those reflected in the official statistics. In its response to the economic crisis in the 1990's, Sweden's fiscal demand is estimated to have reached 40% of the country's GDP (Andersson and Jonung, 2019).

Larger debts increase the possibility of an unexpected short-term shock evolving into a crisis. We also need to consider the difficulties with effective response due to limited fiscal space to cope with economic crises. Along with increased debts, we also need to pay attention to the increase in the rate for interests incurred on additional debts. In other words, costs of debt are endogenous to the level of government debts.

Lastly, a group of researchers published their studies where they criticize the simple model

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10 Korea ranks fifth or higher in terms of the total amount of investments in research and development, and ranks second in terms of their percentage in the country's GDP. Investments in education are also on par with leading countries in the sector. The country also invests not a small amount of money in infrastructure developments.

used by Blanchard (2019). In 2020, in a session during an American Economic Association conference, five papers were presented under the theme, "Is United States Deficit Policy Playing with Fire?" These papers provided theoretical refutations to the argument that, as r-g<0, the government can expand fiscal investments using debts without incurring political pressure or sacrificing the wellbeing of future generations.

This study continues to cite criticisms to Blanchard (2019) in order to stress the need for securing the accountability for the expansion of fiscal investments, while practicing fiscal management that is aligned with the need to ensure fiscal sustainability, even when the growth rate continues to exceed the interest rate. Sweden is considered a model country in terms of its fiscal flexibility, soundness, and accountability. Experts from this country criticized Blanchard (2019) based on their experience in their home country, and proposed that Sweden's fiscal management framework should be used as a best practice.
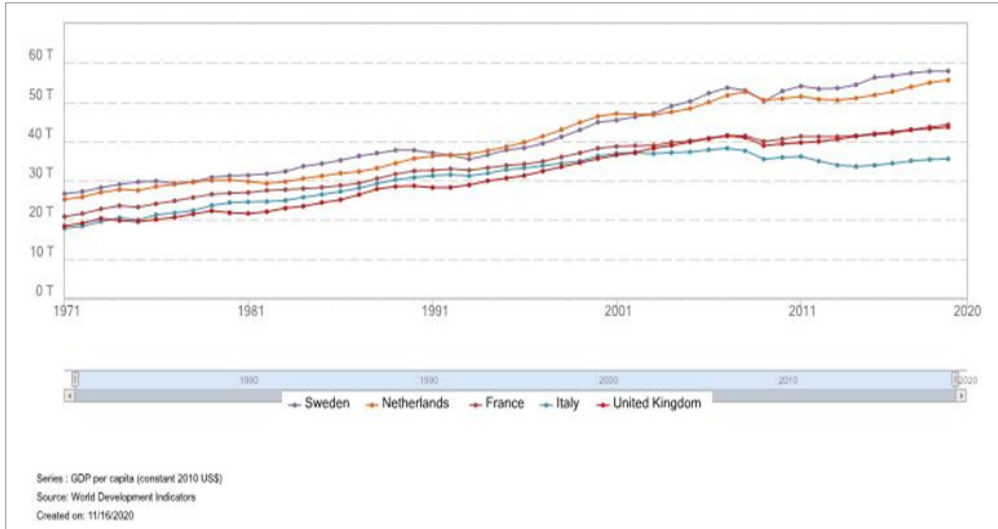
III. Fiscal Management in the Netherlands and Sweden

To identify the agenda for innovating Korea's fiscal policy framework this study analyzes best practices to be used in fiscal management as economic policy measures. Specifically, the best practices of the Netherlands and Sweden are analyzed, two countries with medium-sized open economies similar to that of Korea, in order to derive implications for fiscal innovation for proactive fiscal policy development and management aimed at economic growth.

1. Economic Performance and Flexible Fiscal Management

The Netherlands and Sweden have garnered worldwide attention for their economic performance and fiscal management practices. This study benchmarks the practices in the Netherlands and Sweden because, like Korea, these two countries are highly reliant on international trade and an open economy, and have achieved economic growth driven by competitive manufacturing sectors and service industries. The two countries have recorded the highest per capita GDP among European countries since the 1970's. In particular, even when the global financial crisis in the late 2000's stalled economic growth in other countries, these two countries' economies continued to grow.

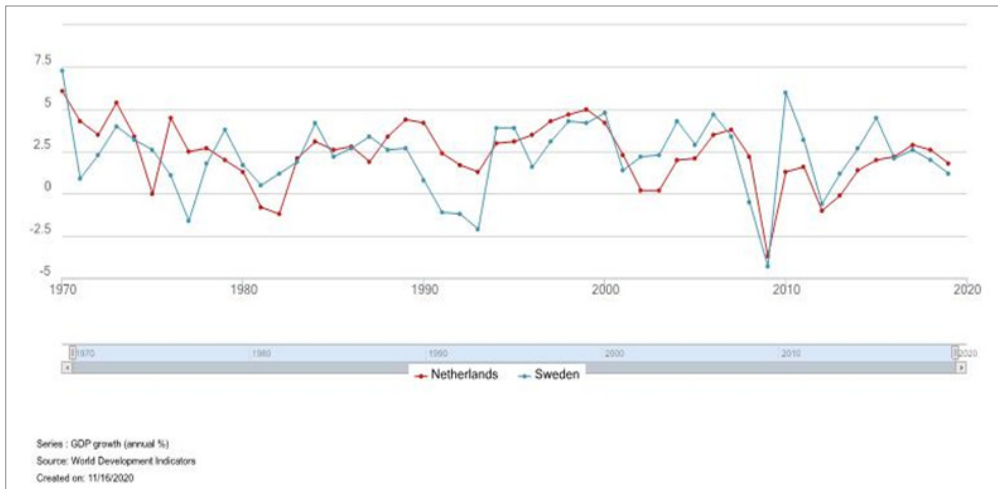**Figure 3_Per Capita GDP in European Countries (based on constant price in 2010 USD)**

Source: World Development Indicators, World Bank, accessed on November 16, 2020.

The two countries have maintained excellent economic growth rates, except during international economic crises.

Figure 4_GDP Growth Rates in the Netherlands and Sweden

Source: World Development Indicators, World Bank, accessed on November 16, 2020.
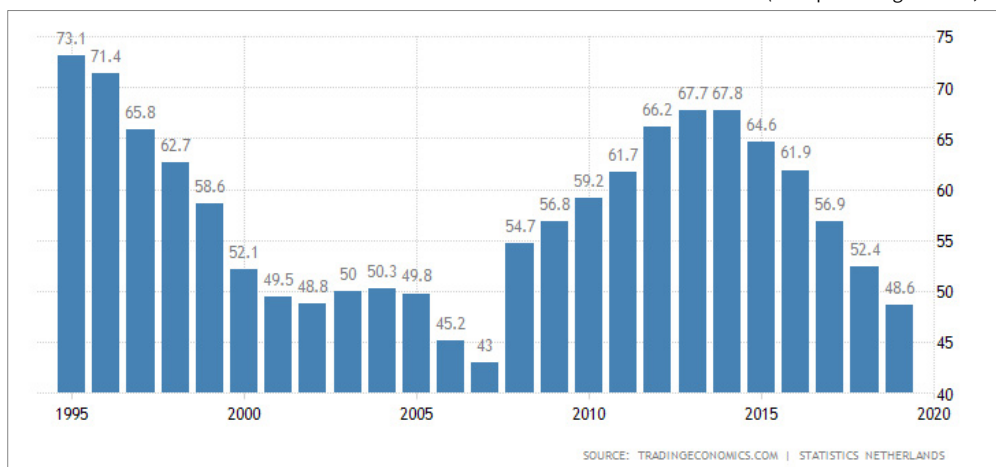
In addition to economic success, the Netherlands and Sweden are widely recognized for their model welfare systems, which are regarded as financially sustainable while being comprehensive. The two countries are also regarded as model countries in terms of fiscal policy frameworks. The countries' fiscal systems have withstood the global financial crisis, helping the countries recover from the shock early on. Their fiscal policy frameworks, which consist of fiscal rules, independent fiscal institutions, and medium-term fiscal plans, have been operating to great effect, and have been benchmarked by m countries. Korea has also benchmarked Sweden's practices for its top-down autonomous budget formulation and medium-term fiscal plans, which were included in the fiscal reform in the mid 2000's.

The Netherlands went through economic crises in the late 1970's and the early 1980's, driven by two international oil price downturns. In the early-to-mid 1990's, Sweden suffered a serious economic crisis caused by a combination of its own financial crisis and an external economic crisis (EMU and Russia). These crises resulted in fiscal crises, which prompted the countries to effect fiscal reforms.

The Netherlands lowered its government debt-to-GDP ratio from 73.1% in 1995 to 43% in 2007. On account of its expansionary fiscal management that was enacted during the global financial crisis, the debt ratio rapidly increased to 67.8% in 2014. However, through yet another belt-tightening, the country's debt ratio went down to 48.6%. These records indicate the high level of fiscal flexibility enacted in addressing economic situations. One of the

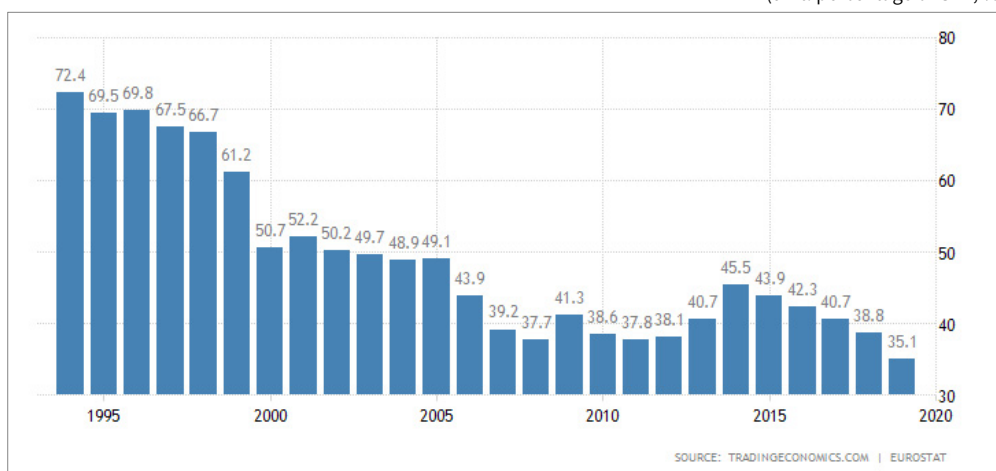**Figure 5_Government Debt in the Netherlands**

(unit: percentage of GDP, %)

Source: http://tradingeconomics.com, accessed on September 16 , 2020.

reasons for the difficulty in using fiscal discipline as a counter-cyclical policy is the deficit bias. The Netherlands addressed this issue by exercising excellent fiscal discipline in order to control the need for increased expenditures after the economic crises.

Sweden recorded the largest fiscal surplus among members of the Organisation for Economic Cooperation and Development (OECD) in the late 1980's. However, the country's government debt more than doubled over the next five years, with the rapid accumulation of deficits in the early 1990's. Sweden also displayed superb fiscal discipline by increasing government debts during a crisis and then rapidly controlling it after the crisis ended. The country's budget reform in 1996 played an important role in highlighting its fiscal discipline (Blondal, 2001). It is worth noting that the country began to form a consensus for the budget reform even before the economic crisis, which then served as a catalyst for the reform. Legal amendments for reform should be approved by the parliament before and after parliamentary elections. In Sweden, the relevant bill was passed by the parliament in December 1993, and again by the newly elected parliament in September 1994. The reformed budget process subsequently went into effect in 1996. The country's government debt ratio against GDP rose to 72.4% during the economic crisis in the early-to-mid 1990's, but then declined to 50% in 2000. The ratio did not significantly increase during the global financial crisis, but dropped to around 35%, which represents a debt anchor for the country.

Figure 6_Government Debt in Sweden

(unit: percentage of GDP, %)

Source: http://tradingeconomics.com, accessed on November 16, 2020.

Sweden and the Netherlands also flexibility changed their percentages of government expenditures in their GDPs. In the Netherlands, the percentage of government expenditures recorded a steep decline, starting in the mid 1990's. The expenditures temporarily increased during the global financial crisis, only to decline once again after the crisis. The Netherlands'

Figure 7_Government Expenditures in the Netherlands

(unit: percentage of GDP, %)

Source: Trading Economics, "Netherlands Government Spending to GDP," ttps://tradingeconomics.com/netherlands/government-spending-to-gdp, accessed on November 16, 2020.

Figure 8_Government Expenditures in Sweden

(unit: percentage of GDP, %)

Source: http://tradingeconomics.com, accessed on November 16, 2020.

government expenditure ratio dropped below 45% immediately before the COVID-19 outbreak. Since its recovery from the economic crisis in the 1990's, Sweden has lowered its expenditure ratio from 70% to 50%.

The ability to flexibility adapt to changing situations is as important, especially in terms of the absolute amounts of government debts or expenditures. The expansion of welfare requiring mandatory spending tends to restrict fiscal flexibility, and actually adds to the difficulty in ensuring fiscal sustainability by securing fiscal space in preparation for crises. The Netherlands and Sweden boast model social safety nets. However, they also managed to achieve high levels of fiscal flexibility, which is why this study pays attention to the fiscal government structures of these two countries.

2. Fiscal Policy Frameworks: Internalization of Fiscal Discipline as a Foundation for Government Formation and Operation

The fiscal policy frameworks of the Netherlands and Sweden share many common features. To summarize, they serve as foundations for government formation and operation, and these countries have now internalized policies pertaining to fiscal discipline. The internalization of fiscal discipline is made possible by the following elements.

A. Independent Fiscal Institutions

An independent fiscal institution provides a wide scope of functions. To cite only the core functions, they project tax revenues, estimate expenditure requirements for existing programs, provide aggregate data for medium-term fiscal planning, and assess fiscal sustainability based on long-term fiscal projections where demographic changes serve as one of the main factors. The global financial crisis highlighted the importance of independent fiscal institutions. After the EU adopted a recommendation for independent fiscal institutions, there was an increase in the number of countries that began to establish their own institutions.

In the EU, under the Stability and Growth Pact (SGP), member states have agreed on a simple fiscal rule to keep debts and deficits under 60% and 3% of GDP, respectively. Despite its simple content, the rule has been marred by various implementation issues. The EU then revised the rule by introducing a rule on economic cycle criteria and exceptions for one-time or temporary fiscal instruments. However, these elements subsequently undermined transparency. The EU also adopted medium-term criteria for fiscal deficits, and assessed

medium-term fiscal deficit targets based on debt trajectories.

To ensure that these fiscal rules are honored by its member states, the EU required the members to establish and operate independent 'fiscal monitoring councils' after the global financial crisis, followed by the establishment of the European Fiscal Board in October 2016. The EU required the establishment of independent fiscal institutions based on the finding that fiscal rules alone cannot ensure the efficacy of fiscal risks. Current discussions regarding independent fiscal institutions involve the issue of what policy measures and powers should be conferred to independent fiscal institutions. Other than the essential functions of producing information on, monitoring, and assessing fiscal sustainability, countries are considering delegating policy measures and decision-making powers to ensure actual fiscal sustainability. Underlying the new considerations is a recognition that information production and disclosure alone cannot overcome the deficit bias inherent in the fiscal policies decision-making processes.

The Netherlands and Sweden were operating independent fiscal institutions, even before the EU's requirement. Established through internal policy consultation processes, these institutions play important roles in ensuring fiscal sustainability.

The Netherlands' independent fiscal institution, the Netherlands Bureau for Economic Policy Analysis (CPB), is a subsidiary of the Ministry of Economic Affairs and Climate Policy. However, its independence is protected by law, and the head of the bureau holds his office for seven years. The bureau was founded by Jan Tinbergen, the laurate of the 1945 Nobel Prize for Economics.

One of the key functions for fiscal management is the annual projection of four elements. Four annual reports are published regarding the economic situations in the Netherlands and the global community. Medium-term fiscal projections are made a year before an election to form a new government, and the bureau publishes a diagnosis report on fiscal sustainability gap (houdbaardheidssaldo). These projections inform the diagnosis of adequacy of fiscal management policies, and helps the new government to set its medium-term fiscal policies.

Based on the sustainability gap submitted by the CPB, the Fiscal Policy Advisory Committee (SBR) drafts recommendations for the new coalition government. If the sustainability gap is positive or balanced, it means that the current policies are sustainable in the long term, with no deficit or debt increase. If the gap is negative, the SBR recommends that the new government should practice austere fiscal management. The fiscal sustainability gap is assessed based on the assumption of no policy change. A positive gap indicates fiscal sustainability, and a negative value indicates a threat to sustainability. Nine months before an

election, the SBR publishes a report that estimates the fiscal space, based on the medium-term projections submitted by the CPB, and proposes fiscal rules. The SBR consists of high-level decision makers in the executive branch, CPB, and officials from the central bank.

One of the key noteworthy functions of the CPB is the assessment of policies pledged by political parties. Pledge assessment involves a comprehensive analysis of the potential effect on fiscal sustainability, inequality, and economic growth. Political parties are free to choose whether to request such assessments. However, most political parties do indeed request these assessments. The assessments include estimations of fiscal requirements for the pledges, which means that, by the time the coalition government is formed after the election, all basic information for medium-term fiscal planning have been derived by the independent fiscal institution.

Sweden established the Fiscal Policy Council in 2007. Smaller in size than the CPB in the Netherlands, its roles are restricted to assessing the adequacy of government projections, fiscal management status, and fiscal targets. One of the main functions of the council is to publish an annual fiscal diagnosis report entitled, "Swedish Fiscal Policies" by May 15. The report contains assessments on long-term fiscal sustainability, fiscal surplus targets, expenditure ceilings, and contributions to long-term growth and employment maintenance.

The report also touches on the adequacy of the government's economic projections and models. The council also organizes conferences and publishes in-depth reports on various aspects of fiscal policies as required. In other words, the Fiscal Policy Council offers limited functions focused on follow-up monitoring and diagnosis. The council consists of six members, five staff members, and a secretary. In contrast, the CPB employs more than 150 researchers and staff members.

B. Medium-Term Fiscal Policy Framework

The Netherlands and Sweden organize medium-term (four-year) budgets in alignment with the government's term of office, and set medium-term expenditure ceilings for each ministry. Such medium-term budget formulation and operation enhances the fiscal discipline while lowering the workload of budget formulation, compared to annual budget formulation, thereby helping the government focus its capabilities on improving the quality of budget formulation and expenditures. Using fiscal policies as counter-cyclical policies requires at least a degree of medium-term fiscal management. Fiscal management aligned with economic cycle requires a medium-term approach.

A fiscal policy framework may be long-term, medium-term, or short-term. A long-term framework manages fiscal sustainability based on fiscal projections that consider long-term changes such as demographic changes. A medium-term framework (three to five years) pursues fiscal management targets for the duration of an administration. A short-term framework manages annual fiscal management targets under medium- and long-term goals.
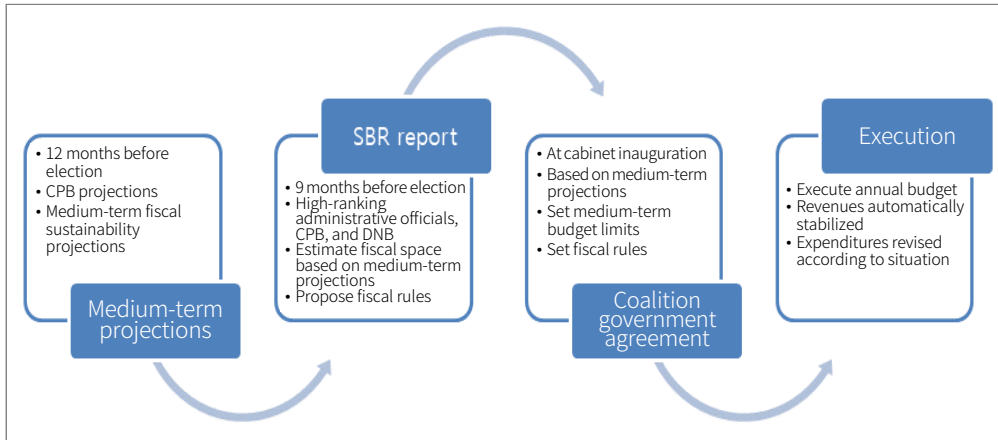
Medium-term fiscal management is organized based on the structural fiscal balance. The EU recommends medium-term objectives (MTOs) for individual member states, taking account of their fiscal management statuses. The MTOs serve three purposes. First, they suggest the size of safety margin (fiscal space) required to prevent the fiscal deficit from exceeding 3% of the GDP. The safety margin is defined based on economic volatility and the sensitivity of fiscal expenditure to the volatility. For example, a country with a high economic volatility needs to increase its fiscal space. Second, MTOs are established based on fiscal sustainability.

They consist of objectives that allow countries to maintain debt ratios at 60% of GDPs, and respond to population aging. Third, MTOs are established in a way that provides individual countries with the fiscal space for public investments. The European Council (EC) reassesses and recommends minimum MOTs for individual countries every three years. Individual countries then use the MTOs recommended by the EC as minimum standards for their medium-term fiscal plans.

Since 1994, the Netherlands has implemented 'trend-based budget policies', which involves medium-term fiscal management based on long-term projections. Under these policies, the government establishes medium-term fiscal rules, and set the medium-term expenditure ceilings for individual ministries under a new administration. To prepare for future uncertainties, the country has set up criteria for responding to situations in which revenues or expenditures exceed a given ceiling. These specific criteria are set up in a way to prevent countries from circumventing their medium-term expenditure ceilings.

Sweden's budget formulation and finalization consists of two stages. In the first stage, the government fiscal policy bills focused on macroeconomic fiscal management in the first half of a year, are presented for the parliament's approval. In the second half, the government submits more specific budget bills to the parliament, which then approves the budget bills after finalizing the direction for financial resource distribution. This process takes a year. In contrast, in the Netherlands, the CPB begins its work a year before an election, which gives the government a total of two years to finalize its medium-term budget.

Figure 9_Election Cycles and Medium-Term Budgeting in the Netherlands

Source: Present study

Figure 10_Budgeting Process and Timeline in Sweden

Source: Wilhelmsson, Thomas, "Fiscal rules and medium term budgeting in Sweden," PEMPAL, p. 2, https://www.pempal.org/sites/pempal /files/event/attachments/28_Thomas%20Wilhelmsson_eng.pptx, accessed on November 17, 2020.

The benefits of multi-year budgeting include: sufficient time for medium-term fiscal planning and budgeting, more time to invest in budget execution and settlement, and project monitoring and evaluation.

C. Establishment and Enforcement of Fiscal Rules

Fiscal rules have rapidly spread after the global financial crisis, one of the major drivers being the widespread recognition of the risk of time-inconsistent fiscal management practices. Many governments expanded their fiscal expenditures during economic crises, and continued to accumulate debts even after the onset of economic recovery. As discussed above, the Netherlands and Sweden appear to have averted such risks after their economic and financial crises in the 1980's and the 1990's.

At the heart of their fiscal management practices lie their medium-term fiscal rules. In the Netherlands, when a new administration is inaugurated, it defines the aggregate fiscal targets to be pursued by the administration. Then, ministry-level expenditure ceilings are defined by the aggregate targets. Sweden clarified its fiscal rules in a recent reform. In 2019, the country adopted a debt anchor, which sets the government debt-to-GDP ratio at 35%. In addition, like the Netherlands, fiscal rules for maintaining a certain level of fiscal surplus within economic cycles are defined when a new government is formed. As of 2019, the current fiscal surplus target is 0.33% against the GDP.

Requirements for meaningful fiscal rules include: reliable information on key aggregate indicators; increased binding force of fiscal rules; independent monitoring and evaluation of compliance with fiscal rules; clear processes for remedying non-compliance; and higher media visibility. The governments of the Netherlands and Sweden satisfy most of these requirements, and implement fiscal rules in a way that they form a foundation for sound fiscal management. In particular, they produce information and perform monitoring and evaluations through independent fiscal institutions, which greatly affects the establishment of, and compliance with, fiscal rules.

D. Institutional Mechanisms for Creating Fiscal Space and Performance

The Netherlands and Sweden offer effective spending reviews for performance management and evaluation as well as expenditure restructuring. Flexible and effective fiscal management requires systemic and regular evaluations and fundamental reviews of expenditure programs. For example, the Netherlands reviews its expenditures in response to

economic and fiscal situations, and ensures flexible fiscal management by restructuring expenditures on continuous projects. The Comprehensive Review in 2010 offers a prime example of such restructuring. Immediately after an economic crisis, a comprehensive review of 20 areas was conducted just before the election. As a result, various measures for reducing expenditures were proposed under a 20% reduction goal for the new government. Such a fundamental review could be performed because medium-term fiscal discipline forms the basis of the government formation.

An increase in mandatory expenditures undermines the tenets of fiscal flexibility and sustainability. As such, the following paragraphs examine how Sweden and the Netherlands address this issue. Specifically, as a best practice for ensuring flexible fiscal management against economic changes and securing fiscal sustainability, this study examines Sweden's public pension program. Sweden's public pension program is characterized by its governance structure, which is separated from the general finance programs to ensure the program's fiscal sustainability. In other words, in Sweden, the pension program does not form a part of the government finance structure, as pension revenues and expenditures are governed by a separate set of regulations. These regulations have been adopted by agreements with politically independent working groups within the parliament.

In addition, based on automatic stabilization, the program is designed to maintain fiscal sustainability, regardless of the demographic structure or economic changes. The balancing mechanism is triggered when the pension program's liability exceeds the estimated asset value. The calculations underlying these decisions are performed by the Swedish Social Insurance Agency.

E. Decentralized Accountability Based on Autonomy

The management function for aggregate targets pertaining to fiscal risks and sustainability are centralized at the independent fiscal institution and by the fiscal authorities. However, the authorities and the accountability for specific policies and projects are decentralized across specific ministries in charge of the specific policies and projects. As a country with a parliamentary government system, each ministry is accountable to the parliament regarding its budgets. However, as ministry-level expenditure ceilings are defined by a centralized process, such decentralization is restricted within the ministries' expenditure ceilings. Decentralized accountability offers the benefit of allowing ministries to develop, execute, and take responsibility for their own budgets and policies using their expertise, thereby ensuring

a close linkage between specific outcomes of fiscal management within their field. In other words, decentralization mitigates the side effects of subjecting even the minutest details under centralized control.

IV. Fiscal Policy Reform Agendas in Korea

In Korea, the increasing influence of the political sphere on the budgetary process has changed the political environment surrounding fiscal management, which has been compounded by the recent economic changes. In keeping with these changes, Korea needs to fundamentally review its fiscal policy framework.

To date, the executive branch, and the budgetary power of the central budgetary authorities in particular, has exercised control over fiscal management policies. However, in recent years, the executive branch's influence has declined, as the National Assembly increased its control over the budgetary process. Recent events surrounding the budgetary and supplementary budget processes have provided clear indications of why securing fiscal discipline through the budgetary power of the central budgetary authorities is no longer feasible.

Figure 11_Elements Required for Active Fiscal Policies

Source: Present study

The most fundamental functions of fiscal policies include ensuring fiscal sustainability, financing the government's basic functions, and achieving fiscal redistribution based on social consensus. In contrast, their roles as economic policy measures include proactive provisions for responses to short-term changes in economic cycles, as well as fiscal investments for long-term growth. Such problem-solving fiscal management requires a departure from centralized control to a fiscal management system that is designed to solve issues experienced by society.

Such a transition to a proactive fiscal management system requires independence, timeliness, accountability, and competency. Fiscal policies are linked with political priority decisions. Therefore, they require political decision-making mandates. Their execution involves actors including the central government, local governments, public institutions, and private businesses. In contrast, monetary policies operate based on a single mechanism, i.e., the interest rate, through a decision-making body consisting of independent experts. Using fiscal policies as economic policy measures requires innovation of the fiscal system, in order to address the limitations of fiscal policies in terms of decision-making and execution processes.

First, proactive fiscal policies require timeliness. Decision making pertaining to fiscal policies requires a few months, at least, with additional months then required for execution. The executive branch has to draft budget bills, the National Assembly has to review and approve the bills, which are then executed by the central government, local governments, public institutions, and private businesses. Such 'time lag' undermines the timeliness of counter-cyclical policies. To address this issue, some researchers have proposed the separation of counter-cyclical policies with less implications on distribution, and designing them to be automatically triggered in times of economic downturn.

Second, proactive fiscal policies require independence. The role of monetary policies as economic policy measures is a relatively new phenomenon. The German central bank (Deutsche Bundesbank) gained independence in 1951. However, it was not until the 1990's when countries began to realize the importance of having an independent central bank as an instrument for economic policies. High inflation persisted in the 1970's and 1980's, which led to criticisms that the monetary policy functions of the central bank do not work properly. The central bank tended to implement monetary policies by setting a target that exceeded the potential growth rate in a natural equilibrium, which led to inflation (Barro and Gordon, 1983). Such a tendency is regarded as being caused by political influence. As a result, institutional mechanisms for ensuring the independence of central banks began to be introduced in the

1990's.

Fiscal policies have significant distributive implications, and are bound to involve political decision-making considerations. However, the role of an independent actor needs to be ensured for at least aggregate fiscal discipline, in order to overcome the tragedy of common pool problems and the issue of deficit bias caused by time-inconsistent preferences. The roles of such an independent fiscal institution need to include independent generation, monitoring, and evaluation of information on fiscal sustainability, which needs to be carried out by experts—as monetary policies are implemented by experts. As evidenced by the experiences of the Netherlands and Sweden, Korea needs to foster a consensus that information and decisions on fiscal sustainability should be tasked to an independent institution, not entrusted to political representatives.

Third, proactive fiscal policies require accountability. Accountability for outcomes of fiscal expenditures is as important as accountability for aggregate targets. Problem-solving fiscal policies require fiscal management based on the expertise of ministries, local governments, and public institutions. The fiscal management system needs to operate in a way that turns the motto, "Let the Managers Manage!" into reality. As Korea deals with increasingly complex issues, the limitations of an administrative system based on centralized control and directions become more prominent. As such, decentralized mechanisms for accountability mechanisms are required. The creation of a system in which the central budgetary authorities manage the aggregate fiscal discipline is required, where each ministry autonomously plans and implements projects and then achieves outcomes.

Fourth, proactive fiscal policies require the internalization of aggregate fiscal discipline in the political processes, and fiscal expertise in the public sector. The executive branch needs expertise in fiscal management and fiscal policies, and the politicians and the public need to agree that sustainable and accountable fiscal management is the starting point of government operations. Korea needs to create a structure in which aggregate fiscal objectives form the basis of a newly elected government. Therisks of fiscal policies should be handled by the fiscal disciplines embedded in the formation of government.

Decentralized fiscal accountability requires a budget office in each ministry with powerful planning and coordination functions. The budget office in each country only carries out slight adjustments and compilation of budget, rather than actively coordinating budgetary demands and leading fiscal management efforts at the relevant ministry. The country's top-down budget process is not working properly.

Fiscal policies aimed at solving complex problems require a higher level of expertise.

Korea's fiscal operation system mostly consists of public officials recruited through national examinations. The system is suitable for training administrators through staff rotation. However, it is not conducive to training experts who plan and execute projects from a medium-term perspective. The Netherlands has a tacit rule of "3-5-7" years. Under the rule, a public official handles the same work for at least three years, moves to a different position in the fifth year, and must transfer to a different position in the seventh year. As Korea deals with increasingly complex issues, the executive branch needs to create a room for cultivating and exercising expertise.

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Fiscal Policies for "Moonshot" R&D Projects

Woo Hyun Chang and Se Hoon Bang*

Ⅰ. Introduction

The fast-follower model has been one of the stronger features of the Korean economy. However, its marginal effectiveness has been dwindling in recent years, along with the increased demand for R&D projects to improve businesses' first-mover capabilities. Innovative first-mover R&D projects that set technological trends are characterized by difficult challenges and low success rates. However, many researchers and experts have voiced their concerns that R&D projects in Korea are far from the first-mover model. Unlike "fast-follower" R&D projects, "first-mover" projects have significant inherent uncertainties. The problem is that the level of acceptance is low for projects that may have a low success rate.

At the same time, it should be noted that the level of social trust in Korea is significantly lower than that of R&D leaders. In such circumstances, innovative R&D projects may produce numerous side effects, unless supported by precise concepts, environmental improvements, and institutional reforms. In a country with a low level of social trust, investing in uncertain projects that lack a clear vision or efforts to improve their reliability or manage their performance may only lead to fiscal waste, potentially even undermining the country's social trust even further.

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Therefore, in order to identify "moonshot" R&D projects and foster dedicated and sincere efforts for those projects, we need to take a close look at the defining elements of a moonshot R&D project and then determine factors that foster successful moonshot projects. However, few studies have touched on this issue.

To address this gap, we first define moonshot R&D, review theoretical obstacles to moonshot R&D projects, and then empirically analyze the effect of R&D-related fiscal expenditures in order to identify institutional and practical issues.

This study consists of the following chapters. Chapter II reviews the elements of a moonshot R&D project, and proposes a definition of moonshot R&D based on the identified requirements. Chapter III builds on the definition from Chapter II to present theoretical estimates, and uses the estimates to discuss the factors that need to be considered in an incentive system to promote moonshot R&D projects, and their theoretical implications for the reform of the performance evaluation system. Chapter IV empirically and quantitatively analyzes the effect of key SME support policies (including public procurement policies and public funding) on the R&D expenses of the beneficiaries, as well as the effect on their short-term and long-term productivity. Through these analyses, we examine whether the effect of the fiscal policies on moonshot R&D projects can be empirically confirmed in the field. Chapter V subsequently proposes policy measures that are based on the findings from the previous chapters, and Chapter VI presents the conclusions of this study.

II. Elements of a Moonshot R&D Project

The terms "moonshot R&D" and "challenging and creative R&D" can be found in numerous policy studies and government documents. However, few of those documents provide specific definitions of moonshot R&D, as most previous literature merely stresses that moonshot R&D projects are "high-risk high-return" projects. Some documents even focus exclusively on the high risk aspect of moonshot projects. For this reason, in this chapter, we review the elements of a moonshot R&D project that the government needs to consider.

Many researchers and businesses consider the high risk level or the low success rate as one of the main characteristics of moonshot R&D projects. However, it should be noted that not all projects with low chances of success are moonshot R&D projects. An R&D project that has a low chance of success and low benefits is socially inefficient and risky, and does not typically offer meaningful benefits relative to its costs. Such a project is not worth the government's support. It may be more beneficial for the society as a whole to discourage such

projects.

Such a project can be defined as a "reckless" R&D project, however, and should be excluded from the definition of moonshot R&D projects.

Furthermore, a moonshot R&D project does not have to have a low chance of success, because we also have to consider the issue of information asymmetry; in other words, the lack of visibility of the agent's efforts. As will be discussed in Chapter III, national R&D projects can be analyzed in terms of the principal-agent relationship between the government funding the projects (principal) and the researchers who carry them out (agent). It is difficult for the principal to ascertain the level of efforts taken by the agent. Even in a project where the agent's efforts can improve its chance of success, the agent may not wage such efforts unless the principal offers effective incentives. In such an asymmetrical situation, it is difficult to distinguish between a failure caused by lack of efforts, and a failure experienced despite sufficient efforts.

As such, a moonshot R&D project cannot be defined solely by a high likelihood of failure. Here, we define a moonshot R&D project as follows:

> An R&D project is ① commissioned by the public or a public institution (principal) to a business or researcher (agent); ② where the agent may fail regardless of the level of efforts taken by the agent, and where the principal cannot infer the level of efforts actually taken by the agent; and ③ the agent can achieve better outcomes than the next best alternative, as long as the agent takes its best efforts.

Building on this definition, Chapter III theoretically analyzes the incentive structure for moonshot R&D projects, whereas Chapter IV empirically analyzes actual data in order to assess and evaluate the outcomes of the relevant policies.

III. Incentive Structure for Moonshot R&D Projects: Numerical Examples[1]

This chapter presents numerical examples of the R&D contract scenarios analyzed in this study. We assumed a linear utility function for the agent, i.e., that both the agent and the principal are risk-neutral.

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[1] See the Korean version of Chang and Bang (2020), Chapter 3, for a more detailed theoretical analysis.

In this scenario, the principal invests $I = 10$ in the agent, who carries out either a "moonshot project" or a "safe project." Let us assume that the agent needs $\psi = 2$ efforts to carry out the "moonshot project," and $\psi = 0$ efforts to carry out the "safe project." Here, by carrying out the "safe project," the agent gains additional benefits in the amount of $\psi = 2$.

Each project leads to either good or bad outcomes. Let us assume that the chance of achieving good outcomes is π_1 for the "moonshot project," and π_0 for the "safe project." Furthermore, let us suppose that good outcomes generate 110 in benefits, whereas bad outcomes generate 10. In this scenario, it is more desirable for the public to choose the "moonshot project" than the "safe project," because the chance of good outcomes for the former is sufficiently higher.

In this scenario, the agent can enter into a contract where it receives $\bar{t}$ for a successful project and $\underline{t}$ for a failed project, and the contract contains a clause that limits the agent's liability ($\underline{t} \geq 0$). Then, if the "moonshot project" is selected, the principal has a $\pi_1 = 0.2$ chance of gaining $\overline{V} = 110$, and a $1 - \pi_1 = 0.8$ change of gaining $\underline{V} = 10$ in benefits. If the "safe project" is selected, the principal has a $\pi_0 = 0.1$ chance of gaining $\overline{V} = 110$, and a $1 - \pi_1 = 0.9$ chance of gaining $\underline{V} = 10$.

Then, the following objective equation and the constraint equation can be defined in a scenario where it is best for the principal, in order to encourage the agent to select the "moonshot project."

∘ Objective equation:
$$\max_{\{(\bar{t}, \underline{t})\}} 0.2(110 - \bar{t}) + 0.8(10 - \underline{t}) - 10 \text{ subject to (1), (2), (3)}$$

∘ Constraint equation (liability):
$$\underline{t} \geq 0 \tag{1}$$

∘ Constraint equation (incentive):
$$0.2\bar{t} + 0.8\underline{t} \geq 0.1\bar{t} + 0.9\underline{t} + 2 \tag{2}$$

∘ Constraint equation (participation):
$$0.2\bar{t} + 0.8\underline{t} - 2 \geq 0 \tag{3}$$

The following rewards can then be identified by considering Equations (2) and (3), which are adopted to minimize the principal's expenses.

$$\bar{t} = \underline{t} + \frac{2}{0.1} = \underline{t} + 20, \; \bar{t} = \frac{2 - 0.8\underline{t}}{0.2} = 10 - 4\underline{t}$$

Therefore, a reward satisfying both constraint equations can be expressed as follows.

$$\bar{t} + 20 = 10 - 4\underline{t}$$
$$\underline{t} = -2, \; \bar{t} = 18$$

Here, the lower limit of rewards is fixed at $\underline{t} = 0$ due to the constraint of limited liability. Therefore, the contingency rewards that satisfies the incentive constraint equation is $\bar{t} = 20$. Then, the rewards at equilibrium under the constraint of limited liability can be defined as follows.

$$\underline{t}^{LL} = 0, \overline{t^{LL}} = 20$$

where the expected utility for the principal V_1 is as follows.

$$V_1 = 0.2(110 - 20) + 0.8(10 - 0) - 10 = 16 > 0$$

Therefore, at equilibrium, a contract is executed under which the principal proposes rewards $\underline{t} = 0$, $\bar{t} = 20$, the agent selects the "moonshot project," and the principal's expected utility is $V_1 = 16$.

1. Reward Scheme with an Upper Limit: Example

Let us consider a scenario in which the reward scheme has an upper limit. As mentioned above, the scope of the effect of such constraint on the equilibrium is:

$$M < h\left(\frac{\psi}{\triangle \pi}\right) = \frac{\psi}{\triangle \pi} = \frac{2}{0.1} = 20$$

For example, if the reward scheme has an upper limit of $M = 19$, as the contingency reward at the previous equilibrium is $\bar{t} = 20 > M$, the principal can set the contingency reward as high as the following.

$$\bar{t}^b = M = 19$$

In this scenario, if both Equations (2) (incentive constraint) and (3) (participation constraint) are satisfied, the agent chooses the "moonshot project." To satisfy both constraint equations, the reward scheme should satisfy the following:

$$\bar{t} \geq \underline{t} + 20, \ \bar{t} \geq 10 - 4\underline{t}$$

Here, if we consider both inequalities, with the maximum contingency reward fixed at $\bar{t}^b = 19$, the condition for $\underline{t}^b$ that leads to the agent's participation in the game and its selection of the "moonshot project" can be expressed as follows.

$$\underline{t}^b \leq 19 - 20 = -1, \ \underline{t}^b \geq 0$$

where $\underline{t}^b$ conflicts with the limited liability constraint $\underline{t} \geq 0$. Therefore, due to the principal's budget constraint, the agent does not have any incentive to choose the "moonshot project" if the principal offers a reward lower than the contingency reward at the previous equilibrium $\bar{t} = 20$. In other words, in cases where the principal's budget limit is binding $(M < 20)$, even if the maximum reward that the principal can offer is $(0, M)$, the agent would not choose the "moonshot project." Therefore, the equilibrium in this scenario is the principal offering $\bar{t} = \underline{t} = 0$, and the agent chooses the "safe project."

2. Reward Scheme with a Stricter Lower Limit: Example

This section examines a scenario with a stricter lower limit for rewards. Under the previous limited liability constraint, the reward is $(0, 20)$ at equilibrium. Then, the principal's expected cost is as follows.

$$C^{LL} = \pi_1 \left(\frac{\psi}{\triangle \pi} \right) = 4$$

The expected cost that lowers the principal's expected utility to zero can be expressed as follows.

$$C^* = \pi_1 \overline{V} + (1 - \pi_1)\underline{V} - I = 20$$

Therefore, due to the stricter lower limit constraint of the reward scheme, the scope of the expected cost at which the principal gives up on encouraging the agent to choose the "moonshot project" can be calculated as follows.

$$C^{ll} = \pi_1 \left(m + \frac{\psi}{\triangle \pi}\right) + (1 - \pi_1)m > 20 = C^* > 4 = C^{LL}$$

$$m + 4 > 20, m > 16$$

Here, in order to assume that the principal always takes part in the contract, in cases where the principal gives up on encouraging the agent to choose the "moonshot project," and the agent chooses the "safe project" after receiving rewards of $\overline{t} = \underline{t} = m$ commensurate to the limited liability, the principal's expected utility should be $- I$ or higher.

$$\pi_0(\overline{V} - m) + (1 - \pi_0)(\underline{V} - m) - I \geq - I$$
$$\pi_0 \overline{V} + (1 - \pi_0)\underline{V} \geq m$$
$$20 \geq m$$

In other words, we can calculate the scope of the stricter limited liability constraint that does not encourage the agent to choose the "moonshot project" based on the principal participating in the contract.

$$16 < m \leq 20$$

For example, if the lower limit of the stricter limited liability constraint is $m = 18$, Equation (1) (limited liability constraint equation) is modified to Equation (1').

$$\underline{t} \geq m = 18 > 0 \tag{1'}$$

Here, as $m > 16$, the principal gives up on encouraging the agent to choose the "moonshot project," and encourages the agent to choose the "safe project" by providing fixed rewards at $\overline{t} = \underline{t} = m = 18$, which is the minimum reward.

Then, the principal's expected utility becomes

$$V_0^u = \pi_0(\overline{V} - \overline{t}) + (1 - \pi_0)(\underline{V} - \underline{t}) - I = -8 > -10$$

Then, the equilibrium is where the principal participates in the contract and provides fixed rewards at $\overline{t} = \underline{t} = 18$, and the agent chooses the "safe project."

3. Co-existence of Public Principal and Private Principal: Example

In this section, we consider a scenario in which a principal in the public sector is restricted by various constraints (hereinafter referred to as the "government principal") and a principal in the private sector is not bound by any such constraint (hereinafter referred to as the "private principal").

Unlike the government principal, the private principal is not restricted by the limited liability constraint, and its expected utility when not participating in the contract is 0(i.e., it can use the R&D budget for other purposes). As such, it does not enter into an R&D investment contract if it does not want to.

The objective equation and constraint equations for the private principal encouraging the private principal to choose the "moonshot project" is as follows.[2]

◦ Objective equation:
$$\max_{\{(\overline{t},\underline{t})\}} 0.2(110 - \overline{t}) + 0.8(10 - \underline{t}) - 10 \text{ subject to (4), (5)}$$

◦ Constraint equation (incentive):
$$0.2\overline{t} + 0.8\underline{t} \geq 0.1\overline{t} + 0.9\underline{t} + 2 \tag{4}$$

◦ Constraint equation (participation):
$$0.2\overline{t} + 0.8\underline{t} - 2 \geq 0 \tag{5}$$

The optimal reward for the principal is $\underline{t} = -2$, $\overline{t} = 18$, where the agent's expected utility is 0, and the private principal's expected utility is $V_1 = 18$. Meanwhile, if the private principal

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2 For ease of comparison, we assume the same figures as we did in the previous section.

does not encourage the agent to choose the moonshot project, the principal only has to satisfy the participation constraint equation. Then, the private principal offers $\underline{t} = \overline{t} = 2$ in rewards, and the agent's expected utility is 2, and the principal's expected utility is $V_0 = 8$. As $V_1 \geq V_0$, in a scenario in which only the private principal exists, the equilibrium is where the private principal offers $(\underline{t} = -2, \overline{t} = 18)$ in rewards, and the agent accepts the offer and chooses the "moonshot project." The expected utilities of the private principal and the agent are 18 and 0, respectively.

Let us now consider what happens if the government principal joins the same scenario. The agent enters into an R&D contract with either the government principal or the private principal, and chooses either the "moonshot project" or the "safe project." In such cases, the agent considers the expected utility of the rewards offered by each principal, and chooses the principal with the contract offering higher expected utility. Here, let us assume that the private principal and government principal offers the maximum reward that grants them the same or higher expected utility compared with the expected utility when they do not enter into the contract.[3]

The private principal enjoys a zero expected utility if it does not participate in the contract. Therefore, it wants to offer a reward scheme that promises zero or higher expected utility for participating in the contract.

$$V_1 = 0.2\,(110 - \overline{t}) + 0.8\,(10 - \underline{t}) - 10 \geq 0$$
$$V_0 = 0.1\,(110 - t) + 0.9\,(10 - t) - 10 \geq 0$$

Here, $\overline{t} = \underline{t} + 20$ in order to satisfy the incentive constraint equation. Therefore, in the case of encouraging the agent to choose the "moonshot project," the maximum reward is (16, 36). In the case of encouraging the agent to choose the "safe project," the maximum reward is (10, 10). In each case, the agent's expected utility is 18, 10, respectively, and the principal's utility is 0.

The government principal's expected utility is $-I$ if it does not participate in the contract. First, let us assume that the government principal is restricted by the limited liability constraint

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3   Competition between principals can be expressed in multiple ways. However, for the sake of this analysis, this section considers a situation in which the principals are engaged in fierce competition and all surpluses are enjoyed by the agent.

$\underline{t} \geq 0$ and the budget constraint $M = 19$. Here, as discussed above, the government principal gives up on encouraging the agent to choose the "moonshot project." Therefore, we can calculate the maximum reward that raises the expected utility above $-I$ in cases in which the government encourages the agent to choose the "safe project."

$$V_0 = 0.1(110 - t) + 0.9(10 - t) - 10 \geq -10$$

In other words, the government principal can offer up to (20, 20) in /. However, it offers (19, 19) on account of the upper limit. Here, the agent's expected utility is 19, and the government principal's expected utility is -9. Therefore, at equilibrium, the agent chooses the government principal over the private principal because the former can offer up to 18 in expected utility, and the agent chooses the "safe project" under the reward (19, 19) offered by the government principal.

In the following sections, we will consider a scenario that has an unconstrained private principal and a government principal restricted by a stricter limited liability constraint. Here, as $16 \leq m < 20$, the government principal participates in the contract. However, it encourages the agent to choose the "safe project." Here, we can calculate the maximum reward that will raise the expected utility to above $-I$.

$$V_0 = 0.1(110 - t) + 0.9(10 - t) - 10 \geq -10$$

The government principal may offer up to (20, 20) in rewards, in which case the agent's expected utility is 20 and the government principal's expected utility is -10. Therefore, as previously discussed, the agent chooses the government principal over the private principal, as the former can offer the maximum expected utility, and the agent chooses the "safe project" under the reward scheme (20, 20) offered by the government principal.

To summarize, in a scenario in which only an unconstrained private principal exists, the equilibrium is the point at which the agent chooses the "moonshot project."

However, if a government principal restricted either by the limited liability constraint and budget constraint or by the stricter limited liability constraint participates/intervenes in the market, the agent enters into a contract with the government principal, and ultimately chooses the "safe project." In other words, the government principal's intervention may lead to social inefficiency, thereby promoting the choice of the "safe project" over the socially more desirable "moonshot project."

The private principal's expected utility for not participating in the contract is 0, whereas the same expected utility for the government principal is $-I$ (i.e., it has to spend its budget somehow), and the government principal has a reason to enter into a contract with the agent despite the high cost. In other words, the government principal has a higher tolerance for the agent's inefficient behaviors than the private principal, and the agent prefers contracts with such "loose" government principals.

IV. Empirical Assessment of the Effectiveness of Moonshot R&D Criteria in Fiscal R&D Policies: The Case of Public Funding

In Chapter IV, based on the definition from Chapter II and the theoretical examples analyzed in Chapter III, we examine whether existing fiscal policies facilitate moonshot R&D projects by businesses and industries. If fiscal expenditures facilitate the performance of moonshot projects, they should report a significant positive effect on either the profitability or productivity. Therefore, it is important to combine the history of fiscal policies with firms' financial documents in order to determine the effect of fiscal expenditures on R&D expenses and productivity. In this chapter, we focus on public funding as an example of a fiscal policy in order to empirically examine the effect of policies on changes in the beneficiaries' R&D expenses, and the effect of R&D expense growth on profitability.

If you are more familiar with the traditional budget classification system than public funding and other similar policy instruments, you may wonder why we analyze policy effects by looking at different types of policy instruments (including public funding) rather than budget categories (industry, SME, energy, etc). We will briefly explain why we chose this approach in the following paragraphs.

Public funding is one of the most crucial instruments for R&D policies. R&D policy is a classification based on purpose, whereas public funding is a classification based on policy instrument. Numerous studies, including this one, have analyzed the effect of fiscal policies based on types of policy instruments (including public funding and public procurement) mainly because the current budget categories in Korea are not classified based on policy instruments or purposes. In Korea, budgets are classified based on which government ministry is in charge of each category. Such a classification is not suitable for analyzing general policy effects.

To illustrate, under Korea's current budget classification system, the industry-SME-energy budgets are classified under the ministries in charge of industry, SME, and energy: the Ministry

of Trade, Industry and Energy (MOTIE) and the Ministry of SMEs and Startups (MSS). Therefore, the categories do not encompass all budgets set aside for industries, SMEs, and energy. For example, the budgets and funds of the Korea Credit Guarantee Fund (KODIT) are not classified under the industry-SME-energy category, despite the fact that the fund provides the largest amount of guarantees among the guarantee providers analyzed in this study. Granted, there are some projects carried out by other ministries that are classified under this category; however, such projects are not classified as the projects under those ministries.[4]

In other words, if projects are classified under either Category A, Category B, or the intersection of the two categories, the current classification system arbitrarily splits the intersection and assigns each part to one of the categories.

The same issue applies to the subject matter of this study. Public fundings are not included in any budget or fund of the Ministry of Science and ICT (MSIT). As such, even though public fundings include numerous funds designed to support R&D efforts, public fundings are not found under the R&D category even when they are technical in nature (such as Korea Technology Finance Corporation funds). This problem occurs because, under the current classification method, the projects in the intersection of public funding projects and R&D support projects are arbitrarily split and categorized as either public funding projects or R&D support projects.

Therefore, the titles currently used for government budget categories are not suitable for research purposes, and new classifications are required. In this study, we classified the relevant policies based on the policy instruments, paying particular attention to two crucial instruments: public funding and public procurement. Then, we focused on policies using instruments that are designed to support the R&D efforts.

It should be also noted that public fundings consist of loans and guarantees, which are distinguished from subsidies. Some may question whether the provision of loans and guarantees can be classified as either a budget or a fund project. However, the Korean budgetary system does not distinguish between loans, guarantees, and subsidies. In this case, the public funding category helps us focus on guarantees and loans in a consistent manner. In fact, a large part of the MSS budget is linked with loan provision from the Small and Medium Business Corporation (SBC). In addition, as will be clarified later, the budget for loan

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4 For example, the Financial Service Commission (FSC)'s 2020 projects related to the Industrial Bank of Korea (IBK) are classified under the industry-SME-energy category, whereas the FSC projects regarding the Korea Development Bank (KDB) are classified under the finance category.

provision is larger than cash subsidies, which means that our focus on loans and guarantees does not seriously undermine the general applicability of our findings.

Granted, ultimately, further analyses on other forms of support (including investments and subsidies) will be required in the future, along with analyses of other types of policy instruments such as the procurement market or regulatory differentiation. Although difficult under the current circumstances, if we can secure microdata on each of the policy instruments, we may be able to determine the effect of each instrument on R&D efforts at the national economy level.

1. Effect of Public fundings on R&D Expenses

Financial supports constitute one of the major policy instruments both in terms of their size and demand.

The based funds included in the industry-SME-energy budget are only a part of the policy-based funds. In fact, Korea ranks second among Organisation for Economic Cooperation and Development (OECD) members, after Japan, in terms of public funding as a percentage of gross domestic product (GDP).

To understand the effect of these public funding on R&D efforts, we analyzed microdata on guarantees and loans provided by three major institutions, with particular focus on the Korea Technology Finance Corporation (KIBO), a fund specifically established for providing technology finances.

Specifically, we combined the SME data and the R&D expense data from the Korea Enterprise Data (KED) with the history data of public funding. The following table summarizes the basic statistics of the data.

Table 1_Integrated Database and Basic Statistics

(Unit: number of firms, number of guarantees/loans, KRW million)

Year	Annual no. of firms	Annual frequency of policy-based guarantees/loans	Annual frequency of KODIT guarantees/loans	Annual frequency of KIBO guarantees/loans	Annual frequency of SBC guarantees/ loans
2011	248,947	130,261	90,265	39,053	19,556
2012	275,929	135,863	91,668	42,550	20,034
2013	300,537	140,660	92,354	45,195	23,604
2014	313,418	145,177	93,274	47,952	25,833
2015	297,861	139,119	87,010	47,242	28,647

Table 1_Integrated Database and Basic Statistics(continued)

(Unit: number of firms, number of guarantees/loans, KRW million)

Year	Annual amount of policy-based guarantees/loans	Annual amount of KODIT guarantees/loans	Annual amount of KIBO guarantees/ loans	Annual amount of SBC guarantees/ loans	Annual amount of R&D expenses at SMEs
2011	55,233,610	28,514,038	13,037,371	13,682,201	9,367,229
2012	56,737,619	29,355,155	13,730,332	13,652,132	10,047,986
2013	59,565,052	30,566,994	14,834,282	14,163,776	10,671,039
2014	60,773,328	31,963,034	15,244,163	13,566,131	11,208,683
2015	63,814,982	35,431,464	15,360,924	13,022,594	10,871,290

Source: Present study, based on the KED (2020), KODIT (2016), KIBO (2016), and SBC (2016) data.

First, let us examine whether fiscal support from the government increased the R&D expenses at the beneficiaries. We used a fixed effect panel model to analyze the data while controlling for the fixed effects of years and firms.

The following shows the equation used to estimate the policy effect over a one-year period.

$$\triangle y_{i,t} = \alpha + \beta P_{i,t} + x_{i,t-1}\gamma + I_{i,t-1}\delta + \nu_i + v_t + \varepsilon_{i,t}$$

$\triangle y_{i,t}$: Increment of R&D expense of Firm i from Year t-1 to Year t

$P_{i,t}$: Whether Firm i received public funding in Year t

$x_{i,t-1}$: Characteristics of Firm i in Year t-1

$I_{i,t-1}$: Characteristics of the industry where Firm belongs to in Year t-1

ν_i : Fixed firm effect

v_t : Fixed time effect

The findings indicate that there are serious concerns about the effect of R&D policies. We then used the fixed effect panel model to analyze the public funding provided from 2011 to 2015, and the beneficiaries reported lower incremental R&D expenses relative to similar firms. The average R&D expense of the beneficiaries of public funding increased by KRW 16.54 million less than for similar firms.

In particular, the gap in incremental R&D expenses was particularly prominent in the beneficiaries of KIBO guarantees and loans. Public funding from KIBO were found to decrease the incremental R&D expenses by around KRW 34 million.

Table 2_Effect of Government Support Over 1 Year (control group: non-beneficiary firms)

(Unit: KRW million)

	Incremental R&D expenses over 1 year			
	Policy-based guarantees/loans	KIBO guarantees/loans	KODIT guarantees/loans	SBC guarantees/loans
Policy-based guarantees/loans	-16.48*** (5.478)			
Revenues in Year t-1	-0.00916*** (0.000447)	-0.0101*** (0.000569)	-0.0117*** (0.000538)	-0.0105*** (0.000617)
Total assets in Year t-1	-0.00269*** (0.000567)	-0.00299*** (0.000702)	-0.00327*** (0.000711)	-0.00225*** (0.000743)
Operating profit in Year t-1	0.0376*** (0.00160)	0.0382*** (0.00194)	0.0386*** (0.00195)	0.0434*** (0.00201)
Operating return on assets (OP-ROA) in Year t-1	-0.0525 (0.0694)	-0.0653 (0.0791)	-0.0540 (0.116)	-0.0696 (0.111)
Average total assets of SMEs in Year t-1	0.0292*** (0.00710)	0.0297*** (0.00872)	0.0203** (0.00878)	0.0287*** (0.00992)
Average total assets of SMES in Year t-1	-9.46e-05 (0.00904)	-0.00956 (0.0115)	0.0166 (0.0114)	-0.0135 (0.0130)
Average operating profit of SMEs in Year t-1	-0.106** (0.0475)	-0.0838 (0.0583)	-0.214*** (0.0608)	-0.212*** (0.0678)
Average R&D expenses of SMEs in Year t-1	-0.530*** (0.0528)	-0.617*** (0.0643)	-0.424*** (0.0678)	-0.434*** (0.0772)
OP-ROA of SMEs in Year t-1	3.102*** (0.978)	3.596*** (1.174)	1.746 (1.434)	5.280*** (1.574)
2013	-2.317 (3.295)	-3.755 (4.101)	-0.928 (4.556)	-8.502* (5.001)
2014	-4.542 (3.855)	-11.34** (4.833)	7.936 (5.308)	-11.81** (5.915)
2015	-23.94*** (4.593)	-29.02*** (5.821)	-21.45*** (6.128)	-29.60*** (6.963)
KIBO subsidies		-33.99*** (7.788)		
KODIT subsidies			4.322 (9.655)	
SBC subsidies				-26.85** (10.91)
Constant	102.8*** (27.50)	168.1*** (33.99)	86.59** (35.65)	162.3*** (40.99)
No. of observations	172,491	127,498	100,337	95,140
Determination coefficient	0.011	0.011	0.018	0.015
No. of companies	72,586	56,552	48,817	45,807

Notes: 1. The figures in the parentheses indicate standard errors.
2. *** p<0.01, ** p<0.05, * p<0.1
Source: Present study, estimated based on the KED (2020), KODIT (2016), KIBO (2016), and SBC (2016) data.

The public funding from the KODIT did not have a significant effect on the changes in R&D expenses.

The table indicates a positive effect, but the effect is not significant.[5] The loans/guarantees provided by the SBC reduced the incremental R&D expenses of the beneficiaries by around KRW 27 million, relative to non-beneficiaries.

The following sections track changes in incremental R&D expenses over two years. The estimates are summarized in Table 3.

The following shows the equation used to estimate the policy effect over a two-year period.

$$\triangle y_{i,t2} = \alpha + \beta P_{i,t-1} + x_{i,t-2}\gamma + I_{i,t-2}\delta + \nu_i + v_t + \varepsilon_{i,t}$$

$\triangle y_{i,t2}$: Incremental R&D expenses of Firm i from Year t-2 to Year t

$P_{i,t-1}$: Whether Firm i received public funding in Year t-1

$x_{i,t-2}$: Characteristics of Firm i in Year t-2

$I_{i,t-2}$: Characteristics of the industry where Firm belongs to in Year t-2

ν_i : Fixed firm effect

v_t : Fixed time effect

The findings were similar to the findings on the one-year effect of public funding; the average incremental R&D expenses over two years reported by the beneficiaries of KIBO finances were lower than that of similar firms by KRW 27.75 million. The effect of the KODIT finances was not deemed to be significant, as it was in the analysis of the one-year effect. The SBC finances decreased incremental R&D expenses at a significance level of P = 5.4%, showing similar findings to the first analysis. For reference, the beneficiaries of SBC finances reported an around KRW 32.76 million decline in the incremental R&D expenses.

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5 The effect becomes significant when the beneficiaries of KIBO finances are included in the control group, which can be explained by the fact that the beneficiaries of KIBO finances reported a more significant decline in incremental R&D expenses.

Table 3_Effect of Supports Over Two Years (control group: non-beneficiary firms)

(Unit: KRW million)

Category	R&D expenses over two years			
	Policy loan	KIBO subsidies	KODIT subsidies	SBC subsidies
Policy-based guarantees/loans in Year t-1	-14.41* (8.198)			
Revenues in Year t-2	-0.0104*** (0.000679)	-0.0119*** (0.000852)	-0.0148*** (0.000825)	-0.0129*** (0.000946)
Total assets in Year t-2	-0.0105*** (0.000904)	-0.0123*** (0.00110)	-0.00760*** (0.00111)	-0.00796*** (0.00117)
Operating profit in Year t-2	0.0432*** (0.00242)	0.0506*** (0.00291)	0.0456*** (0.00298)	0.0482*** (0.00302)
OP-ROA	-0.236** (0.112)	-0.332*** (0.124)	-0.360* (0.188)	-0.459** (0.185)
Average total assets of SMEs in Year t-2	0.0562*** (0.0105)	0.0455*** (0.0127)	0.0505*** (0.0127)	0.0457*** (0.0146)
Average revenues of SMEs in Year t-2	-0.00299 (0.0134)	-0.0151 (0.0168)	0.0351** (0.0168)	-0.00668 (0.0194)
Average operating profit of SMEs in Year t-2	-0.120* (0.0699)	-0.0786 (0.0840)	-0.253*** (0.0916)	-0.350*** (0.101)
Average R&D expenses of SMEs in Year t-2	-0.637*** (0.0774)	-0.762*** (0.0926)	-0.866*** (0.106)	-0.682*** (0.116)
OP-ROA of SMEs in Year t-2	2.735 (1.669)	4.053** (1.985)	2.879 (2.378)	7.961*** (2.682)
2014	0.353 (4.039)	-5.030 (4.993)	12.54** (5.593)	-4.855 (6.159)
2015	-13.81*** (5.014)	-19.90*** (6.239)	-4.196 (6.943)	-13.21* (7.742)
KIBO guarantees/loans in Year t-1	-27.73** (11.43)			
KODIT guarantees/loans in Year t-1		14.83 (14.68)		
SBC guarantees/loans in Year t-1			-32.73* (16.98)	
Constant	121.7*** (44.34)	244.4*** (54.62)	67.04 (57.40)	222.4*** (66.83)
No. of observations	103,168	76,516	56,074	55,005
Determination coefficient	0.016	0.019	0.027	0.020
No. of companies	48,018	37,331	29,293	28,706

Notes: 1. The figures in the parentheses indicate standard errors.
2. *** p<0.01, ** p<0.05, * p<0.1
Source: Present study, estimated based on the KED (2020), KODIT (2016), KIBO (2016), and SBC (2016) data.

The next section discusses how the beneficiaries of public funding adjust their R&D expenses when the amount of public funding change.

The following shows the equation estimated for policy effect over a two-year period.

$$\triangle y_{i,t2} = \alpha + \beta P_{i,t-1} + x_{i,t-2}\gamma + I_{i,t-2}\delta + \nu_i + v_t + \varepsilon_{i,t}$$

$\triangle y_{i,t2}$: Incremental R&D expenses of Firm i from Year t-2 to Year t
$P_{i,t-1}$: Amount of public funding received by Firm i in Year t-1
$x_{i,t-2}$: Characteristics of Firm i in Year t-2
$I_{i,t-2}$: Characteristics of the industry where Firm belongs to in Year t-2
ν_i : Fixed firm effect
v_t : Fixed time effect

The findings are summarized in Table 4. Among the firms that benefited from public funding, the amount of public funding is seen to be negatively correlated with the incremental R&D expenses. An average firm receiving KRW 1 million in public funding reduced its incremental R&D expenses by around KRW 26,000. The incremental R&D expenses of an firm receiving the same amount from KIBO decreased by around KRW 48,000. The increment gap increased to KRW 54,000 for SBC. On the other hand, an average beneficiary of KODIT finances increased its incremental R&D expenses by KRW 18,000, albeit at a 10% significance level.

Table 4_Effect of Public Funding on R&D Expenses Among Beneficiaries

(Unit: KRW million)

Category	R&D expenses over two years			
	Beneficiaries	KIBO beneficiaries	KODIT beneficiaries	SBC Beneficiaries
Public funding amount in Year t-1	-0.0259*** (0.00471)			
Revenues in Year t-2	-0.00725*** (0.000890)	-0.00559*** (0.00129)	-0.00869*** (0.00121)	-0.00774*** (0.00161)
Total assets in Year t-2	-0.0104*** (0.00123)	-0.0161*** (0.00174)	-0.0108*** (0.00185)	-0.00775*** (0.00189)
Operating profit in Year t-2	0.0308*** (0.00359)	0.0471*** (0.00516)	0.0130** (0.00660)	0.0311*** (0.00538)
OP-ROA	-0.0488 (0.135)	-0.239 (0.154)	1.053** (0.445)	-0.156 (0.303)

Table 4_Effect of Public Funding on R&D Expenses Among Beneficiaries(continued)

(Unit: KRW million)

Category	R&D expenses over two years			
	Beneficiaries	KIBO beneficiaries	KODIT beneficiaries	SBC Beneficiaries
Average total assets of SMEs in Year t-2	0.0581*** (0.0143)	0.0332* (0.0200)	0.0985*** (0.0208)	0.0261 (0.0311)
Average revenues of SMEs in Year t-2	-0.0137 (0.0165)	-0.0405* (0.0233)	0.0292 (0.0232)	-0.0410 (0.0313)
Average operating profit of SMEs in Year t-2	0.00523 (0.0868)	0.131 (0.115)	-0.0121 (0.136)	-0.182 (0.165)
Average R&D expenses of SMEs in Year t-2	-0.524*** (0.0949)	-0.654*** (0.124)	-0.464*** (0.156)	-0.0518 (0.185)
OP-ROA of SMEs in Year t-2	2.437 (1.963)	3.844 (2.494)	-1.598 (3.356)	10.67** (4.249)
2014	-1.742 (4.636)	-11.41* (6.162)	18.48*** (7.112)	-15.48* (8.547)
2015	-16.10*** (5.881)	-21.99*** (7.922)	2.386 (9.045)	-19.27* (11.49)
KIBO guarantees/loans in Year t-1		-0.0482*** (0.00996)		
KODIT guarantees/loans in Year t-1			0.0184* (0.0105)	
SBC guarantees/loans in Year t-1				-0.0536*** (0.00998)
Constant	90.79* (54.05)	287.0*** (73.54)	-216.0*** (79.94)	236.9** (110.1)
No. of observations	72,527	45,875	25,433	24,364
Determination coefficient	0.010	0.013	0.018	0.011
No. of companies	34,441	22,076	12,946	12,257

Notes: 1. The figures in the parentheses indicate standard errors.
    2. *** $p<0.01$, ** $p<0.05$, * $p<0.1$
Source: Present study, estimated based on the KED (2020), KODIT (2016), KIBO (2016), and SBC (2016) data.

These findings suggest that financial support from KIBO actually reduces the incremental R&D expenses. As this may be counter-intuitive, we then assessed the robustness of the findings by controlling the year of provision and the year of control. When analyzing Year t, the analysis should not be affected by whether the beneficiaries received finances from KIBO in Year t-2. We tested the robustness of our findings by applying variables in Year t-2 to the effect of KIBO finances in Year t, and found that KIBO finances lose their effect, thus confirming the robustness of the findings.

Table 5_Application of Policy Variables in Year t-2 to the Effect of KIBO Finances in Year t

(Unit: KRW million)

Category	Incremental R&D expenses over a year KIBO finances in Year t-2 (counterfactual confirmation)
KIBO finances in Year t-2 (for counterfactual confirmation)	-14.25 (13.07)
Revenues in Year t-1	-0.0110*** (0.000798)
Total assets in Year t-1	-5.02e-05 (0.00108)
Operating profit in Year t-1	0.0258*** (0.00290)
Operating return on assets (OP-ROA) in Year t-1	0.172 (0.179)
Average total assets of SMEs in Year t-1	0.0379** (0.0159)
Average total assets of SMES in Year t-1	0.0129 (0.0191)
Average operating profit of SMEs in Year t-1	-0.348*** (0.0911)
Average R&D expenses of SMEs in Year t-1	-0.651*** (0.109)
OP-ROA of SMEs in Year t-1	3.077 (2.027)
2014	10.78** (4.887)
2015	-26.92*** (6.293)
Constant	78.59 (55.34)
No. of observations	70,851
No. of companies	38,786
Determination coefficient	0.011

Notes: 1. The figures in the parentheses indicate standard errors.
      2. *** $p<0.01$, ** $p<0.05$, * $p<0.1$
Source: Present study, estimated based on the KED (2020) and KIBO (2016) data.

2. Effect of R&D Expense Growth on SME Performance

This section analyzes the effect of R&D expense growth on SMEs' performance without considering the relevant policies. To be specific, we used the fixed effect panel model to analyze the effect of R&D expense growth on the revenues, total assets, operating profit, and

OP-ROA of SMEs. As the effect of R&D projects takes time to manifest, we focused on the effect on Years t-2 and t-3.

The following shows the equation used to estimate the policy effect over a two-year period.

$$\triangle y_{i,t2} = \alpha + \beta P_{i,t-1} + x_{i,t-2}\gamma + I_{i,t-2}\delta + \nu_i + v_t + \varepsilon_{i,t}$$

$\triangle y_{i,t2}$: Changes in performance indicators of Firm i from Year t-2 to Year t

$P_{i,t-1}$: Amount of R&D expense of Firm i in Year t-1

$x_{i,t-2}$: Characteristics of Firm i in Year t-2

$I_{i,t-2}$: Characteristics of the industry where Firm belongs to in Year t-2

ν_i : Fixed firm effect

v_t : Fixed time effect

The estimates are summarized in Table 6. We were not able to confirm that, when an SME increases its R&D expenses, there is corresponding revenue growth after two years. However, the SMEs that expanded their R&D expenses in Year t-1 reported a significant growth of total assets between Year t-2 and Year t. Overall, a KRW 1 million increase in R&D expenses led to a KRW 0.14 million increase in total assets.

On the other hand, operating profit declined between Year t-2 and Year t among the SMEs that expanded their R&D expenses in Year t-1. During this period, their operating profit declined by KRW 0.16 million per KRW 1 million growth in R&D expenses. The same SMEs also reported a decline in OP-ROA in the same two-year period; the OP-ROA declined by 1%p per KRW 1 billion increase in R&D expenses.

Table 6_Overall Effect of R&D Expenses Over Two Years

(Unit: KRW million)

	(1) Revenues	(2) Total assets	(3) Operating profit	(4) OP-ROA
R&D expenses in Year t-1	0.0371 (0.0599)	0.141*** (0.0408)	-0.157*** (0.0178)	-0.00101*** (0.000374)
Total assets in Year t-2	-0.478*** (0.00777)		-0.0395*** (0.00247)	0.000102** (5.18e-05)
Operating profit in Year t-2	-1.531*** (0.0204)	0.0883*** (0.0152)		-0.00680*** (0.000136)
OP-ROA in Year t-2	-1.478* (0.832)	2.392*** (0.568)	-9.160*** (0.242)	

Table 6_Overall Effect of R&D Expenses Over Two Years(continued)

(Unit: KRW million)

	(1) Revenues	(2) Total assets	(3) Operating profit	(4) OP-ROA
Operating return on assets ratio of SMEs in Year t-2	0.351*** (0.0923)	-0.110* (0.0629)	-0.0873*** (0.0275)	0.000876 (0.000578)
Average revenues of SMEs in Year t-2	-0.712*** (0.118)	0.237*** (0.0803)	0.0847** (0.0351)	-0.00223*** (0.000736)
Average operating profit of SMEs in Year t-2	0.684 (0.626)	-0.787* (0.427)	-0.961*** (0.186)	0.0123*** (0.00392)
Average R&D expenses of SMEs in Year t-2	-1.079 (0.688)	-1.629*** (0.469)	0.218 (0.205)	-0.00182 (0.00430)
OP-ROA of SMEs in Year t-2	1.227 (14.70)	14.61 (10.03)	9.896** (4.382)	-0.347*** (0.0920)
2014	-29.02 (35.09)	89.13*** (23.86)	47.18*** (10.46)	-1.514*** (0.220)
2015	-114.6*** (44.21)	19.99 (29.86)	124.5*** (13.17)	-2.007*** (0.277)
Revenues in Year t-2		-0.187*** (0.00389)	-0.124*** (0.00167)	-0.000157*** (3.81e-05)
Constant	5,307*** (380.5)	1,822*** (259.0)	1,079*** (113.4)	9.793*** (2.381)
No. of observations	138,428	138,428	138,428	138,417
Determination coefficient	0.150	0.037	0.131	0.047
No. of companies	68,623	68,623	68,623	68,615

Notes: 1. The figures in the parentheses indicate standard errors.
　　　 2. *** p<0.01, ** p<0.05, * p<0.1
Source: Present study, estimated based on the KED (2020), KODIT (2016), KIBO (2016), and SBC (2016) data.

The following shows the equation used to estimate the policy effect over a three-year period

$$\triangle y_{i,t3} = \alpha + \beta P_{i,t-2} + x_{i,t-3}\gamma + I_{i,t-3}\delta + \nu_i + v_t + \varepsilon_{i,t}$$

$\triangle y_{i,t3}$: Changes in performance indicators of Firm i from Year t-2 to Year t

$P_{i,t-2}$: Amount of R&D expense of Firm i in Year t-2

$x_{i,t-3}$: Characteristics of Firm i in Year t-3

$I_{i,t-3}$: Characteristics of the industry where Firm belongs to in Year t-3

ν_i : Fixed firm effect

v_t : Fixed time effect

Table 7_Overall Effect of R&D Expenses Over Three Years

(Unit: KRW million)

	(1) Revenues	(2) Total assets	(3) Operating profit	(4) OP-ROA
R&D expenses in Year t-2	-0.0686 (0.0862)	-0.165*** (0.0613)	-0.114*** (0.0260)	-0.000583 (0.000517)
Total assets in Year t-3	-0.425*** (0.0124)		-0.0360*** (0.00389)	0.000201*** (7.76e-05)
Operating profit in Year t-3	-1.660*** (0.0311)	-0.0955*** (0.0241)		-0.00656*** (0.000198)
OP-ROA in Year t-3	0.872 (1.226)	3.625*** (0.873)	-7.882*** (0.360)	
L3.Average total assets of SMEs	0.256* (0.153)	-0.284*** (0.109)	-0.173*** (0.0462)	0.000661 (0.000920)
L3.Average total assets of SMES	-0.834*** (0.183)	0.347*** (0.130)	0.139** (0.0552)	-0.00120 (0.00110)
L3.Average operating profit of SMEs	1.070 (0.844)	1.257** (0.601)	-1.264*** (0.254)	0.000255 (0.00506)
L3.Average R&D expenses of SMEs	-0.970 (1.038)	-1.274* (0.739)	0.137 (0.313)	-0.00367 (0.00622)
L3.OP-ROA of SMEs	-16.83 (22.36)	-10.75 (15.91)	3.394 (6.733)	-0.0863 (0.134)
2015.Year	-197.7*** (40.08)	-36.47 (28.36)	70.86*** (12.07)	-0.909*** (0.240)
L3.Revenues		-0.161*** (0.00618)	-0.121*** (0.00250)	-0.000125** (5.42e-05)
Constant	6,326*** (621.8)	2,235*** (440.6)	1,282*** (187.3)	5.457 (3.729)
No. of observations	79,870	79,870	79,870	79,868
Determination coefficient	0.148	0.033	0.116	0.046
No. of companies	49,509	49,509	49,509	49,507

Notes: 1. The figures in the parentheses indicate standard errors.
      2. *** $p<0.01$, ** $p<0.05$, * $p<0.1$
Source: Present study, estimated based on the KED (2020), KODIT (2016), KIBO (2016), and SBC (2016) data.

3. Ultimate Effect of Public Funding on OP-ROA

This section examines the ultimate effect of public funding on the OP-ROA. The estimates are summarized in Table 8. SMEs that received financial support from KIBO, KODIT, and SBC were found to report a significant decline in the OP-ROA over two years, relative to non-beneficiaries. In other words, the public funding from the three funds are not aligned with the goal of promoting moonshot R&D projects.

Table 8_Effect of Public Funding on OP-ROA Over Two Years

(Unit: KRW million)

	Effect on ROA over two years			
	Policy loan	KIBO subsidies	KODIT subsidies	SBC subsidies
Policy-based guarantees/loans in Year t-1	-2.715*** (0.219)			
Revenues in Year t-2	-0.000423*** (2.17e-05)	-0.000420*** (3.19e-05)	-0.000446*** (2.23e-05)	-0.000397*** (3.02e-05)
Total assets in Year t-2	0.000242*** (2.99e-05)	0.000157*** (3.89e-05)	0.000224*** (3.08e-05)	0.000156*** (3.63e-05)
Operating profit in Year t-2	-0.00721*** (8.33e-05)	-0.00645*** (0.000108)	-0.00655*** (8.65e-05)	-0.00574*** (9.85e-05)
Operating return on assets ratio of SMEs in Year t-2	0.000321 (0.000214)	4.77e-05 (0.000277)	0.000285 (0.000211)	-0.000194 (0.000264)
Average total revenues of SMEs in Year t-2	-0.000867*** (0.000323)	-0.00106** (0.000482)	-0.000672** (0.000331)	-0.000577 (0.000467)
Average operating profit of SMEs in Year t-2	0.00402** (0.00191)	0.00366 (0.00261)	0.00236 (0.00201)	0.00269 (0.00257)
Average R&D expenses of SMEs in Year t-2	0.00318* (0.00179)	0.00468* (0.00253)	0.00453** (0.00185)	0.00295 (0.00250)
OP-ROA of SMEs in Year t-2	-0.355*** (0.0498)	-0.374*** (0.0702)	-0.253*** (0.0541)	-0.276*** (0.0735)
2014	-0.737*** (0.106)	-1.202*** (0.164)	-0.594*** (0.114)	-1.100*** (0.169)
2015	-1.341*** (0.131)	-1.893*** (0.203)	-1.072*** (0.140)	-1.724*** (0.207)
KIBO guarantees/loans in Year t-1		-2.561*** (0.457)		
KODIT guarantees/loans in Year t-1			-2.866*** (0.263)	
SBC guarantees/loans in Year t-1				-2.108*** (0.591)
Constant	8.623*** (1.107)	9.826*** (1.599)	7.035*** (1.152)	8.310*** (1.588)
No. of observations	598,352	379,274	484,149	327,043
Determination coefficient	0.032	0.027	0.033	0.031
No. of companies	274,780	192,741	234,920	174,901

Notes: 1. The figures in the parentheses indicate standard errors.
       2. *** $p<0.01$, ** $p<0.05$, * $p<0.1$
Source: Present study, estimated based on the KED (2020), KODIT (2016), KIBO (2016), and SBC (2016) data.

These findings are deeply worrisome, and suggest that there is a considerable need to reconsider the performance management systems of the institutions. The following table summarizes the items considered for fund performance evaluation at KIBO.

Table 9_Summary of KIBO Fund Performance Evaluation

Category	Item	Non-quantitative		Quantitative	
		Weight	Rating	Weight	Points
Business management	1. Management strategy and social contribution				
	(1) Strategy planning and social responsibilities	5	B$^+$		
	(2) Management innovation	3	B$^+$		
	(3) Public evaluation			2	1.926
	(4) Open innovation			1.5	1.335
	(5) Management information disclosure			1.5	1.500
	(6) Government-recommended policies			6	5.543
	2. Work efficiency				
	(1) Project efficiency			1	1.000
	(2) Work efficiency			1	1.000
	3. Organization and human resource management	4	B^0		
	4. Financial and budget management				
	(1) Budget management (management expenses)	3	B$^+$		
	(2) Self-support performance	2	B^0		
	(3) Debt reduction progress			1	1.000
	(4) medium and long-term fiscal management plan			1	0.906
	(5) Fund management and performance			5	3.647
	5. Remunerations and welfare management				
	(1) Remunerations and welfare	6	B^0		
	(2) Labor cost management			3	3.000
	(3) Employer-worker relationship	4	B$^+$		
Key Businesses	1. Technology finance				
	(1) Job creation at tech firms			10	10.000
	(2) Contribution to overcoming death valley			7	7.000
	(3) Accident rate management at guaranteed firms			4	3.158
	(4) Appropriate performance management of technology finance projects	12	B^0		
	2. Technology evaluation projects				
	(1) Performance of patent commercialization through IP and R&D evaluation			7	6.407
	(2) Appropriate performance management of technology evaluation projects	4	C		
	3. Reimbursement right management				
	(1) Support for recovery of failed SMEs and reimbursement right			4	4.000
	(2) Appropriate performance management of reimbursement right management projects	2	D^0		
	Total of business management and key projects	45		55	

Source: MOEF (2018), p. 326

One of the noteworthy items in the list is the "(3) Accident rate management of guaranteed firms" in the technology finance category. This item pertains to a possible default by SMEs. This item promotes safe R&D projects rather than supporting moonshot R&D projects. Granted, though removing the item would not promote moonshot R&D projects at firms, it would be reasonable to conclude that the existence of the item hinders the promotion of moonshot R&D projects.

Table 10 presents a simple comparison of the average R&D expenses and standard deviation between beneficiaries in Year t-1 and non-beneficiaries. Even though it is a simple comparison, the beneficiaries report a much lower standard deviation in R&D expenses than the non-beneficiaries. The behaviors suggested by these findings are far from those of moonshot investments.
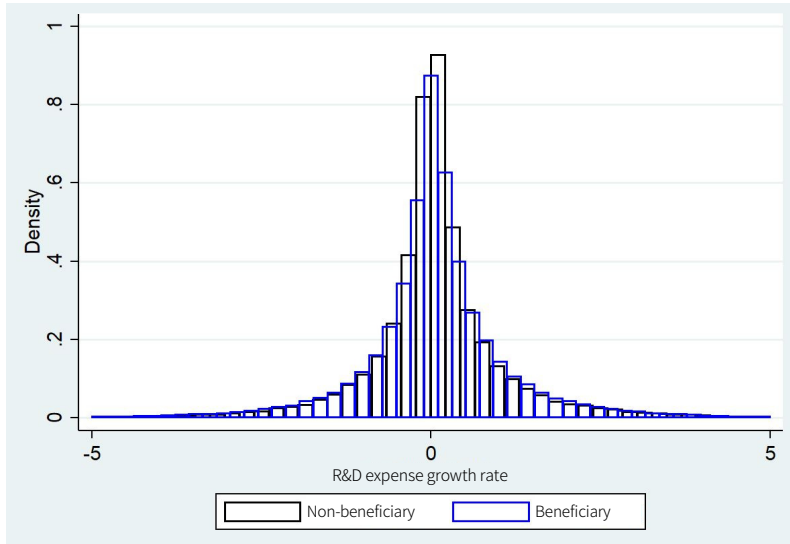
Table 10_Public Funding, Means, and Deviations

(Unit: KRW million)

Year	Beneficiary in Year t-1	Mean R&D expense	R&D expense deviation
2012	○	211.91	467.29
	×	222.86	733.11
2013	○	206.91	446.47
	×	211.26	613.25
2014	○	189.01	435.62
	×	190.16	623.15
2015	○	161.40	396.61
	×	158.03	564.46

Source: Present study, estimated based on the KED (2020), KODIT (2016), KIBO (2016), and SBC (2016) data.

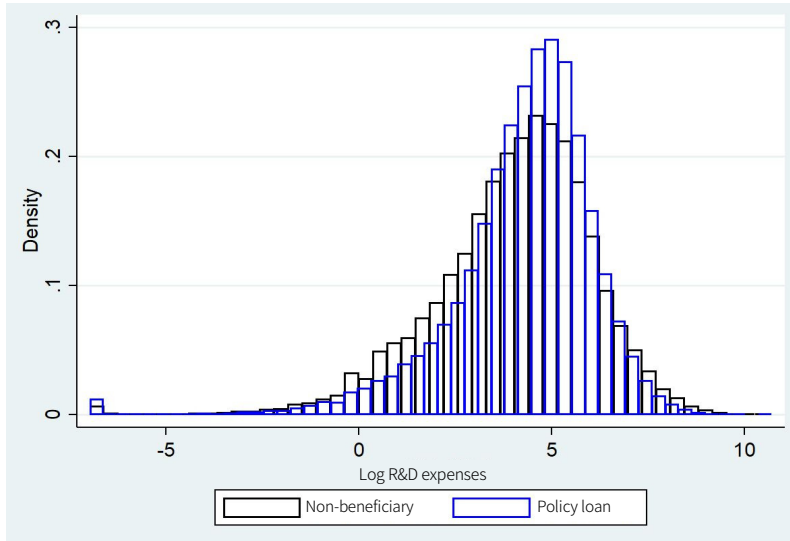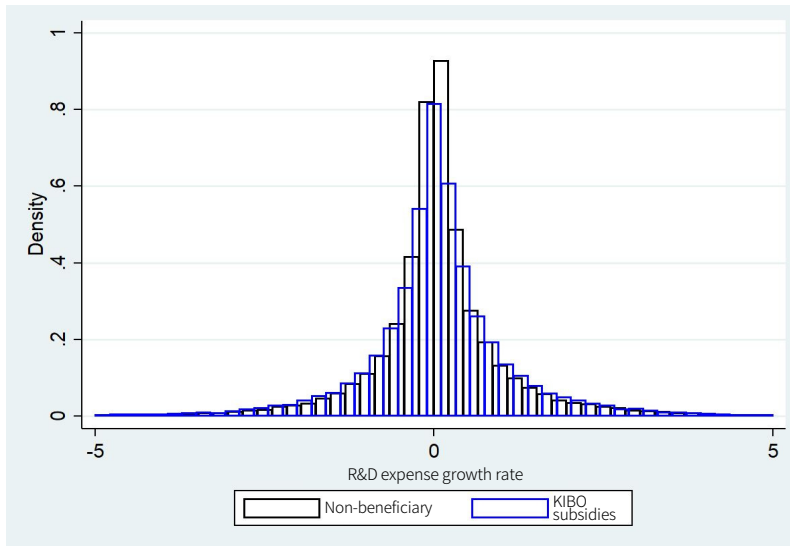**Figure 1_Public Funding and Distribution of R&D Expense Growth Rate**

(Unit: KRW million)

Source: Present study, estimated based on the KED (2020), KODIT (2016), KIBO (2016), and SBC (2016) data.

Figure 2_Public Funding and Distribution of R&D Expense Growth Rate

(Unit: KRW million)

Source: Present study, estimated based on the KED (2020), KODIT (2016), KIBO (2016), and SBC (2016) data.

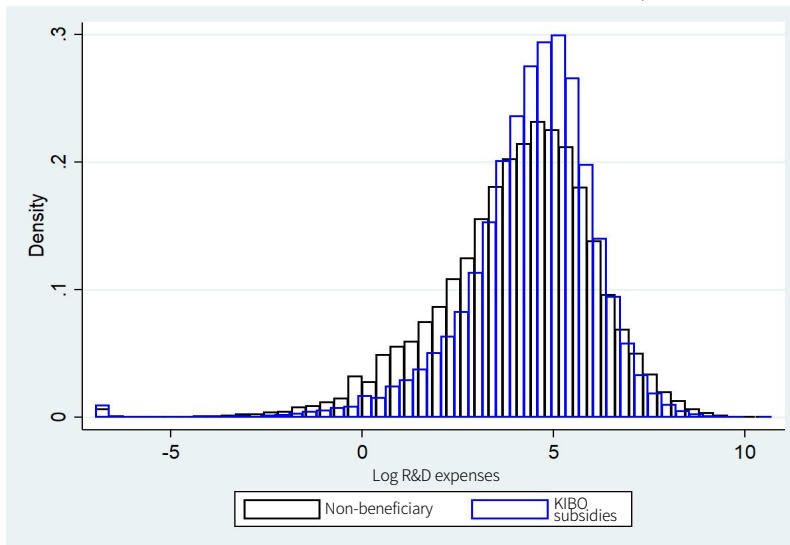**Figure 3_KIBO Public Funding and Distribution of R&D Expense Growth Rate**

(Unit: KRW million)

Source: Present study, estimated based on the KED (2020) and KIBO (2016) data.

Figure 4_KIBO Finance and Distribution of R&D Expense Growth Rate

(Unit: KRW million)

Source: Present study, estimated based on the KED (2020) and KIBO (2016) data.

4. Chapter Conclusion

The findings of the empirical analysis indicate that the government's public funding for SMEs produced outcomes that are far from the purpose of increasing R&D expenses at firms. Public funding provided by KIBO were found to have a particularly negative effect, and thus require further research. These findings may actually indicate that the firms increased their R&D expenses before being selected for KIBO finances and reduced them later; more worrisome, it may even indicate moral hazards among the beneficiaries.

The OP-ROAs of beneficiaries were found to be lower than other similar firms, which suggests that there is a low likelihood that the beneficiaries are engaged in moonshot R&D projects. On the other hand, public procurement supports did not produce the side effects caused by public funding, which seems to indicate that the former exerts a greater effect on R&D and profitability.

In addition, we also confirmed that the R&D expense growth between 2011 and 2015 did not greatly improve the business performance of SMEs. Particularly worrisome are the findings that SMEs with larger R&D expenses reported a lower profitability.

According to the theoretical analysis in Chapter III, KIBO and other public funding institutions are typical principals in the public sector. However, these institutions cannot readily reduce the amount of support because their budget is pre-determined based on political reasons or the issue of unspent budgets. They also apply upper limits to rewards for high performance. The rewards available for the institutions are restricted to lowering policy finance interest rates below the market rates, even for firms with highly successful R&D projects. As such, it should also be noted that the findings of the empirical analysis in this study may be the result of the principals encouraging safe R&D projects, rather than moonshot projects. This study theoretically confirmed that, without the intervention from the public sector, firms may have more actively engaged in moonshot R&D projects.

Based on these findings, the conclusion of this chapter can be summarized as follows. First, we need innovative measures to help SMEs achieve outcomes through their R&D projects. We need to encourage SMEs to launch moonshot R&D projects, as promoting such projects will improve the overall productivity of those firms. To that end, we need to mitigate the nature of public funding institutions as public principals.

In other words, we need to enact institutional reforms in order to allow these institutions to flexibly reduce support for firms with low performance, rather than simply providing support from a pre-determined budget. Reforms are also required to flexibly provide additional incentives to high-performing R&D firms. With regard to performance evaluation

at the institutions, items encouraging safer R&D projects need to be removed from the performance evaluation, such as the accident rate of guaranteed firms.

In particular, we need to identify factors that hinder R&D outcomes. As conventional methods are not working as intended, it is high time that we advanced our policies further.

Ⅴ. Policy Suggestions

The findings in the previous chapters confirm that promoting moonshot R&D projects requires providing sufficient rewards for good outcomes, rather than merely tolerating failures. As many researchers have pointed out, we need to pay attention to the failure rate of R&D projects, as a low failure rate may be circumstantial evidence that the firms did not carry out moonshot R&D projects. However, the failure rate alone is not a suitable performance indicator for the purpose of policy management. In a situation in which information asymmetry exists, a failure of an individual R&D project may be the result of a moral hazard. Therefore, a high failure rate does not necessarily promote moonshot R&D projects.

As these theoretical findings indicate, when a commissioner guarantees a certain level of rewards even if the project fails, as many policies do these days, it may result in both the researcher and the commissioner choosing safer projects over moonshot projects. As such, a high failure rate cannot be equated to moonshot R&D efforts; i.e., the failure rate is not a suitable performance indicator for the purpose of policy management.

It is important to note that this study theoretically confirmed that moonshot R&D projects cannot be promoted without sufficient rewards for high performance. As such, we need to further review the performance management systems and other mechanisms that affect the behaviors of ministries and researchers, to evaluate the management of high performance firms in the medium and long term, and to address any shortcomings identified. Caution is required when providing rewards for high performance firms, because rewards need to be varied depending on the type and stage of the research project.

The empirical analysis in this study found that public funding may actually encourage SMEs to reduce their investments in R&D expenses, which ultimately undermines the profitability of the firm. Overall, these findings are not aligned with moonshot R&D projects, as they should result in improved average profitability, even with high deviations.

This study also confirmed that many of the evaluation items used by KIBO promote safer choices. As such, we propose the need for shifting the focus of evaluation items at ministries and funds to rewards for high performance, in order to encourage moonshot R&D projects.

Promoting moonshot R&D projects requires multi-faceted efforts. One of the most pressing requirements is the improvement of performance management systems at the government level. If the government aims for a stable implementation of its policies, it would not be able to promote moonshot R&D projects. The government needs to review evaluation items so that they include items that promote R&D projects having a high average performance, despite the potential for high deviations, or to at least remove the items that discourage moonshot R&D projects.

The government also needs to enhance rewards for high performance. First, R&D projects for fundamental technologies require more time to complete, get recognition, and produce widespread effects. For these types of projects, it would be helpful to provide large-scale public incentives in the long term. The science community is already aware of a best practice case where fundamental R&D projects were encouraged through long-term investment: the Nobel Prize. Even though not planned by a government, the Nobel Prize is operated by a foundation that was established in order to promote public interest. The Nobel Committees do not review whether an applicant's project is challenging enough. Nor do they manage the failure rates of the relevant projects. They successfully fulfill their purposes by directly providing monetary rewards. Today, the direct rewards are accompanied by the honor as a Nobel Laureate, in addition to various indirect rewards.

To propose a number of specific measures regarding fundamental research projects, the government and public interest foundations can set up R&D-related reward programs that could be placed between typical reward programs and the Nobel Prize. The government may as well encourage such programs across different levels of ministries, policies, and institutions, as a higher number of such programs mean more incentives for researchers.

As for applied R&D projects, while still providing monetary rewards or honors, the support for these projects should extend to the commercialization phase, to institutionally ensure that the profits from commercialization are shared. Patent protection requires further research, as it may only increase the number of patents not suitable for commercialization. A viable option is to backtrack R&D projects that successfully commercialized patents in order to identify and compensate researchers who contributed to the success.

Lastly, the need for institutional improvement seems to be lower for the commercialization stage, because successfully commercialized R&D projects are protected by patent rights and other intellectual property rights, to a large extent. However, the performance management systems of government institutions play a more crucial role during the commercialization stage of individual firms. As discussed above, rather than using indicators that may promote

safer projects in order to avoid failures, the government needs to evaluate institutions and funds that provide public funding with indicators that promote moonshot R&D projects in the commercialization stage. Such indicators include: the number of firms that grew into large- or middle-sized firms; and the number of firms that achieved exceptionally high productivity and profitability through the success of their R&D projects.

Another issue that needs to be considered when providing rewards for high performance firms is the need to set up different reward systems in the short, medium, and long term. Some R&D projects may produce outcomes in the short term. However, it would be more common for an R&D project to produce outcomes in the medium or long term. Therefore, sufficient rewards for high performance cannot be provided based solely on short-term evaluations. Short-term evaluations should be accompanied by long-term evaluations (medium term: 3~5 years; long term: 5 years or longer) in order to mitigate the concerns that performance-based evaluations only recognize short-term successes and subsequently discourage R&D projects requiring an analysis of long-term effects.

VI. Conclusions

Korea has achieved stellar economic growth over the last six decades. The country's success has been contributed to by the various technological achievements of its researchers and industries that are on par with any other part of the world. In the early years of economic growth, in which the private sector still lacked competence, the government's public support must have been effective in promoting technology development, even though an empirical analysis is limited by a lack of microdata. Nevertheless, Korea's high global ranking in terms of national investments in technology development is a positive signal for Korea.

However, Korea has not secured global competitiveness in all R&D areas. In particular, it has been repeatedly pointed out that Korea has a large room for improvement in fundamental sciences and source technologies. There have been also controversies pertaining to whether the current investments have achieved outcomes commensurate to the size of financial resources committed.

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A Study on the Relationship between Social Value and Financial Performance of Public Institutions

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I. Introduction

Public institutions are established to pursue public interests. They also need to consider their overall efficiency and profitability in order to maintain their operations. As such, public interests and profitability go hand-in-hand in the operation of public institutions. However, their relative significance may change depending on the specific policy direction that the government takes. The Moon Jae-in administration has put more emphasis on the pursuit of public interests by public institutions, as reflected in Task 12 of the 100 policy tasks put forward by the administration: to restructure public entities to take the lead in realizing social values. The administration has been actively implementing the policy task, and emphasizes social values in the operation of the government and public institutions. To further encourage the pursuit of social values by public institutions, the administration has added social value-related items to management performance evaluation of government projects and public institutions, and greatly increased the points ascribed to the related items.

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These efforts have resulted in visible outcomes, including an increase in new recruits, employees in temporary positions being upgraded to permanent positions, and other achievements in the safety and environment sectors.[1] However, the emphasis on social values have generated widespread concerns, including possible conflict between the pursuit of social values and the financial performance and efficiency of public institutions. In fact, after the government increased the relative importance of social values in management performance evaluations, Korean public institutions are showing signs that they may be less interested in increasing their financial performance and efficiency than they had in the past. The financial performance data of public institutions indicate an increase in liabilities coupled with a decrease in profits. In addition, the increase in new recruit and the upgrading of temporary positions to permanent positions have rapidly scaled up the total staff size of public institutions, which raised concerns about a possible increase in labor costs and the undermining of staff efficiency.

The purpose of this study is to analyze how public institutions are affected by changes in public institution management policies. Specifically, this study examines how changes in the relative emphasis on public interests and profitability affect the financial performance of public institutions. To that end, this study conducts various analyses on public institutions designated under the Act on the Management of Public Institutions.

In this study, we first examine the current status of social value realization policies pursued by the government, and changes in government policies reflected in public institution management performance evaluations. Second, we analyze the financial performance of public institutions in recent years in order to determine the scale and direction of changes in financial performance. Third, we empirically analyze the effect of social value activities at public institutions on their management performance. Fourth, we examine the experiences of key public institutions to understand how the pursuit of social values changed those institutions. Then, building on the findings from the analyses, we present our conclusions regarding the relationship between the pursuit of social values at public institutions and their financial performance, and subsequently propose ways to improve social value practices.

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[1] As of the end of 2019, the pursuit of social values by public institutions has led to an increase in public institution jobs (by 34,000 between 2017 and 2019), a decrease in workplace fatalities among public institution employees (from 59 in 2017 to 37 in 2019), and improvement in public institution integrity scores (from 8.29 in 2017 to 8.46 in 2019, according to the Anti-Corruption and Civil Rights Commission), and an increase in employees with disabilities at public institutions (2.9% in 2017 to 3.2% in 2019). Ministry of Economy and Finance, Strategy for Realization of Social Value by Public Institutions, press release, July 21, 2020.

II. Pursuit of Social Values by Public Institutions

The Moon Jae-in administration decided to fully integrate the pursuit of social values by public institutions in its policy tasks. This emphasis on social values is driven by the administration's understanding that the Korean public sector remains seriously lacking in the pursuit of public interests. According to the administration, Korean public institutions should be managed in accordance with the new public management (NPM) theory and, as a result, public institutions have focused on increasing their profitability, which has undermined their alignment with public interests.[2] Evaluations of public institutions also focused on economic feasibility, efficiency, and effectiveness, which drove institutions to engage in excessive profit-seeking behaviors and increase the percentage of temporary positions in their workforce. To overcome these perceived problems, the Moon Jae-in administration has been actively encouraging the pursuit of social values in the public sector. As mentioned above, the government included "to restructure public entities to take the lead in realizing social values" in its 100 policy tasks, and promoted the pursuit of social values as one of its key programs for the public sector.

The definition of "social values" promoted by the current administration has expanded the concept of social responsibility (SR). The government defines social values as being based on the concepts and elements of social values discussed in previous studies; we define social values as "values with potential contribution to public interests and the sustainable growth of the community across all areas including society, economy, environment, and culture."[3] Social values represent "non-monetary values" not captured by monetary values (Lee and La, 2010). They contribute to the advancement of public interests and communities (Yoon et al., 2017). The two concepts seem similar, and overlap in many areas. The government recognizes 13 priority areas where the Korean society should pursue social values: human rights, safety, welfare, labor, social integration, shared growth, jobs, local communities, local economies, corporate social responsibility (CSR), environment, participation, and communities.

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[2] Relevant Ministries, Press Release, "Implementation Strategy for Realization of Social Value by Public Institutions," January 15, 2020.

[3] Relevant Ministries, Press Release, "Implementation Strategy for Realization of Social Value by Public Institutions," January 15, 2020.

Table 1_Social Values and their Specific Meanings

Social value	Meaning
Protect human rights as basic rights for maintaining human dignity	Protect fundamental rights recognized by the Constitution, including pursuit of happiness, equality, right to knowledge, freedom of occupation, and stable residential life
Keep working and living environments safe from disasters and accidents	Take active measures to keep the public safe from issues not addressed by market-based solutions
Provide health welfare services for healthier living	Demand the government to provide public health and healthcare services that allow the people to lead healthy lives with dignity
Protect labor rights and improve working conditions	Protect the right to work for livelihood and the three major labor rights, maintain stable working conditions, and provide job security
Provide opportunities to the socially disadvantaged and pursue social integration	Implement social security policies to ensure that women, the elderly, youths, people with disabilities, and others who lack means of livelihood
Pursue shared growth and cooperation between large and small businesses	Adopt regulations and adjustments to prevent the abuse of market dominance and economic power, and democratize the economy by promoting harmony among economic actors
Create quality jobs so that workers can live with dignity	Create jobs in both public and private sectors, encourage job-sharing by reducing work weeks, and increase quality jobs and reduce temporary positions
Revitalize local communities and restore communities	Promote local autonomy and decentralization on the local community level
Contribute to local economy to ensure that economic activities benefit local communities	Revitalize local economies for balanced growth, and address the adverse effects of overpopulation of the Seoul Capital Area
Encourage businesses to fulfill social responsibilities including ethical production and distribution	Encourage businesses to fulfill their responsibilities as members of the society Promote human rights, labor rights, environment, consumer protection, contribution to local communities, and good governance
Maintain environmental sustainability	Fulfill the state's obligation to protect people's right to live in a pleasant environment
Achieve democratic decision making and participation based on citizens rights	Improve government practices, develop mechanisms to promote participation, and increase the level of participation, so as to build a nation based on popular sovereignty
Realize the interest of the community and enhance the pursuit of public interests	Restore communities disrupted by economic polarization, and support and foster the 'third sector'

Source: Relevant Ministries, Press Release, "Implementation Strategy for Realization of Social Value by Public Institutions," January 15, 2020.

To encourage public institutions to pursue social values, the government enhanced social value-related items in the management performance evaluation of public institutions. Management performance evaluations are one of the key policy instruments for the government's supervision of public institutions. The government annually evaluates the management performance of all public corporations and quasi-governmental institution under the Act on the Management of Public Institutions, and takes various actions depending on evaluation results ranging from incentives to recommendation of dismissal of the CEO.

In fact, previous administrations have also considered social value-related indicators in their management performance evaluations. The implementation of government-recommended policies was considered in the 2010 evaluation (2 points). It was joined by social contributions

(2 points), and points for the implementation of government-recommended policies went up (to 5 points). Starting in 2015, the government also considered strategic planning and social responsibilities (2 points) and implementation of government-recommended policies (5 points) as items related to social values. In 2017, after the adoption of social value realization

Table 2_ Point Allocation for Social Value-Related Items in Public Institution Management Performance Evaluation and Item Descriptions

(unit: points)

Social value realization	Points		Description	Quantitative items
	2018 (22)	2019 (24)		
Job creation	7	7	· Upgrading of temporary positions to permanent positions; employment of unemployed young adults; performance regarding the permanent part-time work system · Job creation (including private sector jobs); efforts to improve employment quality and their outcomes	· Upgrading of temporary positions to permanent positions · Employment of unemployed young adults · Performance regarding the permanent part-time work system
Equitable opportunities and pursuit of social integration	4	4	· Efforts for social integration and their outcomes, including employment and protection of socially disadvantaged workers · Efforts for equitable use of workforce and provision of equitable opportunities, and their outcomes	· Mandatory employment of people with disabilities · Priority employment of people of national merits · Compliance with the guidelines on the protection of outsourced workers
Safety and environment	3	5	· Performance regarding safer working environments and environmental sustainability · Efforts to keep working and living environments safe from disasters and accidents and their outcomes	· Greenhouse gas reduction and energy saving · Purchase of green products
Shared growth, cooperation and local growth	5	5	· Performance regarding promotion of local economies, and cooperation and shared growth with SMEs and social enterprises · Performance regarding promotion of local economies and communities, and cooperation and shared growth with SMEs and micro enterprises	· Purchase of SME products · Purchase of products employing technologies developed in Korea · Purchase of products from woman-owned businesses · Purchase of products from social enterprises and cooperatives · Purchase of products made by people with disabilities · Purchase of products made by people of national merits · Purchase of Onnuri Gift Certificates (for traditional markets) · Early budget execution
Ethical management	3	3	· Efforts to comply with economic and legal responsibilities and socially expected ethical responsibilities in their management activities, and their outcomes · Improvement in work efficiency	

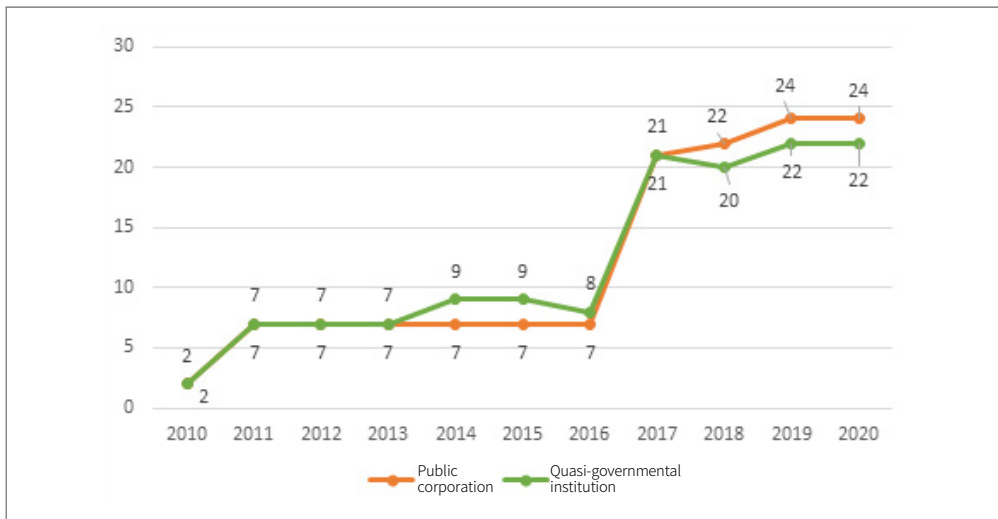Note: 1. based on the 2018 evaluation of public corporations
     2. Numbers in ( ) represent aggregate points.
Source: Present study, based on Ministry of Economy and Finance, *Public Institution Management Performance Evaluation Report,* 2018~2019.

as a government task, the government increased the points for strategic planning and social responsibilities (5 points) and the implementation of government-recommended policies (6 points), and added an item for job creation (10 points). The 2018 evaluation adopted the "realization of social values" item in the business management category as a 22-point item for public corporations, and a 20-point item for quasi-government institutions. The evaluation items did not change in 2019. However, the points assigned to the "realization of social values" item increased to 24 points for public corporations, and 22 point for quasi-governmental institutions.

Figure 1_Point Allocations for Social Value-Related Items in Management Performance Evaluation of Public Institutions
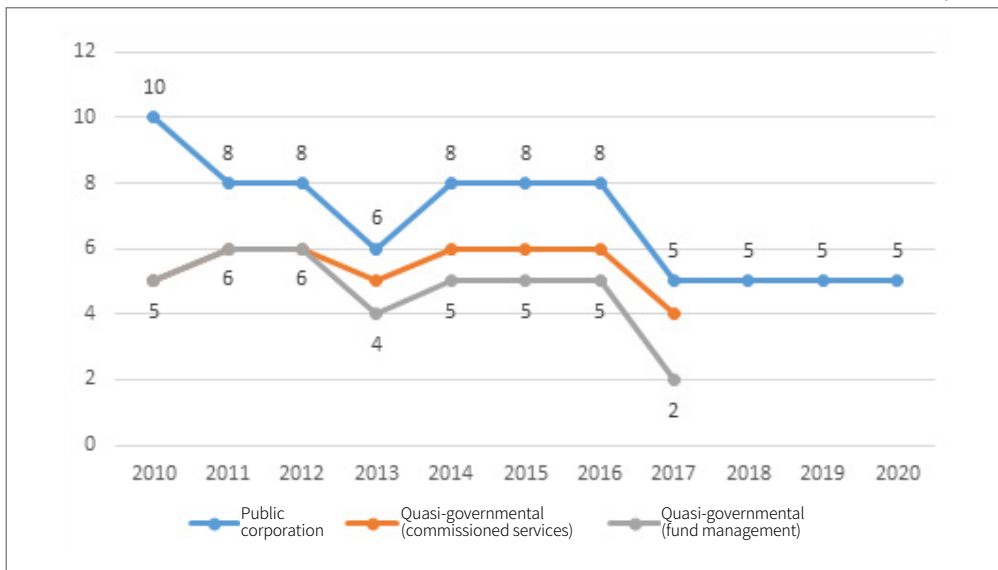
(unit: points)

Note: The 2018 and 2019 points only include the points assigned to realization of social values. The points in 2017 and earlier include the points for all related items (social contribution, social responsibilities, and implementation of government-recommended policies)

Source: Present study, based on Ministry of Economy and Finance, *Public Institution Management Performance Evaluation Handbook,* 2010~2020.

The increased points for social value-related items, however, meant fewer points for items in the other categories. Items related to work efficiency and financial performance were hit especially hard, as indicated in the figure below. The work efficiency of public corporations was assigned 10 points in 2010. The points were reduced to 8 in 2011, and 5 in 2017. For quasi-governmental institutions, the same item was assigned 5 points in 2010. The points did not change until it declined to 4 points for quasi-governmental institutions carrying out

commissioned services, and 2 points for quasi-governmental institutions tasked with fund management. The decreased points for these items signaled a decline in the importance of work efficiency, as measured by capital and labor productivity. The items no longer held significance for quasi-governmental institutions. Financial performance was a 10-point item in 2010. In 2014, the government's emphasis on debt management at public corporations drove the increase in points assigned to the item: 20 points for quasi-governmental institutions tasked with fund management, 18 points for quasi-governmental institutions carrying out commissioned services, and 17 points for public corporations. However, in 2017, the points once again were cut back to 7 for quasi-governmental institutions tasked with fund management, 5 for public corporations, and 2 for quasi-governmental institutions carrying out commissioned services.

Figure 2_Point Allocations for Work Efficiency-Related Items in Management Performance Evaluation of Public Institutions
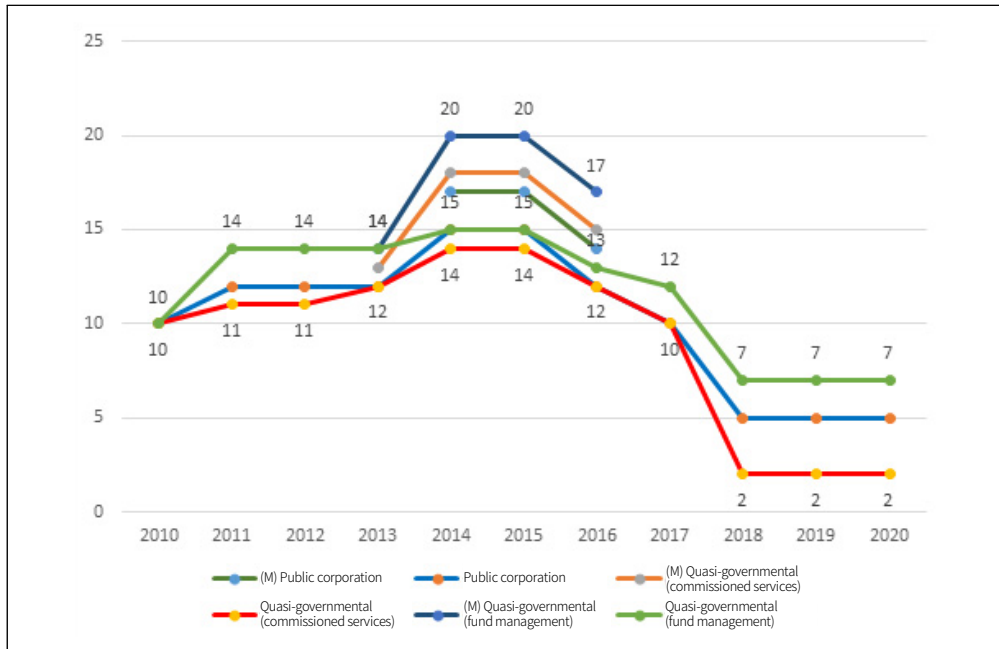
(unit: points)

Source: Present study, based on Ministry of Economy and Finance, *Public Institution Management Evaluation Handbook,* 2010~2020.

Figure 3_Point Allocations to Financial Performance-Related Items in Management Performance Evaluation of Public Institutions

(unit: points)

Note: (M) indicates an institution required to submit medium and long-term financial management plans.
Source: Present study, based on Ministry of Economy and Finance, *Public Institution Management Performance Evaluation Handbook,* 2010~2020.

To summarize, the current administration significantly increased the points assigned to social value-related items in the management performance evaluation of public institutions. However, items related to the work efficiency and financial performance suffered drastic cutbacks.

These changes are closely aligned with the direction of the current administration's public institution policies, as well as its understanding that management performance evaluations that focused on efficiency and profitability led to a relative indifference to the pursuit of social values.

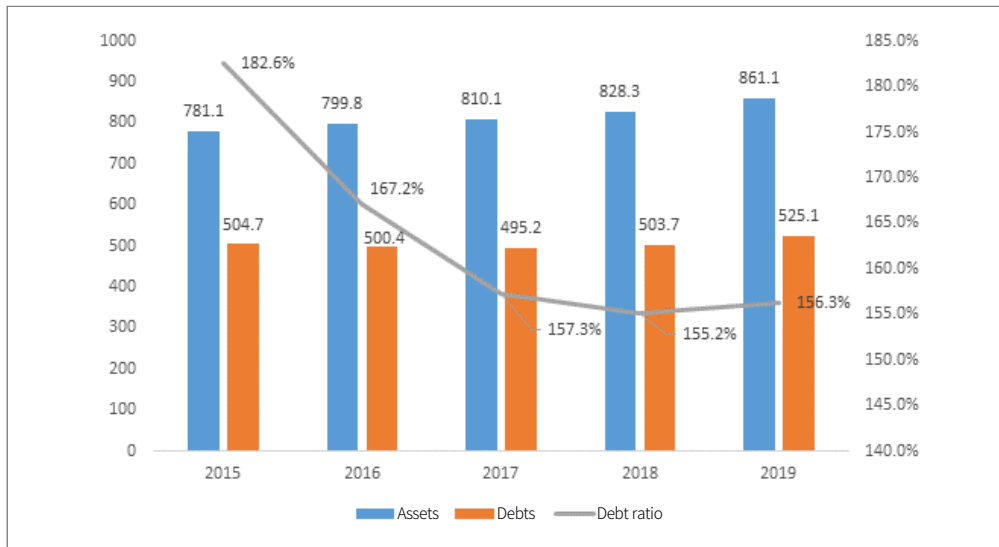## III. Financial Performance Analysis

In this section, we track changes in the financial performance of public institutions over

a five-year period from 2015 to 2020. Second, we look into the total expenditures and area-specific expenditures of public institutions. Third, we analyze the five-year financial performance and expenditures of eight public corporations listed in the stock exchange market, for whom profitability holds great importance. Fourth, we review the medium and long-term financial management plans submitted by public institutions in an attempt to summarize their financial outlook for the next five years. With these analyses, we then seek to elucidate changes in the financial performance of public institutions in the period characterized by the government's social value drive.

Public institutions reported increased liabilities for two years from 2018. Their current net income also declined rapidly in 2017 and the following years. The total debts owed by public institutions declined from KRW 504.7 trillion in 2015 to KRW 495.2 trillion in 2017. However, the debts began to increase again in 2018, and reached KRW 525.1 trillion in 2019. The total current net income of public institutions went up between 2015 and 2016 from KRW 12.5 trillion to KRW 15.4 trillion, and declined to KRW 7.2 trillion in 2017, followed by a rapid decline in 2018 and 2019 (to KRW 0.7 trillion and KRW 0.6 trillion, respectively).

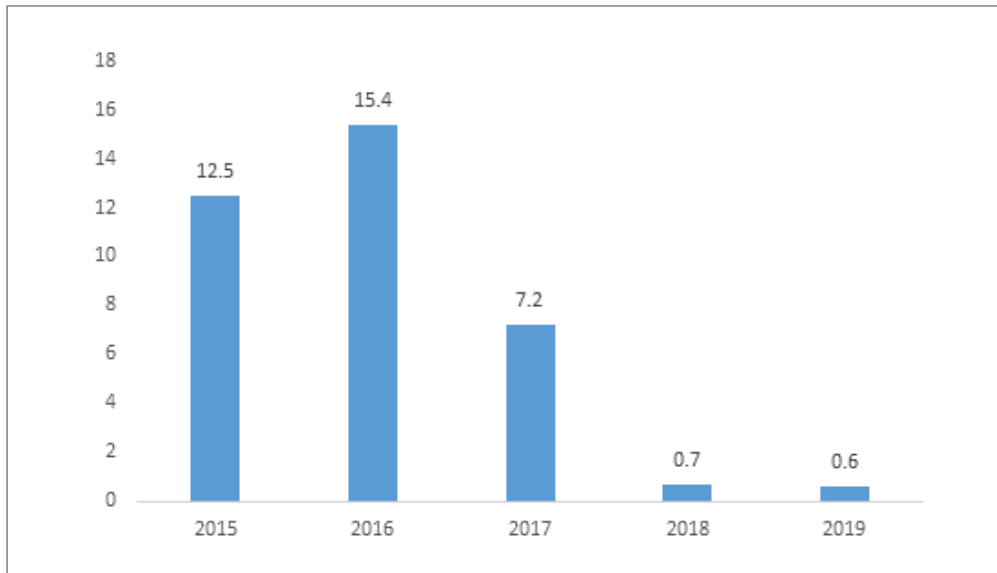## Figure 4_Financial Positions of Public Institutions

(unit: KRW trillion, %)

Source: Ministry of Economy and Finance, All Public Information In-One (ALIO), http://www.alio.go.kr/home.do , accessed on August 3, 2020.

Figure 5_Current Net Income of Public Institutions

(unit: KRW trillion)

Source: Ministry of Economy and Finance, All Public Information In-One (ALIO), http://www.alio.go.kr/home.do, accessed on August 3, 2020.

There are a total of 340 public corporations in Korea, and 8 are listed in the stock exchange market: Korea Electric Power Corporation (KEPCO), Korea Gas Corporation (KOGAS), Kangwon Land, Industrial Bank of Korea (IBK), KEPCO Plant Service & Engineering (KEPCO KPS), Grand Korea Leisure (GKL), KEPCO Engineering & Construction Company (KEPCO-ENC), and Korea District Heating Corporation (KDHC). Unlike other public corporations, the listed public corporations are co-owned by the government, the public sector, and private investors. Their stocks are traded in the stock exchange market. However, the government still controls the corporations, having a 51% or higher equity. As such, profitability and shareholder values hold great importance for the listed public corporations.

A look into the financial performance of the eight public corporations in the 2015~2020 period shows that three corporations reported increased net income, and the other five reported a decline. The stock price index (Korea Composite Price Index, KOSPI) greatly increased in the same period. However, all of the eight public corporations saw a decline in their stock prices.

Figure 6_Stock Prices of Listed Public Corporations[1)]

(unit: KRW)

Note: 1) 2015~2019: closing prices; 2020: price on December 11.
Source: Present study, based on Korea Exchange, Market Information Statistics, http://marketdata.krx.co.kr/mdi#document=13010101, accessed on December 11, 2020.

Table 3 _Stock Prices of Listed Public Corporations[1)]

(unit: KRW, %)

Name	2015 (A)	2016	2017	2018	2019	2020 (B)	Change (B-A)	Change Ratio
KEPCO	50,000	44,050	38,150	33,100	27,800	23,800	-26,200	-52.4%
KOGAS	36,850	48,450	42,550	48,200	37,850	30,900	-5,950	-16.1%
KDHC	57,600	68,100	73,000	57,000	47,300	39,950	-17,650	-30.6%
IBK	12,350	12,700	16,450	14,050	11,800	9,520	-2,830	-22.9%
Kangwon Land	38,400	35,750	34,800	32,000	29,600	23,950	-14,450	-37.6%
GKL	24,200	20,450	29,250	24,900	19,450	18,100	-6,100	-25.2%
KEPCO KPS	89,000	54,200	40,600	33,200	39,150	30,350	-58,650	-65.9%
KEPCO-ENC	34,600	23,650	23,800	20,900	20,050	17,100	-17,500	-50.6%
KOSPI	1,961.31	2,026.46	2,467.49	2,041.04	2,197.67	2,770	809	41.2%

Note: 1) 2015~2019: closing prices; 2020: price on December 11.
Source: Present study, based on Korea Exchange, Market Information Statistics, http://marketdata.krx.co.kr/mdi#document=13010101, accessed on December 11, 2020.

The current administration's social value drive increased new recruits at public institutions, accelerated the upgrading of temporary positions to permanent positions, and expanded the number of public institution employees from 314,000 in 2015 to 423,000 in 2020 by 109,000 (34.7%).[4]

Figure 7_New Recruits at Public Institutions
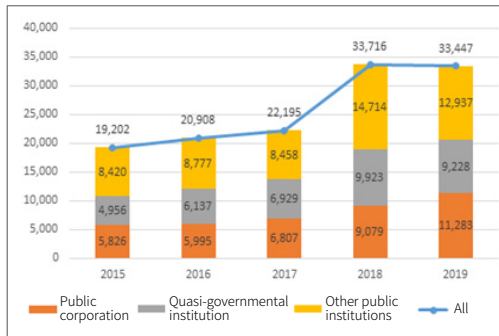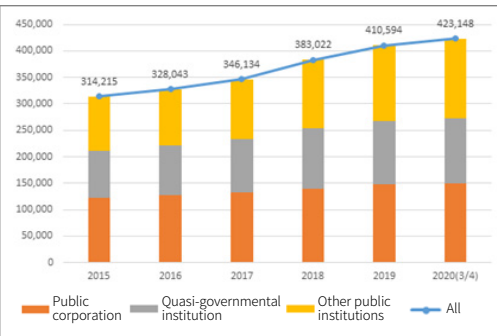(unit: number of employees)

Figure 8_Number of Employees at Public Institutions
(unit: number of employees)

Source: Ministry of Economy and Finance, All Public Information In-One (ALIO), http://www.alio.go.kr/home.do, accessed on August 3, 2020.

In terms of expenditures, public institutions spent 9.3% more money during the 2015~2020 period. By area of expenditure, business expenses increased by 15.1%, while labor expenses and current operating expenses increased at even higher rates (34.0% and 47.7%, respectively). On the other hand, expenditures on loan redemptions declined by 14.4%, and miscellaneous expenditures decreased by 4.8%.

Figure 9_Overall Expenditures and Business Expenses of Public Institutions
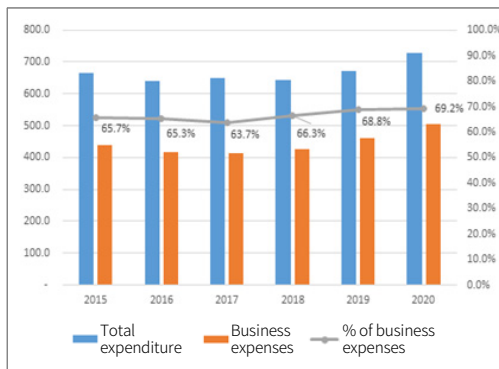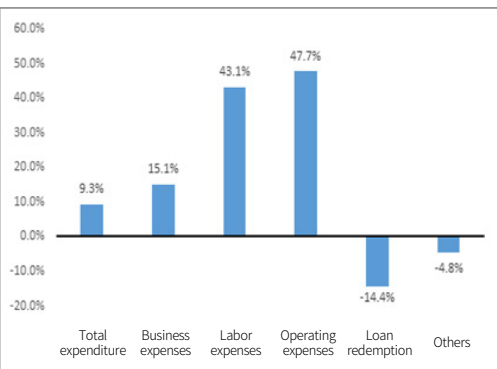(unit: KRW trillion, %)

Figure 10_Changes in Public Institution Expenditures by Area
(unit: %)

Source: Ministry of Economy and Finance, All Public Information In-One (ALIO), http://www.alio.go.kr/home.do, accessed on August 14, 2020.

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4 As of the end of the 3rd quarter of 2020.

Table 4_Public Institution Expenditures By Area[1]

(unit: KRW trillion, %)

	Category of Public Institutions	2015 (A)	2016	2017	2018	2019	2020 (B)	Change (B-A)	% of change
Total expenditures	All	665.9	639.2	650.8	642.2	670.2	727.9	62.1	9.3%
	Public corporation	245.3	229.9	237.9	241.5	235.9	248.7	3.4	1.4%
	Quasi-governmental institution	281.2	258.9	274.6	272	292.4	334.1	52.9	18.8%
	Other public institutions	139.3	150.5	138.3	128.7	141.9	145.1	5.8	4.2%
Labor expenses	All	21.1	22.9	24.2	25.6	27.6	30.3	9.1	43.1%
	Public corporation	9	9.8	10.3	10.6	11.2	12	3	34.0%
	Quasi-governmental institution	5.7	6.1	6.5	6.9	7.6	8.3	2.5	44.6%
	Other public institutions	6.5	7	7.5	8	8.8	10	3.5	54.5%
Operating expenses	All	11.3	12.6	12.7	13.1	13.2	16.7	5.4	47.7%
	Public corporation	5.4	6.3	6.2	6.3	6.1	9.4	4	73.6%
	Quasi-governmental institution	2.3	2.4	2.5	2.6	2.8	2.8	0.4	18.8%
	Other public institutions	3.6	4	4	4.2	4.4	4.5	1	27.6%
Business expenses	All	437.7	417.6	414.9	425.6	461.3	503.9	66.2	15.1%
	Public corporation	151.8	137.5	142.4	152.5	155.5	161.8	10	6.6%
	Quasi-governmental institution	188.8	174.8	181.9	189.8	210.8	244.3	55.6	29.4%
	Other public institutions	97.1	105.2	90.6	83.3	95	97.8	0.6	0.7%
Loan redemptions	All	96.1	84	92.9	84.5	75.4	82.2	-13.9	-14.4%
	Public corporation	39.7	36	38.2	35.8	31.2	29	-10.7	-27.0%
	Quasi-governmental institution	35.9	24.2	28.8	27.1	22.3	30.4	-5.5	-15.3%
	Other public institutions	20.5	23.8	25.9	21.6	21.9	22.8	2.3	11.3%
Others	All	99.7	102.2	106.1	93.4	92.7	94.9	-4.7	-4.8%
	Public corporation	39.5	40.3	40.8	36.4	32	36.5	-3	-7.5%
	Quasi-governmental institution	48.5	51.4	54.9	45.5	48.9	48.4	-0.1	-0.3%
	Other public institutions	11.6	10.5	10.4	11.5	11.8	10	-1.6	-14.1%
Change			-26.6	11.6	-8.6	28	57.8		
% of change			-4.00%	1.80%	-1.30%	4.40%	8.60%		

Note: 1) 2015~2019: account data; 2020: budget data

Source: Ministry of Economy and Finance, All Public Information In-One (ALIO), http://www.alio.go.kr/home.do, accessed on August 12&14, 2020.

According to the medium- and long-term financial management plans submitted by public institutions, they expect a 150.6 trillion won increase in assets and a 94.2 trillion won increase in liabilities in the next five years. The debt ratio is expected to be stabilized at around 172.% in 2020 and 171.4% in 2024.

The data indicate a significant change in the general trends of public institutions', especially after the end of the government's debt reduction initiative in 2017. Notable effects of the current administration's social value drive can be found in the increased labor expenses and operating expenses, which reflects the increased number of public institution employees. The administration's efforts to expand housing welfare programs, investments in the environment, safety, the Green New Deal, and the public response to COVID-19 also resulted in the enhanced roles of the public institutions and an increase in business expenses. As the recession brought on by the pandemic continues, the public sector will continue to play an increasingly larger role in the recovery efforts.

If the social value activities of public institutions are limited to social contributions and SR activities outside their primary mandates, the costs related to social values would not have significant impact on the financial performance of public institutions. On the other hand, if the social value drive affects the institutions' mandates and the performance of policy tasks requiring massive investments, it will have a widespread effect across the society. The current administration has heavily invested in the environment, public housing projects, and energy conversion projects since 2017. These investments are directly linked to the social values pursued by the administration. In this case, it would be difficult to separate the pursuit of social values from the observed changes in the financial performance of public institutions. Therefore, understanding the effect of social values on financial performance requires an identification of the scope and scale of the social values, as well as careful and systemic collection and analysis of the relevant data.

IV. Effects of Social Values on the Financial Performance of Public Institutions

In this chapter, we empirically analyze how public institutions' pursuit of social values affect their financial performance. For this task, we focus on public corporations and quasi-governmental institutions, which go through annual management performance evaluations. We analyzed the management performance evaluation results of public corporations and quasi-governmental institutions from 2016 to 2018, as well as their financial

statements. We also used the ALIO system to access the financial data of public institutions, their management performance evaluation results, number of employees, and number of safety accidents. To test the null hypothesis that a public institution's pursuit of social values does not affect its financial performance, we used corporate social responsibility (CSR) as the independent variable, and the return on assets (ROA) and operating profit ratio (OPR) as dependent variables representing the financial performance. We also measured the total performance (TP) of the institutions based on management performance evaluation results on work efficiency, financial performance, and key businesses.

Table 5_Regression Analysis of CSR and Financial Performance (ROA)

$$ROA_{i,t} = \beta_o + \beta_1 CSR_{i,t} + \beta_2 SIZE_{i,t} + \beta_3 LEV_{i,t} + \beta_4 ATR_{i,t} + \beta_5 EMNUM_{i,t} + \beta_6 TYPE_{i,t}$$

Dependent variables	ROA	ROA	ROA
Sample	All	Public corporation	Quasi-governmental institution
Intercept	-0.828	-0.516	-0.853
	(-1.00)	(-0.30)	(-0.88)
CSR	-0.001	0.001	-0.001
	(-0.55)	(0.63)	(-0.52)
SIZE	0.022	0.030	0.021
	(0.78)	(0.52)	(0.64)
LEV	-0.149***	-0.034	-0.152***
	(-3.93)	(-0.45)	(-3.38)
ATR	0.000**	0.036	0.000*
	(2.05)	(0.46)	(1.81)
EMNUM	0.065	-0.051	0.082
	(0.97)	(-0.98)	(0.90)
TYPE	0.001		
	(0.01)		
Firm/Year Fixed	yes	yes	yes
Adj. R	0.096	0.111	0.104
N	340	97	243

Notes: 1. Variables are defined as follows:
　　　ROA: return on assets - current net income / total assets
　　　CSR: comprehensive social responsibility
　　　SIZE: asset size - natural logarithm of total assets
　　　LEV: levelness - total debts/total assets (debt ratio)
　　　ATR: asset turnover ratio - sales/total assets
　　　EMNUM: natural logarithm of number of employees (permanent positions, contractual positions, and temporary positions)
　　　TYPE: dummy variable (quasi-governmental institution = 1, public corporation = 0)
　　2. Figures in parentheses represent t-values, and *, **, *** indicates statistical significance at 10%, 5%, and 1%, respectively.
Source: Present study

The findings show that public institutions' pursuit of social values do not significantly affect their ROA and OPR, whereas the institutions' CSR was positively correlated with their TP. We also separately analyzed the quantitative and qualitative parts of the management performance evaluation results. Public institutions' social value activities had a positive effect only on the qualitative part of the management performance evaluation. We did not find any direct evidence that social value activities have a practical and objective effect on TP and financial performance.

Table 6_Regression Analysis of CSR and Financial Performance (OPR)

$$OPR_{i,t} = \beta_o + \beta_1 CSR_{i,t} + \beta_2 SIZE_{i,t} + \beta_3 LEV_{i,t} + \beta_4 ATR_{i,t} + \beta_5 EMNUM_{i,t} + \beta_6 TYPE_{i,t}$$

Dependent variables	OPR	OPR	OPR
Sample	All	Public corporation	Quasi-government
Intercept	0.182	8.500	0.273
	(0.28)	(1.21)	(0.58)
CSR	-0.000	0.001	-0.000
	(-0.35)	(0.37)	(-0.39)
SIZE	-0.020	-0.302	-0.015
	(-0.92)	(-1.26)	(-0.96)
LEV	-0.016	0.291	-0.024
	(-0.55)	(0.92)	(-1.11)
ATR	-0.000	0.137	-0.000
	(-0.09)	(0.42)	(-0.03)
EMNUM	0.066	0.013	0.029
	(1.26)	(0.06)	(0.65)
TYPE	0.005		
	(0.07)		
Firm/Year Fixed	yes	yes	yes
Adj. R	0.025	0.144	0.015
N	340	97	243

Note: 1. Variables are defined as follows:
OPR: operating profit ratio, operating profits / sales
CSR: comprehensive social responsibility
SIZE: asset size: natural logarithm of total assets
LEV: levelness Total debts/total assets (debt ratio)
ATR: asset turnover ratio - sales/total assets
EMNUM: natural logarithm of number of employees (permanent positions, contractual positions, and temporary positions)
TYPE: dummy variable (quasi-governmental institution = 1, public corporation = 0)
2. Figures in parentheses represent t-values, and *, **, *** indicates statistical significance at 10%, 5%, and 1%, respectively.
Source: Present study

Table 7_Findings of the Regression Analysis of CSR and Quantitative and Qualitative Total Performance (NUMTP and NONTP)

$$NMTP_{i,t}(NONTP_{i,t}) = \beta_o + \beta_1 CSR_{i,t} + \beta_2 SIZE_{i,t} + \beta_3 LEV_{i,t} + \beta_4 ATR_{i,t} + \beta_5 EMNUM_{i,t} + \beta_6 TYPE_{i,t} + \beta_7 ROA$$

Dependent variables	NUMTP	NUMTP	NONTP	NONTP
Sample	All	All	All	All
Intercept	-84.494	-66.269	4.510	8.404
	(-0.82)	(-0.65)	(0.10)	(0.18)
CSR	-0.105	-0.089	0.288***	0.291***
	(-0.64)	(-0.55)	(3.88)	(3.93)
SIZE	4.711	4.235	1.484	1.382
	(1.37)	(1.25)	(0.95)	(0.89)
LEV	7.937*	11.224**	-0.653	0.049
	(1.69)	(2.33)	(-0.31)	(0.02)
ATR	-0.006	-0.012	-0.002	-0.003
	(-0.33)	(-0.70)	(-0.19)	(-0.36)
EMNUM	9.055	7.624	-1.212	-1.518
	(1.09)	(0.93)	(-0.32)	(-0.40)
TYPE	-14.335	-14.349	6.854	6.851
	(-1.26)	(-1.28)	(1.33)	(1.33)
ROA		22.005***		4.702
		(2.63)		(1.23)
Firm/Year Fixed	yes	yes	yes	yes
Adj. R	0.046	0.076	0.215	0.220
N	340	340	340	340

Note: 1. Variables are defined as follows:
    TP: Average of total performance, work efficiency performance, finance and budget performance, and performance of key businesses
    NUMTP: quantitative part of the total performance (TP); NONTP: qualitative part of the TP
    CSR: comprehensive social responsibility
    SIZE: asset size: natural logarithm of total assets
    LEV: levelness Total debts/total assets (debt ratio)
    ATR: asset turnover ratio - sales/total assets
    EMNUM: natural logarithm of number of employees (permanent positions, contractual positions, and temporary positions)
    TYPE: dummy variable (quasi-governmental institution = 1, public corporation = 0)
    ROA: return on assets - current net income / total assets
    2. Figures in parentheses represent t-values, and *, **, *** indicates statistical significance at 10%, 5%, and 1%, respectively.
Source: Present study

An analysis of the effect of individual social value activities on financial performance was then conducted. The management performance evaluation results on quality of life (work-family balance) were found to be positively correlated to the institutions' OPR,

meaning improved quality of living, and the resulting mental stability may also positively affect the productivity of public institutions. The findings also showed that cooperative labor-management relations reduce the number of safety accidents, which may also positively affect the performance of public institutions. On the other hand, an increase in the percentage of workers in permanent positions appears to negatively affect the ROA of the institutions in the following year.

To summarize, different social value activities affected the financial performance in different ways. As such, public institutions can expect to improve their financial performance while pursuing social values, by focusing on those social value activities that positively affect their financial performance.

V. Case Analysis: Social Values and Financial Performance of Public Institutions

In this chapter, we discuss the experiences of four public institutions (KEPCO, KOGAS, LH, and Incheon International Airport Corporation (IIAC)) regarding their pursuit of social values and the resulting effect on financial performance.

The findings indicate that different institutions have different concepts of social values, and that perceptions on social values may even vary from department to department. Some respondents defined the scope of social value activities based on how their enhancement of existing CSR activities, and contribution to local communities and socioeconomic activities. Others added projects closely aligned with public interests to the list, or even included all of their institutions' businesses in the scope of social value activities. Meanwhile, an increase in new recruit, upgrading of temporary positions to permanent positions, contributions to local communities, and socioeconomic developments were listed as the unique elements of social value activities not included in CSR activities.

Despite these differences, all public institutions surveyed in the case study felt burdened by the increase in labor expenses, safety management expenses, and shared growth expenses required for shared social value activities, and did not feel that they benefited from these activities. Many public institutions are the only or one of few suppliers in the relevant markets, tasked with providing various necessities. This means that their social value activities are not likely to increase their revenues, profits, or competitiveness. What this means is that if members of these institutions do not feel the benefit of their social value activities, it may weaken their motivation for those activities and undermine their sustainability. In fact, social

value activities at public institutions are driven by strong external forces in the form of management performance evaluations. If this force weakens, it will be difficult to maintain the current level of social value activities.

The following table summarizes the investments, quantitative outcomes, and social return on investments (SROI) regarding social value activities of the four public institutions. Many public institutions try to measure the outcomes of their social value activities, and announce the results in monetary units.

The percentage of investments in social values varies depending on the institution, from 2~3% (KOGAS), 6% (KEPCO), 14~20% (IIAC) to 21~22% (LH). The budget allocated to social value activities are affected by the scope of the activities as defined by each institution. KEPCO spends only 0.03% of its total budget on CSR activities per se. Then, the institution spends 200 times more money on social value activities. As for the outcomes of social value activities, KOGAs reported 2~3% of the total budget, LH reported 13~15%, and IIAC reported 37~75%.

These findings indicate that the outcomes of social value activities greatly vary depending on the scope of social values and the method of quantifying the outcomes of the activities.

Table 8_Investments in, and Outcomes of, Social Value Activities of Public Institutions

(unit: KRW 100 million)

Name	Item	2017	2018	2019	2020
KEPCO	Investments			43,282 (6.2%)	43,975 (6.4%)
	Outcomes				
KOGAS	Investments				
	Outcomes	6,377 (2.3%)	9,125 (3.1%)	6,079 (2.1%)	
LH	Investments	80,295 (21.2%)	82,021 (22.1%)	118,567 (31.8%)	
	Outcomes	50,534 (13.5%)	50,979 (13.7%)	56,897 (15.4%)	
	Social return on investment (SROI)	0.63	0.62	0.48	
IIAC	Investments		5,316 (14.9%)	6,439 (20.0%)	
	Outcomes		12,698 (35.6%)	24,161 (74.9%)	
	SROI		2.39	3.75	

Note: Figures in parentheses represent percentages against the total budget.

Source: Present study, based on sustainability reports, management performance evaluation reports, and other submissions of the institutions.

As for SROI, LH reported 0.64~0.69 while IIAC reported 2.39~3.75, which shows differences in how corporations define and quantify their investments and outcomes with related to social values.

Another noteworthy aspect of the findings is the effect of financial performance on the pursuit of social values. We conducted in-depth interviews with the staff of the surveyed institutions, and their responses reveal the significant effect of the institutions' financial positions and prospects pertaining to how they set up goals and plans to pursue social values and determine the size of investments in those efforts. Public institutions with outstanding financial performance actively invest in social value activities, whereas institutions with rapidly deteriorating performance are more reluctant to actively pursue social values activities and adjust the relevant activities in accordance with their financial reality. In the case of institutions that recently suffered an extensive financial loss or a rapid decline in revenues on account of COVID-19, or expect a financial deterioration brought on by a large public investment, the respondents felt the need to reduce donations to social contribution activities, or to adjust their social value-related budget items.

However, the high percentage of social value-related items in public institution management performance evaluation often leads to conflicts between departments tasked with management performance evaluation and those that manage the institutions' financial affairs. These institutions try to focus their investments on areas where they can improve their social value performance without incurring a sizable investment in various ways.

In particular, public institutions reported difficulties with the upgrading of temporary positions to permanent positions. Many public institutions have established plans for this upgrade. However, some institutions have not yet decided how they will achieve the goal, or are still discussing specific ways to achieve that transition. The upgrade poses great difficulties as institutions need to reach agreements with stakeholders, each of whom has different opinions pertaining to the scale and process of the upgrade, the recruitment practices, wages, and treatment. In addition, even after completing the transition, institutions have to deal with remaining issues such as demands for improved treatment in the future, the power balance among multiple labor unions, the increase in labor expenses, and the use of human resources. The inherent nature of public institutions dictates the need to retain their workforce even when their workforce demand dwindles due to work automation and other factors. This issue may further undermine the institutions' ability to flexibly manage their human resources and ensure efficient operation.

The respondents also pointed out the need to diversify social value actions, in accordance

with the characteristics of the respective institutions. In public institution management performance evaluation, the social value efforts of an institution are measured under the "realization of social values" item. The item consists of five sub-items: job creation; equitable opportunities; social integration; safety and environment; shared growth, cooperation and local development; and ethical management. However, public institutions operate in diverse industries and under diverse business structures. Each institution has its own unique characteristics. Institutions in need of large-scale construction projects and procurement from multiple sectors are in a better position to create jobs in the private sector and purchase from SMEs, micro-enterprises, and social enterprises. Institutions with small budgets and operating only with their own staffs experience more difficulties with pursuing such social values. The pursuit of social values related to environment and safety is only affected by the characteristics of an institution, especially in terms of the scale and scope of social values that it can realize.

Lastly, respondents reported the challenges posed by social value activities to their efforts to improve the institutions' competitiveness. Public institutions need to increase their purchases from SMEs and social enterprises. However, some of these products are characterized by low quality and high prices, which negatively impacts the services and goods provided by these institutions. LH is required in order to furnish public rental apartment units with SME products. However, this requirement may lead to a quality gap between public rental apartments and those sold in the private market, which in turn may undermine the social mix and housing welfare of the residents.[5] Other institutions may face similar complaints if they purchase products for consumers and employees from SMEs or social enterprises. To address these issues, stricter requirements for the quality of the goods need to be applied to the purchase of SME or social enterprise products.

VI. Policy Implications

The current administration's efforts to pursue social values have achieved visible outcomes across various sectors. However, we propose the following improvements in order to ensure the sustainable and effective pursuit of social values.

First, public institutions need to pay more attention to their financial sustainability in order

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5 LH is not required to use SME products in the apartment units that it sells in the private market.

to ensure the continuous pursuit of social values. The administration increased the points for social value activities in the management performance evaluation, while greatly reducing the points for work efficiency and financial performance. However, these changes in the evaluation do not indicate that financial performance is any less important for public institutions. Our case study confirmed that public institutions will try to adjust their investments in social values when their financial performance suffers or they expect significant loss. Therefore, in order to pursue social values in a sustainable way, public institutions need to set up and adhere to practices in order to ensure their long-term financial sustainability. The government needs to support these efforts by individually monitoring institutions in need of better financial performance and increase the percentages of work efficiency and financial performance in management performance evaluation.

Second, job creation has typically been the most crucial part of the social value efforts of public institutions. As a result, public institutions increased their recruitment and upgraded temporary positions to permanent positions as job security and better treatment initiatives. However, these policy changes were implemented over a short time span, resulting unintended problems. In particular, the temporary-permanent upgrade requires extensive preparations and consultation in order to account for different organizational characteristics and determine the employment method and additional costs. However, the fast pace of the implementation restricted the institution's ability to fully address these challenges. The findings of our empirical analysis suggest that having a high percentage of permanent positions in an institution's workforce negatively affects its work efficiency. Recent financial data report that there has been a significant increase in the labor expenses and operating expenses of public institutions. Furthermore, that this upgrade may restrict the institutions' ability to employ more workers in the future. The government and public institutions need to continuously work together to meet the challenges posed by recent changes in the workforce management at public institutions. Indeed, in order to improve the wages and treatment for employees of parent companies and subsidiaries who became permanent employees, the efforts at individual institutions need to go hand-in-hand with discussions on the general direction of the relevant government policies.

Third, to achieve a sustainable pursuit of social values, the government needs to motivate public institutions to participate in these efforts and to then provide them opportunities to experience the benefits. The pursuit of social values at public institutions can be driven by government policies and management performance evaluation in the early stages. However, these external factors are not sufficient for achieving the stated social values in a sustainable

way because shifts in government policies and management performance evaluations are likely to change how public institutions pursue these social values.

In addition, given the nature of public institutions, it would be difficult to motivate them to voluntarily pursue social values if these efforts are perceived as being mere burdens, and that they do not translate to revenues and profits. In this regard, institutions need to be able to quantify their investments in, and outcomes on, social values. Although specific measurement may vary among institutions, quantification allows institutions to monitor and improve as they invest and produce outcomes in accordance with consistent criteria. It also provides a foundation for proposing cost-effective alternatives for pursuing social values. According to our empirical findings, public institutions are likely to receive higher scores by focusing on qualitative social value items in their management performance evaluations (key business outcomes and financial performance). Institutions may find such focus on qualitative items helpful in the early stages, as it measures outcomes not easily reflected in the market. However, these items may change when the government changes its management performance evaluation practices. Therefore, the government needs to develop sustainable ways to implement the relevant policies in ways that motivate public institutions, and to then allow them to experience the benefits of social value activities.

Fourth, the current management performance evaluation practices need to be improved in terms of the pursuit of social values. Currently, all public institutions are evaluated by the same five sub-items. However, these items need to be diversified to account for different industries and their inherent characteristics. In addition, evaluations need to focus on what each institution can do best in their specific areas, rather than pitting them against each other, or by comparing year-over-year improvements. Each institution needs to be encouraged to identify the areas that suit their characteristics best, and then monitor/evaluate their achievements in those areas. In addition, evaluation items and points need to be adjusted for goals that either are achieved or show steady performance, as institutions proceed with their pursuit of social values.

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