

KOREA INSTITUTE OF PUBLIC FINANCE

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A Study for Improving the Income Identification System and the Social Insurance Administration in Korea¹

Inhyuk Choi, Dawoon jung, Hoon Chung, and JinSoo Kim*

I. Introduction

The outbreak and prolonged impact of COVID-19 drove society's demand and need to improve both the income identification process and social insurance administration system in Korea. The government has taken various measures to support people severely affected by the pandemic, including relief funds distribution. However, the identification of (and provision of relief funds to) affected groups has revealed various issues with Korea's current income identification system. In addition, in recent years, Korean society has been mired in controversies regarding special employment type workers,² self-employed workers, and other non-standard workers not covered by social insurance (see Tables 1 and 2). This controversy

1 This paper is the English version of an updated summary of Choi, Jung and Kim(2021) and Choi and Chung(2021).

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2 The Industrial Accident Compensation Insurance Act defines the term "special employment type worker" as a worker who works in a type of business that needs protection from industrial accidents. For the purpose of this study, we use the term to refer to entrepreneurs who share similarities with typical workers in terms of, say, dependency, and are distinguished from typical self-employed workers.

highlighted practical and institutional coverage issues regarding this fulcrum of the social safety net.

In this paper, we study concrete measures required to improve Korea's income identification and social insurance administration system. As of January 2022, Korea has adopted and currently implements a system for real-time income identification. As such, our discussion will focus on short- and long-term roadmaps not only to advance the current system but also to enhance its integration with social insurance administration. To this end, we also discuss experiences in selected countries and derive policy implications from them, considering Korea's specific situation as well as recent and potential developments in the taxation environment.

This paper consists of the following chapters. Chapter II briefly outlines the income identification system and social insurance administration in Korea, and compares Korea's experience with those in selected countries to derive policy insights. Chapter III discusses concrete measures to improve income identification practices and the social insurance administration system, which is followed by a summary and conclusions in Chapter IV.

Table 1_ Social Insurance Coverage By Employment Type (as of June 2021)

(Unit: %, %p)

Employment Type	Employment Insurance	National Health Insurance	National Pension	Industrial Accident Compensation Insurance
All	90.5 (0.2)	91.5 (0.4)	91.7 (0.4)	97.8 (0.0)
Regular workers	94.2 (△0.2)	98.5 (0.0)	98.3 (0.0)	97.8 (△0.1)
Non-regular workers	76.1 (1.7)	66.4 (1.5)	63.0 (1.3)	97.6 (0.1)
Fixed-term workers	89.3 (3.1)	93.6 (0.5)	88.7 (2.1)	98.9 (△0.1)
Part-time workers	80.3 (△0.8)	79.1 (0.1)	76.5 (△1.1)	95.9 (0.2)
On-call workers	58.6 (2.8)	22.9 (2.7)	22.9 (2.4)	98.5 (0.8)
Agency workers	95.3 (△1.9)	94.3 (△2.3)	95.2 (△1.9)	97.4 (△2.2)
Subcontract workers	94.9 (△1.1)	95.6 (△0.5)	92.6 (△1.7)	98.7 (△1.0)

Note: Numbers in parentheses represent year-over-year changes (%p).

Source: Ministry of Employment and Labor, press release (May 25, 2022), p. 6.

Table 2_Employed Persons Not Covered by Employment Insurance (as of August 2020)

(Unit: 1,000 persons, %)

Employed persons				
Self-employed workers	Wage and salary workers			
	Not eligible for Employment Insurance ¹⁾	Not enrolled in Employment Insurance	Covered by employment insurance for public officials, etc. ²⁾	Subscribers
6,639	1,970	3,247	1,436	13,793
(24.5)	(7.3)	(12.0)	(5.3)	(50.9)
Institutional non-coverage		Practical non-coverage		

Note: 1) Workers employed by agricultural and fishery businesses with less than five employees; workers aged 65 and older; workers with a less than 15-hour work per week and less than three-month term, excluding daily workers; special employment type workers, etc.

2) Data on pension holders in special professions, such as government employees, private school teachers, and post office employees. Source: Lee et al. (2021), <Table 5-1>.

II. Income Identification System and Social Insurance Administration in Korea

1. Income Identification System

Table 3 summarizes the latest trends in the means of income identification for workers and personal service providers. The incomes of full-time employees are identified based on simplified statements of payment (wage and salary income) on a half-yearly basis; those of workers employed on a daily basis are identified using daily labor statements of payment on a monthly basis. The means and cycle of income identification for personal service providers vary depending on whether the provider constitutes an entrepreneur exempted from value-added tax under the Value-added Tax Act. On the one hand, as for entrepreneurs exempted from value-added tax, the Income Tax Act was revised to identify their income on a monthly basis (as of January 2022). Incomes subject to withholding taxes are identified using simplified statements of payment (residents' business income), and the other incomes are identified based on taxation data submission specification provided by business place providers and others. On the other hand, the incomes of taxable businesses are identified using (electronic) tax invoices. Incomes are identified on a half-yearly basis for non-electronic tax invoices, and in real time for electronic tax invoices.

Table 3_Means of Income Identification for Workers and Personal Service Providers

Type			Income identification	Cycle	
Employee	Full-time employee		Simplified statement of payment (wage and salary income)	Half-yearly	
	Daily employed worker		Statement of payment (income of a worker employed on a daily basis)	Monthly	
Business entity	Personal service provider	Exempt from value-added tax	Subject to tax withholding (36 types)	Simplified statement of payment (business income of a resident)	Monthly
			Not subject to tax withholding (8 types)	Taxation data submission specification of the place of business provider, etc.	Monthly (since Nov. 2021)
	Subject to value-added tax (4 types)		Tax invoice		Half-yearly
			Electronic tax invoice		Daily

Note: Submission cycle as of July 2021.

Source: National Tax Service (2021), p. 29, partially edited.

Table 4_Means of Income Identification for Personal Service Providers

Special employment type workers under the Industrial Accident Compensation Insurance Act	Workers under the Employment Insurance Act	Types of personal services			Types of entrepreneurs under the Value-added Tax Act	Means of income identification	
○	○	Couriers, construction machine operator, truck driver, home appliance technicians		4 types	Taxable	Tax invoice	
		Housekeeper		8 types	Tax-free	Taxation data submission specification of the place of business provider, etc.	Invoice
		Used car dealer					
○	Since Jan. 2022	Chauffeur	36 types				
○	Since Jan. 2022	Quick service (package courier)					
○	×	Caddie					
		Caregiver					
		Body scrubber (bathhouse employee)					
		Delivery (luggage porter)					
						Taxation data submission specification of the place of business provider, etc. (if not subject to tax withholding); Simplified statement of payment (if subject to tax withholding)	

Table 4. Means of Income Identification for Personal Service Providers(continued)

Special employment type workers under the Industrial Accident Compensation Insurance Act	Workers under the Employment Insurance Act	Types of personal services	Types of entrepreneurs under the Value-added Tax Act	Means of income identification
○	○	Insurance planner, door-to-door sales persons, visiting teacher (home school materials), visiting teachers (educational materials), visiting inspectors (rental products), loan solicitor, credit card solicitor		Simplified statement of payment
×	○	Afterschool instructor		
		Other solicitation commissions, writer, painter, composer, actor, model, singer, classical singer, professional athlete, go player, entertainment assistant, flower arrangement teacher, tutoring institution teacher, event helper, errand service, one-person media content creator, multi-level marketer, other self-employed worker, service fee earner, advisor/consultant, hospital/clinic, beverage carrier		

Note: “Software engineer” (a special employment type worker under the Industrial Accident Compensation Insurance Act) is omitted from the table.

Source: National Tax Service (2021), p. 83, partially edited.

Table 4 provides a more detailed overview of income identification for personal service providers. As mentioned above, the incomes of taxable entrepreneurs can be identified using (electronic) tax invoices. Four of the personal service business types under the tax law fit into the following categories: courier, construction machinery operator, truck driver, and home appliance technician. As for the other 38 business types, the means of income identification are determined based on actual contracts and transaction types. More specifically, simplified statements of payment can be used if the business owner³ receives compensation and distributes it to workers (see Figure 1).⁴ In cases where the worker personally collects their

³ As defined in the Employment Insurance Act.

compensation (see Figure 2), income identification may use taxation data provided by business place providers. Table 4 shows that the means of income identification vary depending on actual contracts and transaction types.^{5,6}

Some comments need to be made about the current system of income identification. First, in cases in which the one who pays compensation does not need to prove the actual expenses, the income tax is not withheld and it is difficult to identify the income. For example, for a business subject to a simplified expense rate, the expense is determined by multiplying its revenue with a rate specified for the business type, rather than the actual expenses. As such, there is no need to withhold the income tax from daily workers, and it may be impossible to identify the income of those who receive the compensation. Second, as it may be difficult for a business place provider, etc. to fully identify the income of its personal service providers, compensation information may be excluded from the information subject to the submission requirement.⁷ In this sense, the income identification system is not complete. Lastly, in response to these changes to the income identification system, service providers may try to avoid going through the income tax withholding system or relying on the business place providers. For example, a personal service provider that directly provides the end consumer with long-term services (caregivers, housekeepers, etc.) is highly likely to directly deal with the end consumer.

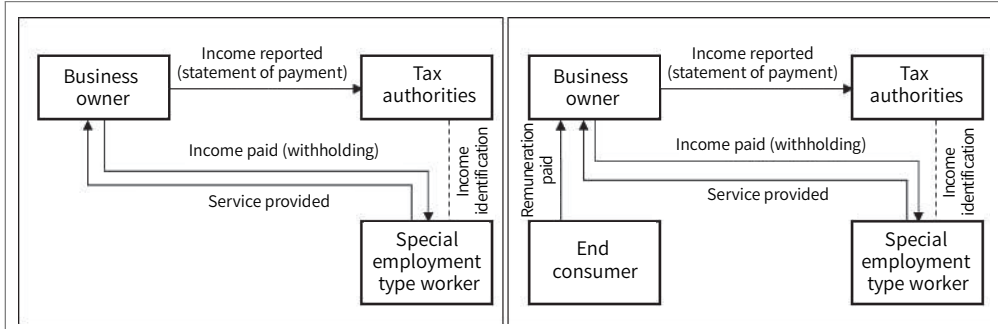
4 In cases in which the income tax is withheld, a business place provider, etc. is not required to submit taxation data (Article 224 (2), Enforcement Decree of the Income Tax Act).

5 In other words, the means of income identification for personal service providers are dependent on the legal rights and obligations regarding the service provision and payment collection. For example, in case of a chauffeur, if the business place provider simply serves as a broker between consumers and chauffeurs and only collects brokerage fees, income tax is not withheld and income identification should use taxation data submitted by the business place provider, etc. On the other hand, if the business place provider collects payment from consumers and distributes it to drivers, the income tax is withheld and simplified statements of payment can be used to identify the income.

6 Granted, the reality can be much more complicated. If the business owner ostensibly collects payments and pays fees to service providers, but only provides the payment function, income tax is not withheld even though the cash flows from the consumer, the business owner, to the service provider. A preliminary answer that confirms this (Preliminary-2016-Statutory Interpretation Income-0305) suggests the existence of real-world cases in this regard.

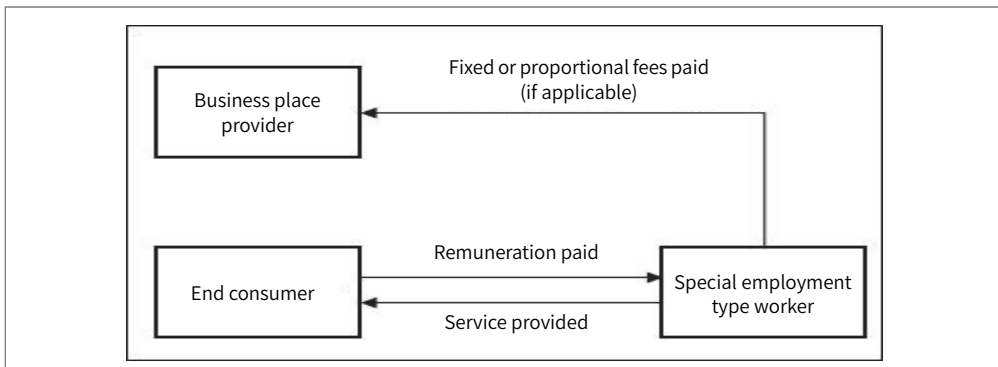
7 Article 224 (3), Enforcement Decree of the Income Tax Act.

Figure 1_Personal service providers whose income can be identified by income tax withheld



Source: Choi and Chung (2021), p. 8.

Figure 2_Personal service providers whose income can be identified by taxation data prepared and submitted by the related business place providers



Source: Choi and Chung (2021), p. 10.

Table 4 compares the personal service business types under the tax law, special employment type workers under the Industrial Accident Compensation Insurance Act, and workers under the Employment Insurance Act. Overall, 13 personal service business types including couriers and construction machinery operators fall under both the special employment type worker under the Industrial Accident Compensation Insurance Act and the worker under the Employment Insurance Act. Caddies and software engineers only constitute special employment type workers under the Industrial Accident Compensation Insurance Act, and after school teachers only constitute workers under the Employment Insurance Act. Note that the scope of personal service providers under the tax laws is far wider than that of

special employment type workers under the Industrial Accident Compensation Insurance Act or that of workers under the Employment Insurance Act.

2. Social Insurance Administration

Korea has four major social insurance types: National Health Insurance, National Pension, Employment Insurance, and Industrial Accident Compensation Insurance. Each of the four types of insurance was adopted at different times, and has been separately managed, operated, and advanced by the administration system of the relevant ministries. The history of these insurances has created discrepancies in terms of their operation and charging systems.⁸ Table 5 provides an overview of the operation of Korean social insurances, which clearly shows the discrepancies in terms of management units, charging units, charging criteria, and the existence of settlements. These discrepancies have caused inconvenience and confusion for both subscribers and businesses, and there have been numerous discussions on the need to address these issues.

Table 5_Overview: Social Insurance Operation in Korea

Social Insurance	National Health Insurance	National Pension	Employment Insurance	Industrial Accident Compensation Insurance
Relevant ministry	Ministry of Health and Welfare (MOHW)		Ministry of Employment and Labor (MOEL)	
Operator	National Health Insurance Service (NHIS)	National Pension Service (NPS)	Korea Workers' Compensation & Welfare Service (KCOMWEL)	
Characteristic	Part-time insurance for healthcare benefits	Long-term insurance for income guarantee	Medium-term insurance for unemployment benefits	Part-time insurance for accident compensation
Management unit	Business place /household	Individual	Business (place)	
Charging unit	Business place, area (household)	Business place, area (individual)	Business	
Charging criteria (employee)	Monthly remuneration, monthly income	Income	Remuneration	
Settlement	○	×	○	○
Eligible for Durunuri program	×	○ ¹⁾	○	×

Note: 1) Artists and workers (under the Employment Insurance Act) are excluded from the eligible group.

Source: Authors, based on Shin et al. (2019), Tables 1-1, 2-1 and 4-9.

⁸ Choi et al. (2021), p. 6.

The distribution of administrative functions for Korea's social insurance administration is as shown in Table 6. As of January 2022, each social insurance corporation manages eligibility for the relevant social insurance, and applies/charges social insurance contributions. However, the NHIS 'collects' all social insurance premiums. This arrangement has been in existence since the premium collection function of the National Pension and KCOMWEL was transferred to the NHIS. The transfer has been regarded as being less successful than expected. Jang (2017) points out that, despite the expectation that the integrated collection will address the coverage problem of the social insurances at the time, the result was less than expected. Shin et al. (2019) reported that the transfer of the collection function to the NHIS did not markedly improve administrative efficiency. In addition, the separation between application and charging of social insurance premiums has been a source of increasing inconvenience for subscribers and administrative inefficiency, which has led to voices that demand a fundamental solution for this issue (Choi et al., 2021).

Table 6_Social Insurance Integration Status and Distribution of the Related Functions: Korea, Germany, Sweden, and the UK

Aspects considered		Korea	Germany	Sweden	UK
Integrated or separate	Scheme	Separate	Separate	Separate	Integrated
	Organization	Separate	Separate	Integrated	Integrated
Distribution of the related functions	Application	Each service	Disease insurance association	Tax authorities	Tax authorities
	Collection	NHIS	Disease insurance association	Tax authorities	Tax authorities
	Benefits	Each service	Each insurance association	Social insurance administration	Social insurance service

Source: Nam and Baek (2011), Table 5.

3. Comparison with Selected Countries

A. Income Identification System

A comparison of experiences in the United Kingdom, Sweden, Germany, France, and Australia does not seem to provide meaningful implications related to the improvement in the timeliness of income identification. First, on the wage and salary income side, the surveyed countries have built and currently operate systems to identify income on a monthly basis. However, given the latest amendment to the Income Tax Act implemented in July 2021, these

countries do not have much to offer for the identification of wage and salary income. The United Kingdom and Australia launched the Real-Time Information (RTI) and the Single Touch Payroll (STP) systems, respectively, to identify the monthly incomes of those receiving payments subject to withholding taxes (wage and salary income earners and some business income earners). However, as is the case in Korea, these systems cannot identify the monthly income of businesses/taxpayers not subject to withholding taxes.

On the business income side, save for some exceptions, as of July 2021, none of the countries are capable of identifying monthly business income. For example, the United Kingdom adopted the Universal Credit system, which allows the authorities to identify the monthly business incomes of sole proprietors who apply for universal credit.⁹ However, the country does not identify the monthly income of all sole proprietors. Sweden and Germany also do not require micro-businesses to report their monthly income, except for the monthly VAT report requirement for businesses exceeding a certain threshold,¹⁰ or require electronic evidencing. As such, they do not offer significant reference points for Korea.

Therefore, Korea needs to look for its own way to improve income identification in the context of its unique taxation environment, while keeping an eye on the latest trends in leading countries.

B. Social Insurance Administration

In terms of the role of the tax authorities in the collection of social insurance premiums, Korea is grouped with Australia and Germany as countries where the tax authorities do not directly collect social insurance premiums or support the collection thereof (OECD, 2019). Table 7 divides 58 countries (including OECD members) into three categories in terms of the role of the tax authorities in the collection of social insurance premiums. In the first group, the tax authorities collect social insurance premiums (17 countries including the United State, the United Kingdom, Sweden, and the Netherlands). In countries in the second group, the tax authorities officially support the collection function of the institutions tasked with social insurance premium collection (20 countries including France, Italy, Japan, and Norway). In the third group, the tax authorities do not collect social insurance premiums or support the

⁹ The monthly business income of sole proprietors applying for universal credit is identified by the Department for Work and Pensions, not the tax authorities (HMRC).

¹⁰ In Sweden, businesses recording SEK 400 million (KRW 5 billion) in revenues; in Germany, businesses that paid EUR 7,500 (KRW 10 million) in VAT in the previous year.

collection agencies (21 countries including Korea, Australia, and Germany).

The tax authorities' support for social insurance premium collection includes information on non-subscribers, collection of premiums in arrears, and verification of payment obligations of business owners. As mentioned earlier, Korea falls under the third group (no collection, no support), which indicates a loose connection between the national tax administration and social insurance administration. Therefore, Korea needs to redefine the function and role of the National Tax Service in the long term taking account of its own tax and welfare environment. For example, the country can expand the boundary of its national tax administration to partially include welfare administration.

Table 7_Role of the Tax Authorities in Social Insurance Contributions Collection in Selected Countries Including OECD Members (as of 2017)

Collects social insurance contributions (17 countries)	Does not collect social insurance contributions (41 countries)	
	Supports collection function (20 countries)	Does not support collection function (21 countries)
Brazil, Canada, China, Finland, Iceland, Netherlands, Russia, Sweden, UK, US, etc.	Austria, Belgium, Denmark, France, Ireland, Italy, Japan, Norway, Spain, etc.	Korea, Australia, Germany, India, Israel, Mexico, New Zealand, Portugal, Switzerland, Turkey, etc.

Source: OECD (2019), Table A.8.

III. Policy Suggestions for Improving the Income Identification System and the Social Insurance Administration

1. Income Identification System

A. Considerations

As discussed in Section 3, Chapter II, no country currently identifies the income of all citizens in real time (or at least on a monthly basis). The reason seems to be the concern over a possible increase in tax compliance costs. Therefore, before adopting a real-time income identification system for all citizens, Korea needs to specify and assess the related social benefits and costs. As such, in the following paragraphs, we review specific social benefits and costs of the adoption and operation of a real-time income identification system. First, it should be noted that the following assessment focuses on 'real time' rather than 'income identification.' In other words, we focus on the timeliness of income identification (*vis-à-vis*

accuracy), and discuss the changes in social benefits and costs relative to non-real-time (e.g., yearly) identification.

1) Social Benefits of Real-time Income Identification: Focused on usability¹¹

A) Employment Insurance

Employment Insurance contributions are charged based on employee remuneration, which requires income identification. The need for income identification has been highlighted by the plan for transition to an income-based employment insurance system and a universal employment insurance system announced in December 2020.¹² However, the extent of the necessity may vary depending on the type of eligible person and the functional area of the employment insurance. For example, real-time income identification should first focus on workers under the Employment Insurance Act, or the self-employed (both not subject to tax withholding). Notice that for these workers, direct cash flow is generated between consumers and persons eligible for employment insurance (unlike the cases where a labor platform operator with a clearly identified cash flow exists,¹³ or a withholding process exists for expense recognition). Furthermore, even when a business place provider is required to submit taxation data, its income cannot be verified if the cash flow exceeds the scope identifiable by the provider, in which case the provider may not submit income information.

11 The NTS describes the necessity of real-time income identification as follows (NTS, 2021, p. 23). First, real-time income identification allows Korea to build an efficient delivery system for bespoke welfare services. Second, real-time income identification can effectively support the expansion of the Employment Insurance to all citizens as specified in the Roadmap for a Universal Employment Insurance System. Third, by supporting welfare administration, Korea can broaden the scope of the national tax administration.

12 Korea Policy Briefing, “Roadmap for a Universal Employment Insurance System,” <https://www.korea.kr/news/policyBriefingView.do?newsId=156428888>, accessed May 30, 2022.

13 However, the identification of personal information should be regarded as a separate issue.

Table 8_Need for Improvement of Real-Time Income Identification for Universal Employment Insurance¹⁾

Function	Worker (full-time, daily)	Artist, worker (under the Employment Insurance Act)			Self-employed
		Withholding	Not withholding	Platform ²⁾	
Application	Low (can be verified by the employer)	Low (verifiable)	Low (business place provider, etc.)	Low (function of platform operators)	Low (verifiable)
Charging/ collection	Low (settlement)	Low (withholding)	High (unidentified income may exist)	Low (function of platform operators)	Low (settlement)
Benefits	Low (can be verified by the employer)	Low (identifiable)	Medium (unidentified income may exist; time gap in income change identification)	Low (function of platform operators)	High (time gap in revenue change identification)

Note: 1) The phrases in parentheses refer to the ground for the determination of necessity.

2) Separate consideration is required for whether the personal information of platform workers can be identified by platform operators.

Source: Authors.

B) Relief Funds

The interest in real-time income identification was fueled by the recent pandemic. The implementation of strict social distancing policies has had a significant financial impact on the self-employed and their employees. As Korea tried to provide financial support to the affected groups outside its social safety net, the lack of timely income information restricted the country's ability to specify the target and scale of relief provisions. For this reason, many argued for the need to identify the income of self-employed workers at least on a monthly basis, along with a significant body of work on improving the timeliness of information on self-employed workers' income.¹⁴ Therefore, the successful development and operation of a real-time income identification system is expected to enhance Korea's ability to address social and economic shocks caused by possible pandemics and other disasters in the future. The advancement of real-time income identification, however, should be preceded by discussions and a social consensus on whether Korea should endure a steep increase in tax compliance and administrative costs in order to prepare for rare incidents, and whether the country can overcome disasters through the use of universal support (which can be accompanied by an *ex-post* settlement system).

¹⁴ See Jeon and Jung (2021), for instance.

C) Earned Income Tax Credit (EITC)

Real-time income identification can enhance both the accuracy and timeliness of EITC payments. As of January 2022, in Korea, EITCs are applied for and paid on a yearly basis. However, the subsidies may be paid on a half-year basis to wage and salary income earners who wish to do so. The establishment of a universal real-time income identification is further expected to enable the government to pay EITC on a quarterly basis. However, the quarterly payment would greatly increase relevant administrative costs, and it would be difficult to streamline the current yearly settlement process. Then, the increase in net social benefits would be limited.

2) Social Costs of Real-time Income Identification: Focused on tax compliance and tax administration costs

As discussed in Section 3, Chapter II, no country currently identifies the income of all citizens in real time (or at least on a monthly basis). The frequently cited examples of universal real-time income identification (e.g. RTI in the United Kingdom, and STP in Australia) are actually restricted to withheld wage and salary income, and do not concern the real-time income identification for self-employed workers. In addition, even though some EU countries (including Germany and France) require monthly income reports for the purpose of VAT, the implications of their experiences for Korea are limited because those requirements only apply to businesses paying a VAT over certain thresholds,¹⁵ and the countries do not require electronic income evidencing. Granted, in cases including the United Kingdom's Universal Credit, self-employed workers are required to report their income on a monthly basis. However, it should be noted that these are voluntary reports from taxpayers who wish to receive universal credit.¹⁶ In addition, the reported information is not used for the application, charging, or collection of social insurance contributions; the information is only for determining the appropriateness of the provided credits.

In sum, despite its potential effect on social welfare, all selected countries do not engage in real-time income identification. Arguably, this is because of the concern over the increase

15 In Germany, a business is required to file monthly income reports only if it paid at least EUR 7,500 (KRW 10 million) in VAT in the previous year. In France, the yearly VAT threshold is EUR 4,000 (KRW 5.4 million), and other requirements apply as well.

16 The United Kingdom can induce voluntary reporting from eligible persons because the Universal Credit is a public aid program, such as the National Basic Livelihood Security Program in Korea.

in tax administration and tax administration costs. In light of the discussion so far, in the following paragraphs, we review the specific social costs of the adoption and operation of a real-time income identification system.

A) Tax Compliance Costs

The increase in tax compliance costs is one of the most significant obstacles for real-time income identification. The tax authorities need to be aware of both the revenues and costs of each self-employed worker in order to identify their monthly income, which can be achieved only through taxpayers' monthly reporting or electronic transaction records in practice.

However, it would be difficult to require taxpayers to file monthly reports (even when only requiring revenue reports). Micro-businesses currently find it difficult to file yearly reports, and a monthly reporting requirement is likely to be received as an excessive burden. In addition, without sanctions against non-reporting or poor reporting, there exists little incentive for individual taxpayers to fully comply with reporting requirements. Therefore, it would be difficult to ensure the accuracy of monthly reported revenues (or income).

As for electronic transaction records, it requires the real-time reporting of transaction details in an electronic format, which can be achieved with Korea's electronic substantiation systems (electronic tax invoices, cash receipts, etc.). However, electronic tax invoices are required only for those whose yearly value of supply equals KRW 200 million or higher, and cash receipt issuance is required only for 95 business types. Expanding the scope of electronic substantiation further is thus expected to result in greatly increased tax compliance costs and public resistance.

B) Resistance to Income Exposure: Deprivation of welfare benefits and psychological factors

Let B_n be the benefit of subscribing to an employment (social) insurance in period n , C_n the costs required in period n , r the discount rate in each period, and N the total period under consideration. Then the current value of the net benefit from employment (social) insurance subscription, denoted by PV , can be calculated as follows.

$$PV = \sum_{n=0}^N \frac{B_n - C_n}{(1+r)^n}$$

Theoretically, a person determines whether to subscribe to an employment (social) insurance by comparing its net benefit with the net benefit of non-subscription. Importantly, the full implementation of real-time income identification is likely to expose previously non-reported income, which will affect each individual differently. If an individual loses their eligibility for welfare benefits due to this exposure, real-time income identification and mandatory subscription may reduce their net benefit. Furthermore, if the number of these individuals is significant, the implementation of real-time income identification would face significant public resistance.

C) Tax Administration Costs

The full implementation of real-time income identification is highly likely to increase tax administration costs. Efforts to improve the timeliness of income identification is expected to shorten the collection cycle of taxation data, and require extensive efforts in order to verify the accuracy of the collected documents, which is likely to result in more than significant increase in administrative costs. In addition, even for transactions in which income identification is expected to be achieved through withholding taxes, there may be some cases where taxes are not withheld (e.g., businesses subject to the simplified expense rate). Thus, the tax authorities will need to be constantly ready for a swift response, which is bound to increase the costs of the relevant efforts. Granted, these issues are expected to decline as the real-time income identification system matures. Nonetheless, a sizable expense will be inevitable during the transitional period.

B. Policy Suggestions

1) Stricter Legal Obligations

Measures to improve the timeliness and accuracy of income identification include the implementation of shorter submission cycle for taxation data of business place providers, etc., and the expansion of the electronic tax invoice requirement. However, most of these measures have been implemented as of February 2022. Table 9 lists improvements taken to enhance legal obligations. In order to accurately identify the income of entrepreneurs exempted from value-added tax not subject to tax withholding, as of January 2022 labor platform operators are also subject to the taxation data submission specification requirement for business place providers, etc. However, for the more timely identification of income

earned by freelancers, etc., the submission cycle for the simplified statement of payment needs to be reduced from once a year to once a month.¹⁷ Given the high consensus for the change, we expect that the authorities will implement the change soon.

Table 9 Improvements for Income Identification System: Stricter Legal Obligations

Target			Details		Schedule
Full-time employee			Shorter submission cycle: Simplified statement of payment (wage and salary income)	Half-yearly → monthly	To be determined ¹⁾
Freelancer			Shorter submission cycle: Simplified statement of payment (other income)	Yearly → monthly	To be determined ¹⁾
Personal service provider	Exempt from value-added tax	Not subject to tax withholding (8 types)	Expansion of requirement: Taxation data submission specification of the place of business provider, etc.	Labor platform operators added	Since Jan. 2022
	Subject to value-added tax (4 types)		Expansion of electronic tax invoice requirement	Previous year's value of supply KRW 300 million → 200 million	Since Jul. 2022
			Expansion of business types subject to cash receipt requirement	19 business types added	From Jan. 2023

Note: 1) Originally included in the 2021 tax law amendment, and scheduled for application starting with income paid on July 1, 2022 and onward. However, as of February 2022, the schedule has not been determined because the relevant provisions were struck down at the National Assembly Strategy and Finance Committee meeting.

Source: Authors.

The amendment and implementation is expected to greatly increase the tax compliance costs, which means that the government may need to adopt and (temporarily) implement measures to reduce taxpayer burden, while at the same time inspecting the compliance with the amended provisions at business places.

¹⁷ As shown in Table 3, the submission cycle for the simplified statement of payment has been already reduced to once a month (for business income earned by residents).

2) Encouragement of Voluntary (Income) Reporting

In order to advance the real-time income identification system, stricter legal obligations need to be accompanied by efforts to encourage voluntary (income) reporting, which requires the revision of the Income Tax Act in order to enhance its horizontal equitability. According to an analysis on the change of tax burden from the income tax and social insurances depending on the type of employment or income, in higher income brackets, self-employed workers and capital gains report a lower burden than for employed workers and wage and salary income (Shin, 2020). In other words, the current tax and social insurance system may facilitate and boost the transition to non-standard forms of employment. Therefore, the tax burden gap between different employment and income types needs to be minimized by revisiting the tax and social insurance system.

In addition, the expansion of EITC and Child Tax Credit (CTC) may be considered as a way to encourage voluntary (income) reporting. For example, the government attempted to increase the beneficiary households of the EITC in 2019, which appears to have been a desirable attempt, in terms of improving income identification. However, the systemic and efficient operation of EITC and CTC is closely related to the improvement of income identification. For this reason, any shortcomings with the operation of these programs need to be addressed through continuous efforts, which includes rationalizing the adjustment rate for business income and increasing mutual support with other welfare fiscal programs.

3) Electronic Transaction Data and Supporting Documents

One of the major obstacles to real-time income identification is the loss or untimeliness of cash transaction data and paper documents. Therefore, in the long term, all transaction data need to be replaced by electronic evidencing documents, and thus the related infrastructure needs to be improved as well. In particular, the government needs to pay attention to micro-businesses that may have difficulty with, or even resist, electronic transactions. In the short term, infrastructure improvement efforts may take the form of a wider use of (simplified) electronic (tax) invoices, or a transaction substantiation service that uses mobile phones. In the long term, the efforts may be linked with the central bank digital currency project, the second phase of which is currently ongoing at the Bank of Korea.¹⁸ Whichever approach the government chooses, the focus should be set on usability (by businesses),

¹⁸ Bank of Korea, Results of Phase 1 of the CBDC Simulation Project and Future Plans, January 25, 2021.

benefits from using the services, and a purposeful design.

4) Development and Use of Income Estimation Models

There would be hardly be an approach that is better at ensuring the timeliness and accuracy of income identification than the adoption of a monthly income reporting requirement. However, adopting such a requirement does not currently seem to be feasible or practically possible. Therefore, until Korea achieves a tax environment that has drastically lower tax compliance costs and less resistance to monthly income reporting requirements, or until mandatory or voluntary income reporting becomes sufficiently prevalent among workers in non-standard forms of employment, the government needs to develop and rely on income estimation models. This income estimation model can be developed in various forms and levels, from a simple model utilizing credit card receipts, cash receipts, electronic (tax) invoices, tax infrastructure data, and (adjusted) standard and simplified expense rates, to a precise model powered by big data and artificial intelligence. The government needs to encourage R&D projects on the development of estimation models because, once developed, a model can be used to determine compliance with reporting requirements after the tax authorities bring its income identification capabilities to maturity.

5) Offline Tax Record Update

The efforts to advance the real-time income identification system need to be accompanied by corresponding efforts at business places. For example, a sweeping inspection of business registrations needs to be conducted for areas or business types that have frequent non-supported or disguised transactions, and the registrations of violating businesses should be revoked *ex officio*. In addition, the government needs to simplify tax administration processes, and focus administrative support on micro-taxpayers.

2. Social Insurance Administration

A. Considerations

1) Functional Integration of Administrative Services

The overall division of social insurance administration undermines the public's experience with administrative services. The division between the application, charging, collection, and benefit payment functions is bound to hinder the government's ability to handle civil complaints. If a separate organization handles the charging and collection, a subscriber must contact the organization separately for questions regarding the charging and collection (see Table 10). In a real-world case, the integrated collection of social insurance contributions by the NHIS has been reported to have saved the government KRW 28.6 billion in labor costs and KRW 12.2 billion in mailing costs per year, while improving people's convenience through the integrated notification and collection, as well as improving the collection outcomes.¹⁹ However, it does not seem to have had much effect on the convenience of the complaint handling process. Notice that in 2008 the government tried to hand over the social insurance collection function by establishing and operating a 'social insurance collection corporation' under the NTS; even under that plan, the existing social insurance corporations were still charged with handling some of the payments, applications, and collection functions (see Table 11), which restricted the prospect for quality improvement for public administrative services.

Table 10_Contact Information of Institutions for Inquiries Regarding Social Insurances

Inquiry	Name	Contact information
National Pension, and subsidies	NPS	1355
National Health Insurance	NHIS	1577-1000
Industrial Accident Compensation Insurance, and Employment Insurance (subscriptions, subsidies for contributions)	KCOMWEL	1588-0075
Employment Insurance (unemployment benefits, maternity protection)	MOEL	1350

Source: Choi et al. (2021), <Table V-1> (partially edited by the authors).

¹⁹ MOHW, press release, "A Year Since Its Implementation: the Integrated Collection of the Four Social Insurances Proves to Be Beneficial to the People," http://www.mohw.go.kr/react/al/sal0301vw.jsp?PAR_MENU_ID=04&MENU_ID=0403&CONT_SEQ=268765&page=216, accessed May 30, 2022.

Table 11_ Roles and Responsibilities of the Social Insurance Collection Corporation in the Bill Led by National Assembly Member Lee Hye-hun

Tasks		NHI	NP	EI	IACI	Social Insurance Collection Corporation
Application	Management and reporting of application, subscription, change, and expiration	○	○	○	○	○
	Encouragement, inspection, etc. targeting businesses with missed reports	○	○	○	○	○
	Determination (or application) of business types	×	×	△	○	NHI/NP: × EI: △ IACI: ○
	Income (wage) investigation and decision	○	○	○	○	○
	Management of insured's eligibility	○	○	×	×	○
	Input of reports related to business places	○	○	○	○	○
	Input of reports related to the insured	○	○	×	×	○
	Issuance of NHI certificate or subscriber certificate	○	○	×	×	NHI/NP: ○ EI/IACI: ×
Charging/ collection	Contribution rate calculation ¹⁾				○	X (IACI: ○)
	Insurer income report (insured's wage management)	○	○	×	×	○
	Contribution calculation	○	○	○	○	○
	Notification	○	○	○	○	○
	Reception, confirmation, and distribution of contributions	○	○	○	○	○
	Processing as deficit	○	×	○	○	○ (NP: ×)
	Surcharge	×	×	○	○	NHI/NP: × EI/IACI: ○
	Charging of late fees	○	○	○	○	○
	Dispositions/encouragement for taxes in arrears	○	○	○	○	○

Note: 1) Contribution rates are calculated in accordance with the law (NP), deliberations of the relevant committees such as the National Health Insurance Policy Review Committee and enforcement decrees (NHI, EI), or minister notifications (IACI). However, the actual rate is once again calculated for each business establishment in accordance with the notified rates based on the accident rate.

Source: Strategy and Finance Committee (2011), p. 4.

2) Administrative Efficiency

Administrative efficiency can be improved by integrating similar functions. Therefore, the integration of similar procedures between tax administration and social insurance administration (information collection and transfer, charging, and collection of contributions) is likely to result in improved efficiency. The issue here is the extent of the improvement. In the United Kingdom or Sweden, the transfer of social insurance functions to the tax authorities garnered marked effects in terms of administrative efficiency, because the measures were completed before the recent advancements in information and communication technology. Now, with most information stored and transferred in electronic forms, functional integration may have only a limited effect on the administrative efficiency.

However, it should be noted that information cooperation using electronic means cannot be fully implemented in the real world. The Board of Audit and Inspection reports on the use of information at social insurance corporations provide a few examples, including the lack of use of corrected income data at the NTS, the failure to seize tax refunds from people with social insurance obligations in arrears (2015),²⁰ and the failure to provide income information (other than wage and salary income) for the Durunuri project (2019) on a monthly basis.²¹

3) Social Conflicts

The integration of social insurance functions may cause various social conflicts. Foremost, we can consider the possibility of conflict between existing organizations caused by any reorganization. A merger of administrative organizations may mean the downsizing of overlapping organizations, and may even lead to conflicts among employees of different statuses, as exemplified by the organizational merger in the Netherlands in the 2000s. In addition, the transfer of all or some social insurance functions to the tax authorities may incur protests from subscribers, because the transfer means sharing all income or property information with the authorities.

20 Board of Audit and Inspection, "Operation of National Health Insurance and Other Social Insurance Programs," <https://www.bai.go.kr/bai/result/branch/detail?srno=1681>, accessed May 30, 2022.

21 Board of Audit and Inspection, "Provision and Management of Salary and Wage Income Subsidies", <https://www.bai.go.kr/bai/result/branch/detail?srno=2420>, accessed May 30, 2022.

A) Interorganizational Conflicts

The 2008 plan for the establishment of the social insurance collection corporation and the plan for collection integration projected the number of employees to be transferred at 5,000 and 1,400, respectively (see Table 12). As of 2022, the sizable gap between the number of transferred employees is likely to be greater. In 2008, the number of employees at the three services totaled around 21,000 (see Table 13); however, the number grew to around 35,000 in 2021 (see Table 14), which means that there is a larger number of employees to be transferred.

Table 12_ Comparison: Lee's Bill and Shim's Bill

Category	Lee's bill	Shim's bill
Institution taking over the functions	Social Insurance Collection Corporation (new)	NHIS
Transferred functions	Application, charging, and collection	Collection
Flow of transfer	MOHW/MOEL → NTS → Collection Corporation	MOHW(NP)/MOEL → NHIS
Supervision by the ministry	×	○
Property transferred from the existing service	○	×
No. of transferred employees	Around 5,000 (30%)	1,400 (7%)

Note: Lee's draft was discarded, and Shim's draft was approved with revision.

Source: Lee (2008), p. 7.

Table 13_Social Insurance Management Organizations in 2008

Category	NPS	NHIS	KCOMWEL	Employment Security Center(MOEL)
No. of employees	4,846	11,262	3,406	1,800 (approx.)
Organization	91 branches, 5 support centers	6 regional headquarters, 178 branches	6 regional headquarters, 43 branches, 2 training centers	Around 120 nationwide

Source: Strategy and Finance Committee (2011), p. 4.

Table 14_ Workforce Status at Social Insurance Corporations (as of the end of 1Q 2022)

(Unit: no. of executives/employees, no. organizations)

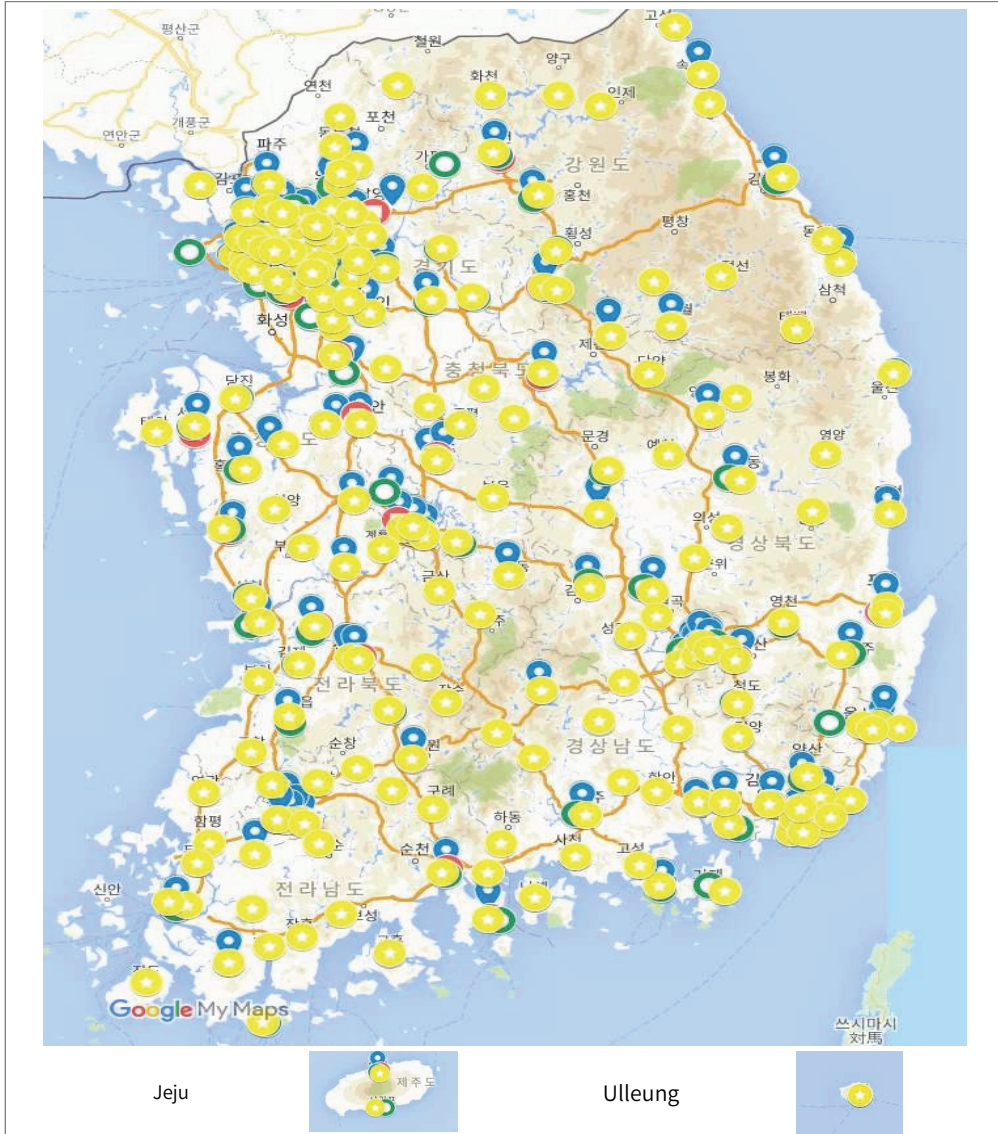
Category		National Pension Service	National Health Insurance Service	Korea Workers' Compensation & Welfare Service
Executive	Standing	6	7	6
	Non-standing	9	9	9
Regular workers ¹⁾	General	5,997 (5,886)	15,006.13 (14,721)	7,516.88 (7,465)
	Indefinite	1,271.25 (1,236)	739 (719)	1,601.75 (1,499)
Non-regular workers ¹⁾	Fixed-term	95.25 (90)	12 (12)	1,152 (1,149)
	Employed by others	7	1,624	436
Total executives/employees		7,596	16,340	10,243.63
(Regional) Sub-organizations ²⁾	Regional headquarters	7	6	7
	Branches	112	178	56 + 4 (special employment type centers)

Note: 1) The numbers in parentheses represent the number of full-time employees.

2) Only includes sub-organizations related to the application and collection of social insurance.

Source: <Table V-4> in Choi et al. (2021) updated based on the 1Q 2022 report of each service available at ALIO (<http://www.alio.go.kr/home.do>); the number of regional headquarters and branches of the NHIS updated based on the NHIS website (<https://www.nhis.or.kr/nhis/about/wbhafb01600m01.do>, accessed May 30, 2022).

Figure 3_Locations of Social Insurance Corporation Branches and Tax Offices



Note: The red, yellow, green, and blue dots represent the KCOMWEL branches, the NHIS branches, the NPS branches, and the tax offices, respectively.

Source: Choi et al. (2021), [Figure V-1].

Transferring social insurance organizations to the NTS may result in an overlap of tasks for existing NTS employees. Integrating social insurance contribution collection and tax collection across Korea, for example, would require merging some of the 137 tax offices and 239 NHIS branches/branch offices across the nation in order to improve the efficiency of charging and collection (see Figure 3). In addition, as was the case in the Netherlands, this form of integration may result in intra-organization conflict brought on by discrimination between employees of different statuses (e.g., between public officials and public institution employees).

B) Subscriber Resistance

Potential drivers of social conflict include subscribers' resistance to the transfer of income and property information (balance of financial assets, etc.) from social insurance administration organizations to the NTS.²² Specifically, the transfer may cause a conflict in two respects. First, whereas a social insurance administration organization uses property and income information solely for the charging of social insurance contributions, the NTS may use the information for the charging of various taxes, including income tax, inheritance tax, and gift tax. Second, there may be concerns about a certain administrative body holding monopoly over massive information.

B. Policy Suggestions

1) Transfer of Functions Through Reorganization

A) Transfer of functions to a new public corporation under the NTS

One of the most widely discussed reforms for the Korean social insurance administration system is to establish a collection corporation for social insurance contributions under the NTS, which would take over the collection function from the NHIS and the application function from each corresponding social insurance corporation. In fact, this option was considered at a highly concrete level under both the Roh Moohyun and Lee Myungbak governments.²³ However, the proposal was discarded in favor of the collection integration

²² There is likely to be resistance to the exposure of income is psychological resistance to the wider collection of personal information by the tax authorities.

²³ For example, the bill for the Act on the Charging and Collection of Social Insurance Contributions led by National Assembly Member Lee Hyuhun (November 7, 2008).

option led by National Assembly Member Shim Jaecheol. Unfortunately yet interestingly, ten years after the integration of the collection function under the NHIS, the collection corporation option once again gained public attention, as the integration failed to achieve its expected effects (e.g., addressing the coverage problem, improving administrative efficiency, etc.).²⁴

The option to establish a collection corporation under the NTS and transferring the charging, collection, and application functions is expected to greatly improve the administrative efficiency, as the new organization will comprehensively handle the application, charging, and collection of social insurance contributions, thereby attenuating the inefficiency issues that have been encountered over the years. In addition, establishing and operating the service under the NTS, which holds the advantage in income identification, is projected to allow for a rapid exchange of accurate income information, which is likely to have a positive impact on the social insurance coverage problem.

However, the option raises concerns about the reshuffling of the existing workforce at the social insurance service corporations. Most of the employees in charge of the application, charging, and collection would need to be transferred to the new service, and the transfer process would incur massive social costs. The establishment and operation of branches for the social insurance collection corporation would also incur significant costs, and it would take considerable time to build an information sharing system between the NTS and the collection corporation. Therefore, the net benefit of the option needs to be carefully assessed through a series of preliminary reviews and discussions.

B) Transfer of Functions to the NTS

The previous section highlighted the possible efficiency or efficacy issue caused by the establishment of a new collection corporation under the NTS. Options to address these issues include transferring the application, charging, and collection functions from each social insurance corporation to the NTS itself. To be specific, the option entails reorganizing the current social insurance administration system by establishing a new NTS department that will be tasked with the administration of the combined social insurance service.

If the NTS absorbs the application, charging, and collection works from each social insurance corporation, it will have a similar benefit to those expected from establishing a new

²⁴ For example, the bill for the Act on the Charging and Collection of Social Insurance Contributions led by National Assembly Member Ki Dongmin in July 2021 is being currently reviewed by the relevant committees.

collection corporation. In addition, the possibility of utilizing regional tax offices will drive down costs relative to the collection corporation option. However, the option is expected to complicate the workforce transfer issue, including social conflicts and costs caused by the transfer of social insurance corporation employees to public official positions at the NTS. Another noteworthy issue is the possible resistance against the collection of insurance contributions by the tax authorities, which needs to be carefully considered before implementing the option.²⁵

2) Redistribution of Roles and Gradual Integration

The functional transfer discussed in subsection 1 above involves transferring parts of the social insurance service organizations and their charging, collection, and application functions to the NTS. However, this approach requires a reorganization that may result in serious social conflicts, as well as the charging of confusion and inconvenience in terms of affecting services to the public.

In this respect, we can consider an alternative to the organizational and functional integration discussed above, by assigning the relevant roles to organizations capable of efficiently and effectively managing the administrative tasks for different types of subscribers. This alternative is expected to create relatively less social conflicts and costs, and facilitate the integration of the divided social insurance functions over time. The option also allows for a single institution to handle all requests and complaints from a single subscriber, thereby creating a one-stop shop for subscribers.²⁶

In order to determine which institution would handle which subscriber type, we can use the ease of income identification as a criterion. A social insurance corporation can handle subscribers whose income information only has to be transferred to the service. The tax authorities can handle subscribers whose income information is inaccurate and thus require estimation, verification, and *ex officio* registration. Specifically, the government can consider having the tax authorities take over subscribers who are self-employed workers or personal service providers that are not subject to tax withholding.

25 Other issues regarding the functional transfer to the NTS include the adoption of a social security tax, and possible conflict with the ‘no taxation without law’ principle under the Constitution. However, these issues lie outside the purview of this study.

26 Subscribers will need to be informed of the institution for different subscriber types (e.g., for subscribers who are employment income earners as well as sole proprietors).

A) Transfer of Functions Regarding Subscribers Not Subject to Tax Withholding

As discussed in Section 1, Chapter II above, personal service providers not subject to tax withholding include courier drivers, construction machinery operators, home appliance technicians, truck drivers, and other taxable entrepreneurs, as well as housekeepers, used car sellers, chauffeurs, ‘quick service’ providers (e.g., package delivery drivers), caddies, caregivers, body scrubbers (bathhouse employees), and other tax-exempt entrepreneurs (see Tables 3 and 4). As of January 2022, the income identification rate of these business income earners not subject to tax withholding is lower than that of the personal service providers subject to tax withholding (e.g., insurance planners, door-to-door salespersons, and visiting teachers (home school materials and educational materials), etc.) whose income is identified using simplified statements of payment (residents’ business income) monthly submitted to the tax authorities. Accordingly, their social insurance subscription rate is low as well. The government can consider transferring the application, charging, and collection functions for these personal service providers from the social insurance corporations to the tax authorities.

One of the major benefits of this option is the possible alleviation of the coverage problem, as the option may increase the social insurance subscription of these personal service providers—who had not been previously covered by the social insurance schemes due to difficulty with income identification. In addition, the option has the NTS (which specializes in income identification) handle the administrative works for (some) workers in special employment, which may improve the administrative efficiency. However, the option may inconvenience and confuse subscribers because, since the social insurance requirement was expanded to include some personal service providers not subject to tax withholding, social insurance corporations have been already handling the administrative functions for them. In addition, this option is likely to cause confusion in the short term because the (potential) subscribers have to identify their relevant social insurance administration organization on their own. However, with the scope of personal service providers subject to social insurance requirement expected to broaden over time, the government needs to closely consider this option along with its benefits and feasibility.

B) Transfer of Functions Regarding Self-Employed Workers

We previously pointed out the possible cost issue and difficulty with identifying eligible persons when transferring the social insurance administration functions for personal service providers not subject to tax withholding to the tax authorities. As a means to address these issues while avoiding the side effects of reshuffling administrative organizations to the possible extent, the government can consider transferring the social insurance functions related to self-employed workers to the tax authorities. Under this option, the NTS would handle all income identification, application, charging, and collection functions for self-employed workers, who have been left out of the institutional coverage of current social insurance schemes. This option involves readjusting the distribution of social insurance administration functions so that the NTS may serve as a one-stop shop (for self-employed workers, at least).

This option offers the benefit of a clear distinction between (potential) subscribers to be handled by different institutions, and a minimization of the employees and functions to be transferred. Furthermore, considering the Roadmap for a Universal Employment Insurance System, which includes the mandatory application of employment insurance to self-employed workers by 2025, selecting an institution dedicated to self-employed workers is likely to add momentum to the wider trend of an improved social safety net. However, the option may require the NTS to set up a new organization, and this organization's functions may still overlap with those of existing social insurance corporations.

3) Summary

The discussions on possible improvements for the social insurance administration system are outlined in Table 15 below.

Table 15_ Medium- and Long-Term Improvements for the Social Insurance Administration System

Improvements		Pros	Cons
Transfer of functions through reorganization	Transfer of functions to a new public corporation under the NTS	- Improves administrative efficiency - Alleviates the social insurance coverage problem	- Requires transfer of social insurance corporation employees - Incurs costs regarding branch establishment and operation for the social insurance collection corporation
	Transfer of the functions to the NTS	- Improves administrative efficiency - Alleviates the social insurance coverage problem - Allows the use of regional tax offices	- Requires transfer of social insurance corporation employees - Contributions collection by the NTS may face resistance
Redistribution of roles and gradual integration	Transfer of functions regarding subscribers not subject to tax withholding	- Improves administrative efficiency - Alleviates the social insurance coverage problem	- May inconvenience or confuse subscribers
	Transfer of functions regarding self-employed workers	- Offers clear distinction of (potential) subscribers to be handled by each institution - Minimizes the scope of transfer	- Need to set up a new organization in the NTS, and incur the relevant expenses - Some functions may still overlap

Source: Authors.

IV. Summary and Conclusions

Against the backdrop of higher demand for and necessity of social safety net reform, this report sought ways to advance Korea's real-time income identification practices and strengthen their ties with social insurance administration. Before the COVID-19 pandemic, the income identification cycle was longer than a month for most employed workers. However, in order to improve the effectiveness of the Roadmap for a Universal Employment Insurance System, the government has been shortening the income identification cycle for the vulnerable to a month. The stable and successful operation and advancement of a real-time income identification system also requires efforts to encourage voluntary (and compliant) income reporting. Until the mandatory/voluntary (income) reporting practices take root deeply in Korea, however, the government needs to consider the development and use of income estimation models.

Our findings indicate a weak connection between tax administration and social insurance administration in Korea, implying that the government has sufficient room to expand on the roles and functions of the tax authorities. The expansion of the NTS's roles needs to be (re)directed based on social discussions and consensus. In the short term, the government needs to build a system for real-time income identification and individual-level management

of income information in order to support the Roadmap.

In the medium- and long-term, the government may consider (1) the (instantaneous) transfer of social insurance administration functions through reorganization, or (2) gradual absorption through the (re)distribution of roles and functions across the NTS and social insurance public corporations. The government may be able to improve efficiency and address the coverage issue by transferring the administrative functions to either the NTS or a new public corporation (specializing in the collection of social insurance contributions) under the NTS. This transfer process, however, is highly likely to incur considerable social costs. In contrast, if the government chooses the option to transfer the social insurance functions related to self-employed workers or personal service providers not subject to tax withholding, the resulting cost may be relatively low. However, this option is not likely to offer much in the way of improved administrative efficiency, as multiple administrative institutions will still perform the same functions. In conclusion, subsequent studies and public discussions are necessary to shape the future direction of Korea's social insurance administration from a long-term and comprehensive perspective.

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Appendix

While the main text focused only on the improvement of the social insurance administration, the government also needs to engage in efforts to improve the alignment between the four social insurance schemes (Choi et al., 2021). For instance, the requirement regarding each type of social insurance may vary depending on whether a worker is classified as daily workers (see Table A1). However, as of January 2022, the Income Tax Act and the laws governing subscriber types of social insurance provide inconsistent definitions for daily workers (see Table A2). This discrepancy, as can be easily expected, has been a source of inconvenience and confusion for both subscribers and business owners. Thus, even considering the nature of each scheme, the four types of social insurance need to be better aligned with each other.

Table A1_Differences between daily workers and business operators under social insurance laws

Social insurance	When classified as daily workers	When classified as entrepreneurs
Employment Insurance	Mandatory	Non-mandatory ¹⁾
Industrial Accident Compensation Insurance	Mandatory	Non-mandatory ²⁾
National Health Insurance	Self-employed insured ³⁾⁴⁾	Self-employed insured ³⁾
National Pension	Individually insured ⁴⁾	Individually insured

Note: 1) Mandatory subscription for workers.

2) Mandatory subscription for persons in special types of employment.

3) Classified as a dependent if supported by other family members and income/assets are below specified thresholds.

4) The employee insured or workplace-based insured persons if working for a month or longer, and working 8 days or more per month or 60 hours or more per month (as of July 2021).

Source: National Tax Service (2021), p. 73.

Table A2_ Definitions of daily workers under the Income Tax Act and social insurance laws

Law	Definition	Meaning of periods (3 months, 1 month, etc.)	Wage calculation
Enforcement Decree of The Income Tax Act, Article 20 (1)	<ul style="list-style-type: none"> • Paid wages based on the number of work days, and not employed by the same employer for three months or longer 	Period of actual work	Daily/ Hourly wage
Employment Insurance Act, Article 2 (6)	<ul style="list-style-type: none"> • Employed for a period of less than a month 	Term of contract	-
Enforcement Decree of The Industrial Accident Compensation Insurance Act, Article 23	<ul style="list-style-type: none"> • Employed on a daily basis or paid wages based on the number of work days, and employed by the same employer for 3 months or less 	Period of actual work	Daily wage
National Health Insurance ¹⁾	<ul style="list-style-type: none"> • Employed on a daily basis, with employment contract terminated on the same day 	-	-
National Pension ²⁾	<ul style="list-style-type: none"> • Labor contract executed on a daily basis (the standard definition for daily workers applied) 	-	-

Note: 1) The definition reflects the Workplace Manual 2020 (p. 23) (no specific definition under the National Health Insurance Act).

2) The definition reflects the glossary at the NPS website (no specific definition under the National Pension Act).

Source: Choi et al. (2021), <Table V-9>.

A Study on Measures to Improve the Effectiveness of Public Procurement Fiscal Expenditures

Woo hyun Chang, Hee woo Kang, and Jin soo Bae

I. Introduction

The primary purpose of procurement administration is to contribute to the national economy by ensuring the quality of public administration services. This is achieved by procuring resources necessary for the production of these public services in the most efficient manner, based on quality and price standards. However, in reality, procurement administration has also considered a variety of ancillary policy goals beyond its original purpose, such as support for small and medium-sized enterprises (SMEs) and women-owned businesses, prompted by external demands. For example, according to the Ministry of SMEs and Startups (April 24, 2019), of the total public institution purchases amounting to 123 trillion won in 2018, 94 trillion won (76.2%) were used to purchase products from SMEs.

While policies that provide public procurement opportunities for specific targets do allow those companies to enjoy sales opportunities and accumulate profits and experience, it's also clear that these policies incur costs for the national economy. Contrary to common belief, such public procurement policies are not without cost.

The first type of cost associated with these policies is the decline in productivity within the public sector. Although they do not lead to a direct reduction in finances as with fiscal expenditure or tax reduction policies, they can cause indirect costs that affect government

productivity both in the short and long term. Products or services reflecting specific policy goals, as opposed to those optimized purely for quality and price, are naturally less productive than optimal choices.

Another cost to consider is the potential adverse impact on long-term public finances if procurement is not optimized based on quality and price standards. For instance, purchasing less durable goods may lead to frequent replacement demands within the public sector, which, in turn, places a long-term financial burden on government finances.

Finally, sustaining less competitive SMEs reliant on government procurement markets can cause direct and indirect negative effects on national competitiveness. Such effect was empirically confirmed by Chang (2016) who utilized Mining and Manufacturing Survey by Statistics Korea and procurement history data from the PPS (Public Procurement Service) of Korea. The analysis revealed that firms participating in SME-exclusive bidding procurement showed significantly lower total factor productivity over time.

Therefore, when secondary policy goals beyond the main policy objectives are considered in procurement administration, an essential process is the evaluation of their quantitative benefits and costs. To justify policies that entail costs to the national economy, it must be demonstrated that such policies indeed yield national economic benefits.

However, there is still a lack of quantitative and consistent evaluation and policy improvement feedback derived from the evaluation regarding the actual distribution status of government procurement demand and the performance of public procurement. Recognizing this issue, this study aims to review the current state of public procurement fiscal expenditure and explore measures to manage and evaluate policies based on evidence to enhance effectiveness. In doing so, this study is structured as follows: Chapter 2 examines how public procurement policies are targeted by industry, using data from Korea Enterprise Data and public procurement records, by looking at current conditions based on public procurement/sales and SME-exclusive bidding procurement/sales for SMEs in sub-class industries and reviews the policy implications. Chapter 3 analyzes the impact of actual public procurement on various performance indicators. Chapter 4 summarizes policy recommendations, and Chapter 5 concludes the study.

II . Analysis of Public Procurement Policy Targeting

1. Basic Statistics

In this chapter, we will examine how public procurement policies are targeted across different industries based on domestic procurement data¹ from the Public Procurement Service (PPS) for the period 2011-2015. For reference, several studies, including Chang (2016), have explored how procurement policies are targeted at specific industries using micro-policy history. However, Chang (2016), limited by the data availability at the time, confined its analysis to the period 2008-2011 and used the Mining and Manufacturing Survey, restricting the findings to these sectors unlike our study.

Chapters 5 and 6 provide two main benefits from confirming industry-specific targeting and analyzing effectiveness, respectively. First, it's necessary to verify whether public procurement policies can be applied universally. Unlike other fiscal expenditures that can generally fund all industries in need via subsidies or financial aid, public procurement is limited to the demands of the public sector. Therefore, if there is no demand in a specific industry, procurement policies may not be effectively utilized. Second, it's important to verify the effects at the industry level to substantiate claims about the efficacy of public procurement policies. This stepwise verification helps establish causality, which can be challenging with macro-level aggregate variables. If there are no effects observed at the individual firm or industry level, yet the overall economic impact is noted, it suggests that the observed effects stem from untargeted areas, which would be an illogical conclusion.

This study utilizes firm data from Korea Enterprise Data (2019) covering 2011 to 2018. Although not exhaustive, this dataset includes most SMEs (excluding some micro-enterprises or self-employed individuals) and is recognized as a suitable database for analyzing SME policies. Additionally, employment insurance data from the Employment Information Service (2018) is linked for employment information.

Table II-1 summarizes the integrated results of data from the PPS (2016) domestic procurement, Korea Enterprise Data, and employment insurance records. In 2015, the linked database contains 305,373 enterprises, with 298,666 being SMEs, and 6.49 million insured

¹ "Domestic procurement" refers to goods and services produced or supplied within the country, excluding facility construction. It contrasts with "foreign procurement," which historically involved goods and services not produced domestically or purchased with loan funds, although its significance has decreased recently.

employees, 3.86 million of which are affiliated with SMEs. Total assets amount to 8,170 trillion won, with SMEs accounting for 1,180 trillion won. Total sales revenue is 3,780 trillion won, with SMEs contributing 1,180 trillion won. Public procurement expenditure exceeded 20 trillion won in 2015, while competitive procurement for SMEs amounted to approximately 5.8 trillion won.

Table 1_Basic Statistics After Merging Korea Enterprise Data, Korea Employment Insurance Service Data, and Public Procurement Service Domestic Procurement Data (Years 2011 to 2015)

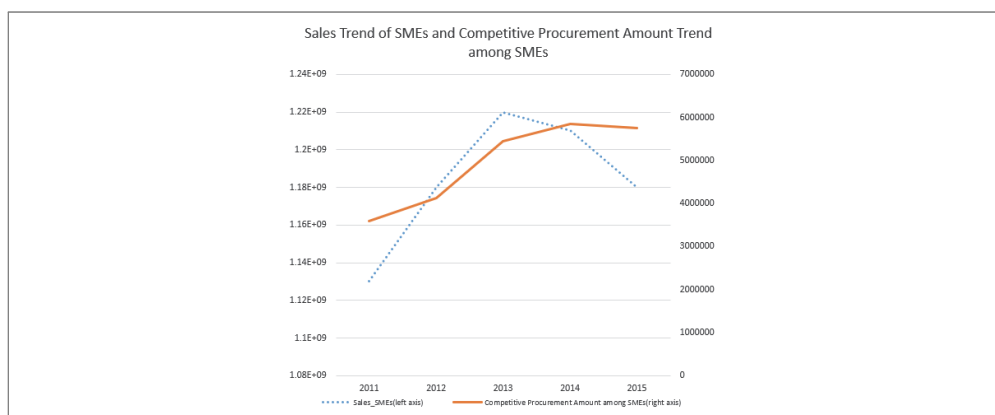
(Unit: KRW 1 trillion, number, persons)

Year	No. of firms	No. of firms (SMEs)	Insured Employees	Insured Employees (SMEs)	Total assets	Total assets (SMEs)	Sales	Sales (SMEs)	Public procurement amount	SME competitive procurement amount
2011	255,341	249,772	5,443,242	3,320,682	4,410	1,140	3,300	1,130	15	3.6
2012	282,510	276,704	5,981,014	3,660,794	5,350	1,250	3,650	1,180	16.5	4.1
2013	307,755	301,539	6,353,914	3,900,574	6,460	1,210	3,640	1,220	18.4	5.5
2014	320,987	314,393	6,537,917	3,933,831	7,810	1,180	3,870	1,210	20.1	5.8
2015	305,373	298,666	6,486,781	3,856,501	8,170	1,180	3,780	1,180	20.4	5.8

Source: Present study, based on Public Procurement Service (2016), Korea Employment Information Service (2018), and Korea Enterprise Data (2019).

For reference, as shown in [Figure 1], although SME sales increased and then decreased during the period, the amount of SME-exclusive bidding program or shows an upward trend.

Figure 1_Trends in SME Sales and Competitive Procurement Amounts, Years 2011–2015



Source: Present study, based on Public Procurement Service (2016) and Korea Enterprise Data (2019).

2. Analysis of Targeting Status by Sub-category Industry

Next, we will examine the targeting status by subsector industry. [Figures II-2] to [Figures II-3] calculate the public procurement amount/sales ratio and the SME-exclusive bidding procurement amount/SME sales ratio for subsector industries, divided into primary, secondary, and service industries from 2011 to 2015.

As observed in the figures, for non-service industries such as manufacturing and construction, procurement demand is concentrated in specific subsector industries like cement, electricity, and sports equipment manufacturing. For service industries, the demand is skewed towards subsectors like book publishing, magazine publishing, computer programming, system integration, market research, and public opinion polling.

As of 2015, it is evident that out of the 206 subsector industries used in this study, there are no companies participating in public procurement in 46 subsector industries. Additionally, in 68 subsector industries, no SMEs benefiting from SME-exclusive bidding procurement for SME products are identified.

III. Analysis of the Effectiveness of Public Procurement Policies

In this chapter, based on the data established in Chapter 2, we present examples of analyzing the effectiveness of public procurement policies and discuss the procedures for deriving measures to improve the effectiveness of these policies based on the evaluation results.

To confirm whether the public procurement market provision policy has achieved the targeted effects, it is fundamentally necessary to evaluate how much the performance indicators of companies that participated in public procurement have improved compared to those that did not. If effectiveness is not observed at the individual company level, it is difficult to expect effectiveness at the industry or national economy levels. Therefore, the analysis of effectiveness at the individual company level is a basic element in the policy effectiveness analysis of public procurement.

However, we should bear it in mind that even if there were positive effects at the individual company level, this does not necessarily imply effectiveness at the industry or national economy levels. Improved performance at the individual company level could merely represent a shift in opportunities from other companies within the same industry, leading to no net effect at the industry level. Similarly, positive effects at the industry level might substitute for opportunities in other industries, making it difficult to justify an overall positive effect at the national economic level.

For this analysis, we combined the PPS domestic procurement data from 2011 to 2015 with data from Korea Enterprise Data for 2011 to 2018 and employment insurance data from 2011 to 2017 to analyze managerial and employment performance. By combining policy variables and firm data in a multi-year panel structure, we tried to control for endogeneity, leveraging the strengths of the data, and utilized fixed-effect panel models controlling for year characteristics, firm characteristics, and support timing as much as possible. To evaluate both short-term and long-term effects of procurement policy, we analyzed the performance of SMEs participating in procurement compared to non-participating firms over a period of 1 to 3 years.

At the individual firm level, in the short term, SMEs that participated in public procurement showed a 0.98 percentage points higher increase in the operating income to total assets ratio (significant at the 1% level) and an increase in sales by 154 million Korean Won (significant at the 1% level) compared to similar SMEs that did not participate. These findings indicate that participation in public procurement helped improve the profitability and growth

of SMEs in the short term, suggesting that the short-term policy goals were successfully achieved.

For reference, here is an example of the estimation equation used to predict the policy effects one year period.

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

$\Delta y_{i,t}$: management performance indicator increments of firm from t-1 to t

$P_{i,t}$: dummy variable, whether firm participates in procurement policy in t

$x_{i,t-1}$: characteristics of firm in t-1

$I_{i,t-1}$: characteristics of the industry where firm operates in t-1

ν_i : firm fixed effect

v_t : year fixed effect

The fixed-effect panel model presented in this study utilizes net increments rather than logs or levels. This approach is taken because growth is an important outcome in corporate policies, including SME policies. Furthermore, in the evaluation of SME policies, the relationship of increments has been found to be more stable than levels. Additionally, using logs is not meaningful when negative values, such as operating losses, are present, since logarithms cannot be applied in such cases. It is worth noting that there is no qualitative difference in the results whether logs or levels are used in the analysis. However, since increments lead to more reasonable results when using estimated values, the results will be reported based on the effects of policies on the potential of growth increments, considering increments and fixed effects of increments as the basic framework.²

² For reference, the robustness is confirmed by performing an analysis using the level variable as a dependent variable in all analyses. There are no cases in which qualitatively different results are derived, to the extent that the sign or interpretation changes.

Table 2_1 Period Effect by Public Procurement Availability

(Unit: %p, KRW 1 million)

VARIABLE	ROA	Sales	Total assets	Operating profit
Public procurement availability	0.976*** (0.327)	154.0*** (38.65)	39.46* (23.82)	8.056 (10.90)
L. Sales	-0.000246*** (1.77e-05)		-0.103*** (0.00122)	-0.0676*** (0.000561)
L. Total assets	7.34e-05*** (2.43e-05)	-0.132*** (0.00273)		-0.0392*** (0.000811)
L. Operating profit	-0.00677*** (6.93e-05)	-0.931*** (0.00796)	0.109*** (0.00516)	
L. Life-span of firms	-0.271 (0.851)	-45.82 (100.5)	63.15 (61.97)	-27.36 (28.36)
L. Youth employment	-0.00718 (0.00635)	-3.088*** (0.750)	-0.910** (0.462)	0.260 (0.212)
L. Senior employment	-0.00575 (0.00430)	2.414*** (0.507)	-0.122 (0.313)	1.240*** (0.143)
L. SME average assets	0.000647*** (0.000214)	0.0925*** (0.0253)	0.000748 (0.0156)	-0.0212*** (0.00714)
L. SME average sales	-0.000995*** (0.000283)	-0.280*** (0.0334)	0.0369* (0.0206)	0.0610*** (0.00944)
L. SME average operating profit	0.00701*** (0.00142)	0.159 (0.167)	0.238** (0.103)	-0.622*** (0.0472)
L. SME average R&D expenses	0.00629*** (0.00156)	0.301 (0.184)	-0.254** (0.113)	0.0862* (0.0518)
L. SME average life span	0.514** (0.208)	-68.94*** (24.53)	-4.110 (15.11)	-13.84** (6.918)
L. SME average ROA	-0.282*** (0.0389)	12.30*** (4.598)	2.082 (2.834)	3.989*** (1.297)
Year 2013	-0.340 (0.860)	-8.420 (101.6)	-19.85 (62.63)	58.11** (28.67)
Year 2014	-0.982 (1.710)	-61.34 (202.0)	-67.05 (124.5)	117.4** (56.98)
Year 2015	-1.118 (2.561)	-153.5 (302.5)	-207.4 (186.4)	188.2** (85.34)
L. ROA		-3.184*** (0.282)	1.537*** (0.174)	-7.772*** (0.0778)
Constant	2.823 (6.564)	2,595*** (775.5)	125.9 (477.8)	694.8*** (218.8)
Observations	684,891	684,926	684,926	684,926
R-squared	0.031	0.051	0.019	0.086
No. of firms	288,570	288,587	288,587	288,587

Note: 1) Standard errors in parentheses

2) *** p < 0.01, ** p < 0.05, * p < 0.1

Source: Present study, based on Public Procurement Service (2016), Korea Employment Information Service (2018), and Korea Enterprise Data (2019).

However, another aspect of the 3 Periods effect is different from the 1 Period and 2 Periods effects. No improvement is observed in terms qualitative indicators such as ROA or operating profit, nor in quantitative indicators such as sales or total assets. There is even a tendency for operating profit to decrease, albeit with weak statistical significance (significant at 10%). Thus, it is difficult to conclude that procurement policies serve as a catalyst for performance improvement in SMEs. Given that the policy effects do not extend beyond the year of support or the following year, it is necessary to seek ways to improve the long-term effects of procurement policies.

Table 3_3 Periods Effect Management Indicators by Public Procurement Availability

(Unit: %, KRW 1 million)

VARIABLE	ROA	Sales	Total assets	Operating profit
L2. Public procurement availability	-0.114 (0.491)	-33.56 (81.08)	-46.27 (53.48)	-40.08* (21.14)
L3. Sales	-0.000239*** (3.04e-05)	-0.133***	-0.0901*** (0.00321)	-0.0999*** (0.00123)
L3. Total assets	0.000301*** (4.72e-05)	-0.441*** (0.00755)		-0.0298*** (0.00203)
L3. Operating profit	-0.00704*** (0.000122)	-1.477*** (0.0196)	-0.0980*** (0.0137)	
L3. Life-span of firms	-3.085 (4.716)	-74.24 (779.4)	-25.84 (514.1)	-17.74 (203.2)
L3. Youth employment	-0.0167 (0.0116)	-17.00*** (1.918)	-7.338*** (1.266)	-1.357*** (0.500)
L3. Senior employment	-0.00655 (0.00744)	-9.513*** (1.228)	-4.467*** (0.811)	1.883*** (0.320)
L3. SME average total assets	-7.79e-06 (0.000385)	-0.168*** (0.0637)	0.0558 (0.0420)	-0.0874*** (0.0166)
L3. SME average sales	-0.000346 (0.000569)	-0.461*** (0.0940)	-0.109* (0.0621)	0.148*** (0.0245)
L3. SME average operating profit	0.00821*** (0.00275)	0.681 (0.455)	2.024*** (0.300)	-1.176*** (0.119)
L3. SME average R&D expenses	0.0105*** (0.00317)	-0.579 (0.524)	-0.942*** (0.346)	0.325** (0.137)
L3. SME average life-span	0.408 (0.467)	-56.69 (77.23)	17.66 (50.94)	-19.17 (20.14)

Table 3_3 Periods Effect Management Indicators by Public Procurement Availability(continued)

VARIABLE	ROA	Sales	Total assets	Operating profit
L3. SME average ROA	-0.347*** (0.0742)	11.55 (12.27)	-7.426 (8.095)	7.328** (3.200)
Year 2015	2.113 (4.718)	-188.9 (779.8)	-49.55 (514.4)	69.93 (203.3)
L3. ROA	-3.506***	3.627*** (0.746)	-8.680*** (0.492)	-9.108*** (0.189)
Constant	25.50 (40.46)	6,307 (6,686)	1,935 (4,411)	754.9 (1,743)
Observations	248,891	248,905	248,905	248,905
R-squared	0.047	0.121	0.029	0.101
No. of firms	158,656	158,664	158,664	158,664

Note: 1) Standard errors in parentheses

2) *** p < 0.01, ** p < 0.05, * p < 0.1

Source: Present study, based on Public Procurement Service (2016), Korea Employment Information Service (2018), and Korea Enterprise Data (2019).

Next, using the PPS domestic procurement data from 2011 to 2015, we evaluated the employment performance of SMEs that received procurement benefits. Since one of the main goals of SME policies is to enhance employment and the creation of quality jobs, the evaluation of employment performance is also an important factor. Similar to the previous section, we analyzed the performance of individual firms over a period of 1 to 3 years, with key performance indicators including the number of employment insurance registrations, the number of youth employment insurance registrations, and the number of quality youth employment insurance registrations. The criterion for a quality job is a monthly wage of 2 million won or more (in 2010 prices) adjusted for inflation using the GDP deflator.

In the first period effect, it was found that firms participating in public procurement saw an increase of 0.84 in the number of employment insurance registrations (significant at the 1% level). Youth employment insurance registrations also increased by 0.438 (significant at the 1% level), indicating that there was an effect on the primary policy goal of increasing youth employment at the individual firm level. However, no significant increase was found in quality youth employment insurance registrations, indicating that the increase was in general job positions, not high-quality jobs.

Table 4_1 Period Effect Employment Indicators by Public Procurement Availability

(Unit: %p, KRW 1 million)

VARIABLE	Employment insurance enrolled	Youth employment insurance enrolled	High-quality youth employment insurance enrolled
Public procurement availability	0.840*** (0.250)	0.438*** (0.108)	0.00364 (0.0278)
L. Sales	-0.000270*** (1.34e-05)	-5.07e-05*** (5.78e-06)	-1.09e-05*** (1.49e-06)
L. Total assets	-1.24e-05 (1.84e-05)	2.73e-05*** (7.94e-06)	-5.63e-06*** (2.05e-06)
L. Operating profit	8.39e-05 (5.22e-05)	3.17e-05 (2.25e-05)	5.83e-05*** (5.81e-06)
L. Life-span of firms	0.120 (0.607)	0.144 (0.262)	-0.0153 (0.0675)
L. ROA	-0.00692*** (0.00221)	-0.00130 (0.000952)	-0.000245 (0.000246)
L. Loss of youth employment	-0.767*** (0.00492)	-0.693*** (0.00212)	-0.00765*** (0.000548)
L. Loss of senior employment	-0.476*** (0.00348)	-0.00465*** (0.00150)	-0.00602*** (0.000388)
L. SME average total assets	-0.000694*** (0.000170)	5.97e-05 (7.31e-05)	-7.14e-06 (1.89e-05)
L. SME average sales	0.000104 (0.000223)	-3.22e-05 (9.61e-05)	1.55e-05 (2.48e-05)
L. SME average operating profit	0.00101 (0.00107)	0.000776* (0.000460)	-0.000142 (0.000119)
L. SME average R&D expenses	0.000489 (0.00121)	-0.00176*** (0.000523)	-0.000305** (0.000135)
L. SME average life-span	0.0285 (0.164)	0.0353 (0.0709)	-0.0261 (0.0183)
L. SME average ROA	-0.0632** (0.0307)	-0.0270** (0.0132)	0.000523 (0.00342)
Year 2013	0.0826 (0.615)	-0.198 (0.265)	0.0570 (0.0685)
Year 2014	0.298 (1.220)	-0.281 (0.526)	0.116 (0.136)
Year 2015	1.175 (1.827)	-0.257 (0.788)	0.196 (0.203)
Constant	7.660 (5.114)	0.969 (2.205)	0.491 (0.569)
Observations	511,463	511,463	511,463
R-squared	0.171	0.283	0.003
No. of firms	214,434	214,434	214,434

Note: 1) Standard errors in parentheses

2) *** p < 0.01, ** p < 0.05, * p < 0.1

Source: Present study, based on Public Procurement Service (2016), Korea Employment Information Service (2018), and Korea Enterprise Data (2019).

3 year periods effects also differ from those observed in the 1 year and 2 years analysis, and concerning results can be identified. SMEs that received procurement benefits and participated in the market showed a decrease of 1.5 in employment insurance registrations compared to similar firms. There was no significant increase in youth employment registrations, and no significant increments were found in quality job registrations either. Similar to the managerial performance discussed in Section 1, the employment outcomes also do not show policy effects of the procurement market provision policy beyond the third period, and in some cases, negative aspects are observed. Therefore, there is a need for policy improvements to ensure that the participation of individual firms in procurement policies leads to long-term performance gains.

Table 5_3 Periods Employment Indicators by Public Procurement Availability

(Unit: %, KRW 1 million)

VARIABLE	Employment insurance enrolled	Youth employment insurance enrolled	High-quality youth employment insurance enrolled
L2. Public procurement availability	-1.492*** (0.555)	0.149 (0.259)	-0.000585 (0.0581)
L3. Sales	-0.000232*** (3.38e-05)	-6.54e-05*** (1.58e-05)	3.49e-06 (3.53e-06)
L3. Total assets	-0.000311*** (5.29e-05)	-0.000132*** (2.47e-05)	-1.70e-05*** (5.53e-06)
L3. Operating profit	-0.000259* (0.000139)	-0.000262*** (6.47e-05)	-3.39e-05** (1.45e-05)
L3. Life-span of firms	-0.979 (4.728)	-0.940 (2.205)	-0.474 (0.494)
L3. ROA	-0.00662 (0.00626)	-0.000653 (0.00292)	0.00103 (0.000654)
L3. Loss of youth employment	-1.095*** (0.0132)	-0.912*** (0.00617)	-0.0233*** (0.00138)
L3. Loss of senior employment	-0.305*** (0.00853)	0.0349*** (0.00398)	-0.00503*** (0.000891)
L3. SME average total assets	-0.000736 (0.000451)	0.000149 (0.000210)	-3.20e-05 (4.71e-05)
L3. SME average sales	-0.000522 (0.000655)	-0.000470 (0.000305)	0.000202*** (6.84e-05)
L3. SME average operating profit	0.00351 (0.00318)	0.00318** (0.00148)	-0.000326 (0.000333)

Table 5_3 Periods Employment Indicators by Public Procurement Availability(continued)

VARIABLE	Employment insurance enrolled	Youth employment insurance enrolled	High-quality youth employment insurance enrolled
L3. SME average R&D expenses	0.000429 (0.00363)	0.000806 (0.00169)	-0.000695* (0.000379)
L3. SME average life-span	0.943* (0.545)	0.579** (0.254)	-0.111* (0.0569)
L3. SME average ROA	-0.143* (0.0859)	-0.143*** (0.0401)	0.0110 (0.00898)
Year 2015	1.721 (4.732)	1.078 (2.206)	0.654 (0.494)
Constant	14.22 (43.70)	8.964 (20.38)	4.922 (4.567)
Observations	185,529	185,529	185,529
R-squared	0.141	0.262	0.008
No. of firms	120,183	120,183	120,183

Note: 1) Standard errors in parentheses

2) *** p < 0.01, ** p < 0.05, * p < 0.1

Source: Present study, based on Public Procurement Service (2016), Korea Employment Information Service (2018), and Korea Enterprise Data (2019).

Next, we evaluate the outcomes of the SME-exclusive bidding, which has been gaining prominence among SME policies and can be seen as a relatively strong regulatory differentiation. The SME-exclusive bidding system excludes large firms, allowing only SMEs to compete and win contracts. This makes it a high-level regulatory mechanism for the protection and fostering of SMEs. As before, we analyze the performance at the individual firm level over a period of 1 to 3 years. Key performance indicators include managerial metrics such as the operating income to total assets ratio, sales revenue, operating profit, and total assets, as well as employment metrics such as the number of employment insurance registrations, the number of youth employment insurance registrations, and the number of quality youth employment insurance registrations. Again, a quality job is defined as one with a monthly wage of 2 million won or more (in 2010 prices) adjusted for inflation using the GDP deflator.

First, regarding the evaluation of short-term managerial indicators, as seen in Table 5, firms that participated exclusively in SME competitions saw an increase in sales revenue of approximately 218 million won compared to similar firms. However, there were no improvements in qualitative indicators such as the ROA or operating profit. This differs from the general SME benefits discussed in Section 1 and also from the findings of Chang (2016).

Considering that the SME exclusive bidding procurement is designed to provide SMEs with greater growth opportunities and benefits, it is concerning that the system does not yield higher performance compared to other general SME participation.

Table 6_1 Period Effect Management Indicators by SME-Exclusive bidding Procurement Availability

(Unit: %p, KRW 1 million)

VARIABLE	ROA	Sales	Total assets	Operating profit
SME-Exclusive bidding procurement availability	0.666 (0.446)	218.0*** (52.63)	56.21* (32.44)	2.914 (14.85)
L. Sales	-0.000246*** (1.77e-05)	-0.103***	-0.0676*** (0.00122)	-0.0676*** (0.000561)
L. Total assets	7.35e-05*** (2.43e-05)	-0.132*** (0.00273)		-0.0392*** (0.000811)
L. Operating profit	-0.00677*** (6.93e-05)	-0.931*** (0.00796)	0.109*** (0.00516)	
L. Life-span of firms	-0.275 (0.851)	-47.19 (100.5)	62.79 (61.97)	-27.37 (28.36)
L. Youth employment	-0.00720 (0.00636)	-3.093*** (0.750)	-0.912** (0.462)	0.260 (0.212)
L. Senior employment	-0.00558 (0.00430)	2.438*** (0.507)	-0.116 (0.313)	1.242*** (0.143)
L. SME average total assets	0.000649*** (0.000214)	0.0933*** (0.0253)	0.000947 (0.0156)	-0.0212*** (0.00714)
L. SME average sales	-0.000994*** (0.000283)	-0.280*** (0.0334)	0.0368* (0.0206)	0.0610*** (0.00944)
L. SME average operating profit	0.00702*** (0.00142)	0.161 (0.167)	0.238** (0.103)	-0.622*** (0.0472)
L. SME average R&D expenses	0.00630*** (0.00156)	0.305* (0.184)	-0.253** (0.113)	0.0862* (0.0518)
L. SME average life-span	0.513** (0.208)	-69.09*** (24.53)	-4.148 (15.11)	-13.86** (6.918)
L. SME average ROA	-0.282*** (0.0389)	12.38*** (4.598)	2.104 (2.834)	3.986*** (1.297)
Year 2013	-0.338 (0.860)	-7.881 (101.6)	-19.71 (62.63)	58.13** (28.67)
Year 2014	-0.976 (1.710)	-59.86 (202.0)	-66.67 (124.5)	117.4** (56.98)
Year 2015	-1.105 (2.561)	-150.2 (302.5)	-206.5 (186.4)	188.3** (85.34)
L. ROA		-3.182*** (0.282)	1.538*** (0.174)	-7.772*** (0.0778)
Constant	2.893 (6.564)	2,607*** (775.5)	128.8 (477.8)	695.3*** (218.7)
Observations	684,891	684,926	684,926	684,926
R-squared	0.031	0.051	0.019	0.086
No. of firms	288,570	288,587	288,587	288,587

Note: 1) Standard errors in parentheses

2) *** p < 0.01, ** p < 0.05, * p < 0.1

Source: Present study, based on Public Procurement Service (2016), Korea Employment Information Service (2018), and Korea Enterprise Data (2019).

In the third year periods effect of managerial indicators, although sales revenue increased by approximately 234 million won (significant at the 5% level), the increment in operating profit significantly decreased by approximately 74 million won, demonstrating a different pattern compared to the first and second periods. While the increase in sales is observed over the three periods in the case of SME-exclusive bidding procurement, the lack of qualitative improvement suggests that the results are still divergent from the original purpose of the system.

Table 7_3 Periods Effect Management Indicators by SME-exclusive bidding procurement

(Unit: %p, KRW 1 million)

VARIABLES	ROA	Sales	Total assets	Operating profit
L2. SME-Exclusive bidding procurement availability	0.553 (0.670)	234.0** (110.7)	17.63 (73.04)	-74.71*** (28.87)
L3. Sales	-0.000239*** (3.04e-05)	-0.133***	-0.0901*** (0.00321)	-0.0999*** (0.00123)
L3. Total assets	0.000301*** (4.72e-05)	-0.441*** (0.00755)		-0.0298*** (0.00203)
L3. Operating profit	-0.00704*** (0.000122)	-1.477*** (0.0196)	-0.0981*** (0.0137)	
L3. Life-span of firms	-3.086 (4.716)	-74.53 (779.4)	-25.90 (514.1)	-17.68 (203.2)
L3. Youth employment	-0.0167 (0.0116)	-17.01*** (1.918)	-7.340*** (1.266)	-1.354*** (0.500)
L3. Senior employment	-0.00659 (0.00744)	-9.526*** (1.228)	-4.478*** (0.811)	1.876*** (0.320)
L3. SME average total assets	-4.87e-06 (0.000385)	-0.167*** (0.0637)	0.0558 (0.0420)	-0.0878*** (0.0166)
L3. SME average sales	-0.000345 (0.000569)	-0.460*** (0.0940)	-0.109* (0.0621)	0.148*** (0.0245)
L3. SME average operating profit	0.00819*** (0.00275)	0.673 (0.455)	2.023*** (0.300)	-1.174*** (0.119)
L3. SME average R&D expenses	0.0105*** (0.00317)	-0.587 (0.524)	-0.945*** (0.346)	0.326** (0.137)
L3. SME average life-span	0.406 (0.467)	-57.64 (77.23)	17.63 (50.94)	-18.83 (20.14)
L3. SME average ROA	-0.346*** (0.0742)	11.61 (12.27)	-7.455 (8.095)	7.272** (3.200)
Year 2015	2.109 (4.718)	-190.2 (779.8)	-49.87 (514.4)	70.13 (203.3)

Table 7_3 Periods Effect Management Indicators by SME-exclusive bidding procurement(continued)

VARIABLES	ROA	Sales	Total assets	Operating profit
L3. ROA		-3.497*** (0.746)	3.629*** (0.492)	-8.680*** (0.189)
Constant	25.50 (40.46)	6,306 (6,686)	1,934 (4,411)	753.7 (1,743)
Observations	248,891	248,905	248,905	248,905
R-squared	0.047	0.121	0.029	0.101
No. of firms	158,656	158,664	158,664	158,664

Note: 1) Standard errors in parentheses

2) *** p < 0.01, ** p < 0.05, * p < 0.1

Source: Present study, based on Public Procurement Service (2016), Korea Employment Information Service (2018), and Korea Enterprise Data (2019).

In the 1 year period effect, unlike general SME participation, it is found that SME-exclusive bidding procurement policy does not show significant policy effects on the increments in employment insurance registrations, youth employment insurance registrations, or quality youth employment insurance registrations. While the policy did not demonstrate negative effects, the lack of expected employment effects from the policy indicates that there are issues that need to be addressed.

Table 8_1 Period Effect Employment Indicators by SME-exclusive bidding procurement

(Unit: per capita, KRW 1 million)

VARIABLE	Employment insurance enrolled	Youth employment insurance enrolled	High-quality youth employment insurance enrolled
SME-Exclusive bidding procurement availability	0.297 (0.338)	0.223 (0.146)	0.0317 (0.0376)
L. Sales	-0.000270*** (1.34e-05)	-5.06e-05*** (5.78e-06)	-1.09e-05*** (1.49e-06)
L. Total assets	-1.23e-05 (1.84e-05)	2.74e-05*** (7.94e-06)	-5.64e-06*** (2.05e-06)
L. Operating profit	8.38e-05 (5.22e-05)	3.16e-05 (2.25e-05)	5.83e-05*** (5.81e-06)
L. Life-span of firms	0.118 (0.607)	0.143 (0.262)	-0.0156 (0.0676)
L. ROA	-0.00691*** (0.00221)	-0.00129 (0.000952)	-0.000245 (0.000246)

Table 8_1 Period Effect Employment Indicators by SME-exclusive bidding procurement(continued)

VARIABLE	Employment insurance enrolled	Youth employment insurance enrolled	High-quality youth employment insurance enrolled
L. Loss of youth employment	-0.767*** (0.00492)	-0.693*** (0.00212)	-0.00765*** (0.000548)
L. Loss of senior employment	-0.476*** (0.00348)	-0.00465*** (0.00150)	-0.00602*** (0.000388)
L. SME average total assets	-0.000693*** (0.000170)	6.06e-05 (7.31e-05)	-6.98e-06 (1.89e-05)
L. SME average sales	0.000104 (0.000223)	-3.20e-05 (9.61e-05)	1.54e-05 (2.48e-05)
L. SME average operating profit	0.00101 (0.00107)	0.000778* (0.000460)	-0.000141 (0.000119)
L. SME average R&D expenses	0.000488 (0.00121)	-0.00176*** (0.000523)	-0.000304** (0.000135)
L. SME average life-span	0.0269 (0.164)	0.0345 (0.0709)	-0.0261 (0.0183)
L. SME average ROA	-0.0634** (0.0307)	-0.0271** (0.0133)	0.000554 (0.00342)
Year 2013	0.0847 (0.615)	-0.197 (0.265)	0.0571 (0.0685)
Year 2014	0.302 (1.220)	-0.279 (0.526)	0.116 (0.136)
Year 2015	1.183 (1.827)	-0.252 (0.788)	0.196 (0.203)
Constant	7.723 (5.114)	1.003 (2.205)	0.491 (0.569)
Observations	511,463	511,463	511,463
R-squared	0.171	0.283	0.003
No. of firms	214,434	214,434	214,434

Note: 1) Standard errors in parentheses

2) *** p < 0.01, ** p < 0.05, * p < 0.1

Source: Present study, based on Public Procurement Service (2016), Korea Employment Information Service (2018), and Korea Enterprise Data (2019).

Table 9_3 Periods Effect Employment Indicators by SME-exclusive bidding procurement

(Unit: per capita, KRW 1 million)

VARIABLE	Employment insurance enrolled	Youth employment insurance enrolled	High-quality youth employment insurance enrolled
L2. SME-Exclusive bidding procurement availability	-1.155 (0.747)	-0.374 (0.348)	-0.0687 (0.0780)
L3. Sales	-0.000233*** (3.38e-05)	-6.55e-05*** (1.58e-05)	3.47e-06 (3.53e-06)
L3. Total assets	-0.000312*** (5.29e-05)	-0.000132*** (2.47e-05)	-1.70e-05*** (5.53e-06)
L3. Operating profits	-0.000259* (0.000139)	-0.000261*** (6.47e-05)	-3.37e-05** (1.45e-05)
L3. Life-span of firms	-0.979 (4.728)	-0.939 (2.205)	-0.474 (0.494)
L3. ROA	-0.00666 (0.00626)	-0.000664 (0.00292)	0.00102 (0.000654)
L3. Loss of youth employment	-1.095*** (0.0132)	-0.912*** (0.00617)	-0.0233*** (0.00138)
L3. Loss of senior employment	-0.305*** (0.00853)	0.0348*** (0.00398)	-0.00503*** (0.000891)
L3. SME average total assets	-0.000747* (0.000451)	0.000147 (0.000210)	-3.24e-05 (4.71e-05)
L3. SME average sales	-0.000528 (0.000655)	-0.000470 (0.000305)	0.000202*** (6.84e-05)
L3. SME average operating profit	0.00355 (0.00318)	0.00320** (0.00148)	-0.000323 (0.000333)
L3. SME average R&D expenses	0.000414 (0.00363)	0.000824 (0.00169)	-0.000693* (0.000379)
L3. SME average life-span	0.950* (0.545)	0.580** (0.254)	-0.111* (0.0569)
L3. SME average ROA	-0.146* (0.0859)	-0.144*** (0.0401)	0.0110 (0.00898)
Year 2015	1.719 (4.732)	1.081 (2.206)	0.654 (0.494)
Constant	14.16 (43.71)	8.973 (20.38)	4.923 (4.567)
Observations	185,529	185,529	185,529
R-squared	0.141	0.262	0.008
No. of firms	120,183	120,183	120,183

Note: 1) Standard errors in parentheses

2) *** p < 0.01, ** p < 0.05, * p < 0.1

Source: Present study, based on Public Procurement Service (2016), Korea Employment Information Service (2018), and Korea Enterprise Data (2019).

Similar to the 1 period and 2 periods effects, the 3 year periods effect also shows no significant policy effects on employment. To sum up, overall evaluations of managerial and employment indicators reveal that SME-exclusive bidding procurement resulted in only the increase in sales revenue of participating firms without contributing to employment or productivity of the firm supported. This highly suggests a need to restructure the policy to better align with its objectives.

Next, we will perform an analysis of managerial indicators at the industry level. Using the PPS domestic procurement data from 2011 to 2015, we analyzed the performance of individual subsectors over a period of 1 to 3 years based on the amount of procurement under the SME-exclusive bidding procurement policy. The indicators used include sales revenue per employee and operating profit per employee by industry. As shown in [Table III-9] and [Table III-10], even with an increase in the SME-exclusive bidding procurement amount, there is no improvement in indicators such as sales revenue per employee or operating profit per employee at the industry level.

Table 10_ 1 Period Effect Management Indicators for SME-exclusive bidding procurement Amount: Sub-category Industry

(Unit: per capita, KRW 1 million)

VARIABLE	Sales per capita	Operating profit per capita
SME-exclusive bidding procurement by industry	-0.0000340 (0.000216)	0.0000124 (7.03e-05)
L. No. of net insured by industry_SMEs	0.0013800 (0.00130)	0.0005520 (0.000423)
L. Total assets by industry_SMEs	-2.31e-06** (1.13e-06)	-1.66e-06*** (3.68e-07)
L. Sales by industry_SMEs	-0.0000023 (5.57e-06)	0.0000000 (1.82e-06)
Year 2013	46.37*** (9.535)	1.9910000 (3.111)
Year 2014	27.24*** (9.989)	-1.2200000 (3.259)
Year 2015	29.40*** (10.09)	0.8780000 (3.293)
Constant	-32.9700000 (29.43)	-0.7950000 (9.602)
Observations	761	761
No. of 9th sub-category industry codes	196	196
R-squared	0.056	0.042

Note: 1) Standard errors in parentheses

2) *** p < 0.01, ** p < 0.05, * p < 0.1

Table 11_3 Periods Effect Management Indicators for SME-exclusive bidding procurement Amount: Sub-category Industry

(Unit: per capita, KRW 1 million)

VARIABLE	Sales per capita	Operating profit per capita
SME-exclusive bidding procurement by industry	-0.0000359 (0.000214)	-0.0000308 (0.000150)
L. No. of net insured by industry_SMEs	-0.0002400 (0.00142)	-0.0007100 (0.000992)
L. Total assets by industry_SMEs	1.83e-05*** (4.61e-06)	2.43e-05*** (3.23e-06)
L. Sales by industry_SMEs	-0.0000154 (9.63e-06)	-0.0000105 (6.75e-06)
Year 2015	26.23*** (5.852)	-2.4890000 (4.102)
Constant	-50.8500000 (51.90)	-70.51* (36.38)
Observations	377	377
No. of 9th sub-category industry codes	191	191
R-squared	0.213	0.24

Note: 1) Standard errors in parentheses

2) *** p < 0.01, ** p < 0.05, * p < 0.1

Source: Present study, based on Public Procurement Service (2016), Korea Employment Information Service (2018), and Korea Enterprise Data (2019).

Next, we will perform an industry-level analysis based on employment performance indicators. Using the PPS domestic procurement data from 2011 to 2015, we will analyze the performance of individual subsectors over a period of 1 to 3 based on the amount of procurement under the SME-exclusive bidding procurement policy. The indicators used include the net increase in insured persons and the number of new employment insurance registrations by industry.

As shown in [Table III-11] and [Table III-12], even with an increase in the SME-exclusive bidding procurement amount, for individual subsectors, no improvements are observed in the scale of employment insurance registrations or the net increase in insured persons.

Table 12_ 1 Period Effect Employment Indicators for SME-exclusive bidding procurement Amount:
Sub-category Industry

(Unit: per capita, KRW 1 million)

VARIABLE	Employment insurance attained	Net increase or decrease of the insured
SME-exclusive bidding procurement by industry	0.0044500 (0.00342)	-0.0004630 (0.00195)
L. Total assets by industry_SMEs	-0.0000018 (1.79e-05)	-0.0000017 (1.02e-05)
L. Sales by industry_SMEs	-0.000351*** (7.99e-05)	-0.000113** (4.56e-05)
Year 2013	-182.2000000 (149.3)	-44.6000000 (85.24)
Year 2014	-505.2*** (152.9)	-130.2000000 (87.30)
Year 2015	-699.6*** (152.5)	25.9000000 (87.07)
Constant	2,740*** (451.7)	745.2*** (258.0)
Observations	761	761
No. of 9th sub-category industry codes	196	196
R-squared	0.097	0.023

Note: 1) Standard errors in parentheses

2) *** p < 0.01, ** p < 0.05, * p < 0.1

Source: Present study, based on Public Procurement Service (2016), Korea Employment Information Service (2018), and Korea Enterprise Data (2019).

Table 13_ 3 Periods Effect Employment Indicators for SME-exclusive bidding procurement Amount:
Sub-category Industry

(Unit: per capita, KRW 1 million)

VARIABLE	Employment insurance attained	Net increase or decrease of the insured
SME-exclusive bidding procurement by industry	0.0019600 (0.00843)	-0.0047700 (0.00324)
L. Total assets by industry_SMEs	-0.0000205 (0.000181)	0.0000252 (6.96e-05)
L. Sales by industry_SMEs	-0.00109*** (0.000351)	-0.0000939 (0.000135)
Year 2015	-562.2** (223.1)	20.6200000 (85.66)

Table 13_ 3 Periods Effect Employment Indicators for SME-exclusive bidding procurement Amount: Sub-category Industry(continued)

VARIABLE	Employment insurance attained	Net increase or decrease of the insured
Constant	7,969*** (2,046)	445.2000000 (785.4)
Observations	377	377
No. of 9th sub-category industry codes	191	191
R-squared	0.13	0.018

Note: 1) Standard errors in parentheses

2) *** p < 0.01, ** p < 0.05, * p < 0.1

Source: Present study, based on Public Procurement Service (2016), Korea Employment Information Service (2018), and Korea Enterprise Data (2019)

As a result, evidence that the increase in SME-exclusive bidding procurement amounts at the industry level led to improvements in performance indicators could not be confirmed. For reference, despite conducting an analysis focusing only on industries with positive medium-term competitive procurement amounts in consideration of the observation from the targeting analysis that many industries do not participate in procurement, no significant differences were found in terms of qualitative aspects.

IV. Policy Recommendations

Summarizing the above review and analysis, we can conclude that there is a significant variation in procurement participation and benefits across industries. It was found that in some industries, there is no public procurement at all. Therefore, in contrast to other fiscal policies, there is a need to strategically utilize public procurement as a tool to support firms. As purchasing goods or services that are unnecessary in the public sector is impractical, it may be desirable to pursue policy effects only in industries where public procurement can be effectively utilized.

While there are some positive aspects in terms of showcasing some effects at the firm level in policy evaluations, there clearly are limitations in terms of the ultimate policy objectives such as serving as a catalyst for improvements in productivity of the firms participating public procurement. Therefore, efforts for policy improvement, enhancement of performance indicators, and continuous monitoring are necessary in the future.

A more serious issue arises from the analysis of industry-level effects. There have been

recent macro discussions on the effectiveness of procurement support. However, the evidence that individual firm effects manifest at the subsector industry level could not be found. The absence of effects at the industry level could suggest a potential “crowding out” effect where supported firms bring about benefits that would have occurred in industries without support. This could have serious implications when considering the effectiveness of national fiscal policy. Managing and evaluating policy outcomes beyond the industry level will be crucial for assessing effects at the industrial and national economic levels in the future.

To adopt evidence-based approaches, systematic management of future support histories and regular quantitative performance evaluations are necessary. While the current data collected in the procurement marketplace is rich in quantity, there is a lack of sufficient policy-related information. Therefore, it is recommended to process policy information considering the analysis of clauses to effectively handle policy information.

In order to prevent the expansion of support without guaranteed effectiveness and to deter moral hazards of supported enterprises, it is important to introduce limitations on the duration of public procurement support and the scale of contracted support within the supported target group. In cases where the economic performance is negative or inconclusive, it may be necessary to set upper limits on the total number of contracts, total contract amounts, and total number of businesses, and continuously reduce them.

V. Conclusions

There is great anticipation for public procurement, which leverages the purchasing power of the public sector, in the execution of procurement and fiscal policies. If designed properly and performance is managed, pursuing policy goals through public procurement can be both logically and empirically a valid approach by providing market opportunities that enhance the competitiveness of supported entities and achieve social objectives.

However, according to the analysis of this study, there are deficiencies in actual performance. Given that public procurement also incurs costs, the absence of significant policy outcomes is a considerable issue. Additionally, it should be noted that public procurement support can only be effective for goods, services, and construction demanded by the public sector, so it is limited when used as a general tool compared to other general fiscal policies.

In conclusion, while there are many possibilities with public procurement, it can be viewed

that its potential is not fully utilized currently. Also, given that public procurement is not a panacea, it is crucial to use the policy with a focus on choice and concentration.

Public procurement is a field where quantitative performance evaluation is possible. If support histories are thoroughly accumulated and the policy performance is managed not only at the level of the supported enterprises but also at the level of industries and national economy, the effectiveness of public procurement as a policy tool will be greatly improved.

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Evaluation of Budget Programs Using Machine Learning: The Case of Government-Sponsored Loans

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I. Introduction

In this study, we explore “How does machine learning contribute to the select the beneficiaries of government-sponsored financial services (GSFS), in terms of efficacy?” GSFS are highly useful for exploring and analyzing the applicability of machine learning. GSFS have been provided to a wide range of businesses having different attributes (company type, years in business, business size, R&D expenses, revenue, operating profits, business items, locations, etc.). As such, they can be suitable for machine learnings, whereby the algorithm creates optimal models for itself using a larger number of explanatory variables. Furthermore, the availability of well-organized data pertaining to the various attributes of numerous enterprises facilitates the use of machine learning algorithms.¹ Lastly, given the absence of a clearly dominant economical theory on the expected effects of GSFS, in addition to the use of different independent variables in previous studies, it seems that machine learning can minimize the arbitrary judgment of researchers.

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¹ For example, this study uses the enterprise overview data provided by KDE, which includes information on around 969,493 business entities as well as their attributes and financial information.

As such, this study assesses the usefulness of machine learning by applying a machine learning algorithm to analyze the effects of GSFS programs. Specifically, we compare and analyze the effect of the guaranteed services provided by the Korea Credit Guarantee Fund (KODIT) using a machine learning algorithm called the ‘causal forest’ along with propensity score matching, which has been widely used for the analysis of policy effects. First, using the propensity score matching, we found that beneficiaries of KODIT saw a 7.8% increase in their revenues while their operating profits declined by KRW 13 million. On the other hand, the estimated effect using the causal forest method included a 4.4% revenue growth and KRW 300 million reduction in operating profits.² Both results are qualitatively similar, suggesting that they are mutually complementary methods capable of deriving meaningful interpretations from data. However, in propensity score matching, the effect of GSFS greatly varied depending on which variables were chosen. Thus, the causal forest can be a good alternative for addressing this vulnerability of the conventional model.

We also compared the propensity score matching and the causal forest method by analyzing the heterogeneity of GSFS effects. First, we analyzed the effects of GSFS using the propensity score matching, by dividing the beneficiary companies into subgroups based on the medians of various independent variables and analyzing the GSFS effects in each group. The heterogeneity of the effects was subsequently analyzed across eleven variables, including years in business, revenue, and operating profits. The analysis found that GSFS produces more positive effects in younger companies with lower revenues and lower operating profits. It was also found that the causal forest method enables the calculation of the conditional average treatment effect (CATE) for each given independent variable, as well as a more detailed heterogeneity analysis than is possible with the propensity score matching. The average treatment effect of KODIT’s GSFS on revenues was 4.45%. The average treatment effect of businesses in the top 10% was 8.82%, whereas the average effect in the bottom 10% was a mere 0.97%, indicating a high level of heterogeneity in the effect of KODIT’s guaranteed services. This finding implies that the efficiency of the GSFS can be maximized by transferring financial resources from the groups with the lowest treatment effect and to the groups with high treatment effects. In addition, a heterogeneity analysis using the causal forest found significant non-linear changes in the treatment effect depending on the operating profits of the beneficiary enterprises. These non-linear patterns will deepen our understanding of the mechanism by which GSFS affect their beneficiaries.

² However, the estimates were not deemed to be statistically significant.

This study is comprised of the following chapters. Chapter II outlines previous studies that empirically analyzed the effect of GSFS, as well as those that used machine learning algorithms to explore possible improvements on various policies. Chapter III uses propensity score matching, which was widely used in previous literature, to analyze the effect of KODIT programs, and the analysis in Chapter III is compared with an analysis that uses machine learning algorithms in order to identify the strengths and drawbacks of machine learning. Chapter IV summarizes the estimation results obtained from the machine learning analysis, and Chapter V provides our conclusions from this study, along with policy implications.

II. Previous Literature

1. Empirical Studies on GSFS

A. Who Are the Beneficiaries?

Chang et al. (2013) mapped the beneficiaries of businesses supported by KODIT, the Korea Technology Finance Corporation (KIBO), and Korea SMEs and Startups Agency (KOSMES). The map shows, as of 2010, the financial services of KIBO, KODIT, and KOSMES were mainly provided to small enterprises employing 30 or less workers. Specifically, most of the beneficiaries with less than seven years in business were enterprises with 30 or less employees. Interestingly, a large number of small and medium enterprise (SME) beneficiaries with 30 or less employees had been in business for ten years or longer. As for the reason why these older enterprises are eligible for GSFS, when they are more than capable of financing their businesses through the financial market, the authors concluded that the government included them in GSFS to stabilize the portfolio of these programs, as many of the beneficiaries of the programs included startups that have inherently high risk levels.

Choi and Ha (2015) used the probit model on the 160,652 enterprises supported by KOSMES, KIBO, and KODIT, as well as non-supported enterprises as of 2007, to analyze the criteria by which GSFS are provided. The findings confirmed that smaller enterprises (with less employees) are more likely to benefit from GSFS and, among enterprises employing more than a set number of workers, the likelihood of receiving GSFS are correlated with higher financial ratios such as debt ratios and total asset turnover ratios.

Kim and Kim (2013) used Heckman's two-stage estimation and the data on businesses that received credit guarantee services and those that did not between 2005 and 2010 to analyze

the effect of KODIT guarantees. A single-stage logit analysis showed that an older enterprise is likely to be a guarantor if it is older, its revenues and total asset growth are lower, and its total asset turnover ratio is higher.

Kang et al. (2008) created virtual panel data on enterprises that applied for KODIT and KIBO guarantees between 2001 and 2004. They sought to analyze the effect of SME support policies on the survivability and outcomes of enterprises based on business size and industry. Using the ordinary least square (OLS) and maximum likelihood estimation (MLE) methods, they found that an enterprise that was a prior beneficiary is more likely to be selected for a support program than an enterprise that may have a high growth potential but insufficient background information.

B. Heterogeneity of the Effects of GSFS

Woo and Binh (2014) analyzed the effect of KIBO guarantees on the beneficiaries. Compared with KODIT, KIBO guarantees are provided to enterprises that have a higher risk and less access to the financial market, after a technical evaluation. The authors used the Korea Enterprise Data (KED) pertaining to the financial positions and KIBO beneficiary status between 2002 and 2008 and a quantile regression model, to analyze changes in financial ratios before and after KIBO guarantees in each quantile (10%, 25%, 50%, 75%, and 90%) of key financial ratios, and compared changes between the beneficiaries and non-beneficiaries using a difference-in-difference (DiD) model. The analysis showed that a KIBO guarantee improves the return on assets (ROA) and the return on equity (ROE) of enterprises with low financial performance (10%) by 6.4% and 12% to 15.4%, respectively. However, the effect of KIBO guarantees on the profitability of a business was estimated to be negligible among businesses with better fiscal performance. An analysis of the enterprises' debt ratios, which represents their stability, also showed that KIBO guarantees improve the stability only among relatively vulnerable businesses.

Lee and Woo (2015) empirically analyzed the effect of public credit guarantee on the survivability of marginal companies. Specifically, they tracked the 2005 beneficiaries of KIBO and KODIT guarantees for three years to see how many of them survived in 2008. Using a survival analysis model, they found that the life span of marginal enterprises was 37.9% shorter than for non-marginal companies. Among the marginal companies, the life span of credit guarantee beneficiaries was 31.7% shorter than that of non-marginal companies. Based on these findings, the authors posited that marginal enterprises are more likely to go bankrupt

despite requiring more and longer guarantees, which may increase the fiscal burden and make it difficult to achieve the policy goal of maintaining employment at marginal enterprises.

Chang et al. (2013) analyzed the effect of government-sponsored financing on SMEs with different years in business. They used a quantile regression model (0.1, 0.25, 0.5, 0.75, and 0.9) inspired by difference-in-difference (DiD) estimation to compare the effect of government-sponsored financing on startups and older enterprises. The authors identified the financial performance of beneficiary enterprises by looking into their profitability indicators (ROA, ROE, and operating profit ratio (OPR)), and growth potential indicators (GSALES and GOP), and analyzed the effect of government-sponsored financing in the short term (1 year after financing) and the medium term (3 years after financing). Their findings indicated that, in the case of financing enterprises with lower profitability growth, older enterprises reported more profitability improvements than startups, whereas older enterprises showed less improvement in profitability when financing enterprises with higher profitability growth. These findings suggest that older enterprises with poor performance in terms of profitability are likely to be going through a temporary setback, and supporting these enterprises is likely to result in meaningful changes in profitability.

2. Previous Literature on the Prediction Problem

A. Is Machine Learning Superior to Conventional Methods?

An increasing body of work compares the performance of machine learnings with those of other quantitative methods. In this study, we outline some of these published studies or those that are scheduled to be published in prestigious journals. Some studies that have compared machine learning and conventional methods concluded that machine learning is superior to conventional methods, whereas others claim that machine learning does not offer a significant improvement over the conventional methods.

Sansone (2019) showed that machine learning may be more effective in predicting dropouts among United States high school students than conventional quantitative models. He used data from a longitudinal study on high school students conducted in 2009, which included data on various variables of the 21,440 students (race, gender, grade, family, attendance, disciplinary action, science course, number of credits taken, etc.) to compare the performance of different models in predicting dropouts among the students. First, the accuracy and recall of the conventional quantitative methods (logit, OLS, probit, etc) were

around 90% and 15% respectively. In contrast, the author was able to increase the recall to 23% while maintaining the accuracy at around 90% by analyzing variables observed in the 9th grade using widely used machine learnings such as support vector machine (SVM), boosting, lasso, and logit-lasso. He claimed that, as 483,270 9th grade students dropped out in the United State in 2009, a 8%p improvement in recall is equal to identifying 4,830 more students in the dropout risk group.

Gentzkow et al. (2019) tracked changes in the partisan gap between the Republican Party and the Democratic Party of the United States by analyzing the texts of Congressional speeches between 1873 and 2016. A data set was built by identifying all two-word phrases included in the speeches, which resulted in 280 million phrases, including 508,352 non-repeated phrases and 7,732 speakers. A larger gap between the phrases used by Republican and Democratic Congress members could be interpreted as evidence of a greater difference between the two parties. The authors estimated changes in partisan difference using the conventional MLE method, as well as the leave-out estimation and lasso estimation, which are machine learning algorithms. The conventional method proved to be less capable of estimating partisan differences. In contrast, both the leave-out and lasso methods estimated that the partisan gap remained stable until 1990, and then rapidly increased in the following years. These findings suggest that machine learning can be a superior alternative to conventional methods in situations where the problem of sample limitation can have serious consequences.

Fuster et al. (2022) analyzed how machine learning can affect the estimation of the insolvency rate of borrowers in the mortgage market. To predict the potential for insolvency, the analysis used the data on around 9.37 million mortgage loans between 2009 and 2013, and included 14 variables such as credit scores, loan amounts, occupations, guarantee status, purposes, and loan periods. The authors applied three models. First, they used a standard logit model. Second, they estimated a non-linear logit model that included numerous dummy variables to capture non-linearity (i.e., dummy variables for the 20 segments across the credit score scale). Third, they used the random forest model, which is widely used in machine learning. The authors found that the random forest model performed better than the two logit models. Specifically, the random forest model was 5.1% more precise than the non-linear logit model, and showed a 14.3% improvement in R^2 . They also confirmed that the random forest model performed better than the logit models across 100 bootstrap samples. These findings indicate that machine learning algorithms may show better performance than non-linear logit

models when using dummy variables arbitrarily added by researchers, as they can capture the complex interrelationships among variables.

From these studies, we identified the following situations where machine learning is likely to produce better predictions than the conventional quantitative models: situations where 1) variables invisible to researchers may improve the prediction results; 2) the samples are seriously limited; 3) there exist non-linearity or complex interactions among variables that are not readily identifiable by researchers. However, it should be noted that machine learning does not always improve the prediction results in these situations. For example, the authors of the following studies claim that machine learning did not significantly improve the prediction results over existing methods.

Beattie et al. (2018) studied a group of first-year college students that had severely lower achievement levels than expectations (divers) and those with significantly higher achievement levels (thrivers). Previous studies reported past grades as the most important predictor of college grades. However, significant gaps existed between the grades of students with similar past grades. The authors studied whether these gaps in achievements (that are not explained by past grades) can be explained by their non-academic characteristics. For the analysis, the authors used questionnaire responses from around 6,000 students who took an introductory course on economics at the University of Toronto in the autumn of 2015, as well as administrative data at the time of their enrollment. The survey questions included students' self-assessment of their level of procrastination, level of endurance, and level of consistency in interests, as well as their risk and time preference. The administrative data included their gender, nationality, type of registration, grades, and courses taken and grades received in high school. The divers and the thrivers could be distinguished by the differences between their actual grades and the grades predicted based on past grades. The top 10% students with the highest difference were classified as thrivers, and the bottom 10% were classified as divers. Then, the authors analyzed whether non-academic characteristics could be used to predict these groups. The findings confirmed that 'cramming' propensity, time spent on studying, time spent on working for money, expected grades, the time of completing the questionnaire (early in the survey period vs. at the end of the survey period), conscientiousness, and endurance as indicators revealed a good explanatory power for the diver and thriver groups. The authors then used the least-angle regression (LARS) algorithm to compare the algorithm model with all the variables and a simple prediction model with the averages of the seven of the variables listed above. The LARS algorithm model did not greatly improve the prediction results over the simple seven-variable model.

Orlov et al. (2021) studied whether students' mathematics grades could be used to predict which students are likely to drop out or receive low grades in economics. For the analysis, the authors chose 711 students and 207 students who took introductory and intermediary courses on microeconomics, respectively, at Cornell University in 2019. The authors had the students take a mathematics test at the beginning of each course, and analyzed whether their mathematics scores could be used to predict the bottom 25% (B- or lower). As for the introductory course, when using the mathematics grades as the single variable and predicting students who scored less than 72 as divers, the percentage of true positive (predicted as divers and actually divers) was 54%, and the percentage of false positive (predicted as divers but not actually divers) was 20%. In the intermediary course, when predicting students who scored less than 66 as divers, the true positive percentage was 52%, where as the false positive percentage was 12%. In order to verify whether the addition of other information could improve the prediction ability, the authors added gender, school year, and answer for each question in the mathematics test as variables, and then used a lasso regression to compare their predictive powers. In the introductory course, when the true positive percentage was 55%, the false positive percentage was 14%, showing a slight improvement over the mathematics-only model. However, in the intermediary course, the lasso model did not improve the predictive power.

Although Nielsen et al. (2021) did not directly compare machine learning and traditional quantitative methods, they found that using a number of variables known to have explanatory power offered better prediction results than using big data, which could potentially infringe on people's privacy. The authors compared the ability of administrative information (gender, age, past grades, etc.) and big data (attendance, use of smartphones during class, alcohol consumption, personality type, etc.) to predict students' grades. The analysis found that administrative information (including past grades) offered better predictions than big data.

Machine learning may not offer better predictive power over conventional methods in the following cases. 1) Cases where there are a large number of explanatory variables, but the variables are merely repeated measurements of similar information; for example, as was discussed in Orlov et al. (2021), when using students' answers to each question in the mathematics test as a variable. 2) Cases where the explanatory variables hand-picked by researchers or extensively covered in previous studies already offer a good predictive power.

B. Is Machine Learning Good at Identifying Heterogenous Treatment Effects?

The studies reviewed above discussed whether machine learning shows better predictive power than traditional statistical methods. They found that, in certain circumstances, machine learning may offer better results than conventional ones.

However, it may be difficult for policymakers to make effective decisions only using models that predict results with attribute variables. Imagine a policymaker who is tasked with implementing a GSFS program with limited resources. The policymaker developed a model that predicts the insolvency rate of businesses using their attributes as variables, and then used the model to successfully identify the characteristics of businesses that are more likely to go bankrupt. Then, should the policymaker provide GSFS to firms with insolvency-prone characteristics? To answer this question, we need proof that GSFS clearly lowers the likelihood of insolvency of firms displaying those characteristics. In other words, when making decisions on which firms should benefit from GSFS, policymakers need proof of causality between GSFS and their treatment effects, not the proof of which firms are more likely to be declared bankrupt. More importantly, they need to understand the heterogeneity of the treatment effects of their policies in order to make effective decisions. Ultimately, they need to know whether the treatment effects can vary across different groups of businesses.

Machine learning is essentially an algorithm that is designed to allow the data to choose their own model. As such, it may be useful for identifying heterogeneity in treatment effects by minimizing the involvement of arbitrary judgments on the part of researchers. The identification of treatment effects serves a different purpose from the prediction, which means, for the former task, we can use an approach that may be different than the machine learning algorithms discussed above. A prime example of such an approach is the causal forest method proposed by Wager and Athey (2019). In brief, the causal forest is a method that is designed to create a model by identifying the group in which the treatment effect is maximized, which distinguishes it from the random forest method that builds a model by minimizing the predicted errors.³ In this section, we review previous studies that used causal forest machine learning to analyze heterogeneous treatment effects.

Knittel and Stolper (2021) analyzed the heterogeneous treatment effects of the Home Energy Report (HER) program using the causal forest model. They analyzed the power consumption of around 700 thousand households taking part in the program, and analyzed

³ See Jung and Lee (2020), Chapter 4, C for a detailed theoretical introduction to the causal forest model.

how household characteristics affected the program's treatment effects. The average treatment effect from a traditional difference-in-difference (DiD) method was a 9.4 kWh reduction in power consumption. However, the heterogeneous treatment effects ranged from a 40 kWh reduction to a 10 kWh increase in power consumption. The household characteristics that significantly affected the treatment effects included baseline power consumption and the market values of houses. However, the effects of these characteristics on the treatment effects were highly non-linear, which means that any heterogeneity may have been difficult to identify using a standard regression model. For example, a higher baseline consumption was found to increase the treatment effect of the HER program. However, when the baseline consumption exceeded 200 kWh, a higher baseline was correlated with a lower treatment effect. House value also had significant effect on the treatment effects. Many of the cheaper houses reported a large reduction in power consumption, whereas the effect on power consumption was very limited among households with houses worth USD 100,000 or higher. None of those households reported a consumption reduction of 23 kWh or higher. The authors claimed that an even more effective policy implementation can be achieved by selecting beneficiaries and designing policies based on such heterogeneous treatment effects that were identified using the causal forest method.

Davis and Heller (2020) used the causal forest model to analyze the heterogeneous treatment effects of the summer youth employment programs (SYEPs) implemented in Chicago. Under traditional methods, the programs were found to greatly reduce the rate of violent crimes. However, they did not improve the employment or learning performance indicators. In addition, the total number of arrests did not decline, and the total number of property-related crimes actually increased. Then, using the causal forest model, they were able to obtain two additional findings on the heterogeneity of treatment effects that were previously unavailable from the conventional methods. First, the treatment effects of the SYEPs were significantly heterogeneous. On average, SYEPs did not improve the youth employment. However, the programs greatly improved the employment of younger students, students with higher attendance rates, Hispanic students, and female students. The authors showed that, in these maximum effect groups, the employment benefits of SYEPs increased up to four times. Second, they found that the existing theories on the effect of youth employment programs were not supported by strong evidence, and that further research is required on new mechanisms of the employment effects. By analyzing potential heterogeneity in the treatment effects, the authors confirmed that a decline in violent crimes was not restricted to a certain group. In the groups where the programs improved employment,

property-related crimes increased. These findings did not support the conventional opportunity cost theory that employment programs reduce crimes by improving the chance of employment in previously underemployed groups, thereby increasing the opportunity cost of crime. Based on these findings, the authors proposed an alternative mechanism. According to them, employment programs provide beneficiaries with opportunities to experience an improvement in their social life—even for a limited period—which helps them develop skills to address social conflicts as they receive and accept criticisms from their employers. On the other hand, people in groups with a significantly higher improvement in employment are likely to work for wealthier employers and meet wealthier people, which further increase their opportunity for committing property-related crimes. As such, studying heterogeneity in treatment effects using the causal forest model may contribute to understanding the mechanism by which policies affect their beneficiaries.

Knaus et al. (2020) used a method based on a lasso regression to study the heterogeneous treatment effects of job search programs (JSPs) in Switzerland. The authors used 2003 data obtained from the local employment offices in the country. The data included information on individual unemployed citizens, which allowed the authors to analyze the effect of JSPs by looking into the employment periods of unemployed persons who participated in the programs and those who did not. To analyze the heterogeneous treatment effects, the authors developed 1,268 variables including (up to quartic) polynomial equations, square cross-terms of variables, and logs of explanatory variables such as the targets' attributes (employment history, demographic attributes, etc.), in addition to evaluations by their social welfare workers. They designed their model by removing variables with lower explanatory powers. The authors found that the employment periods (number of days) of JSP participants were lower than non-JSP unemployed workers within six months from the first date of participation, because unemployed workers participating in JSPs tended to reduce their job-seeking efforts in the early stage of these programs. These short-term negative effects varied depending on the characteristics of the participants, with the less significant effect being among people with lower educational attainment and less qualifications. The negative effects were smaller among foreigners, and unskilled workers benefited more from JSPs than skilled workers. It was found that the short-term negative effects can be reduced by 60% by choosing the best program beneficiaries, as proposed by the machine learning algorithm. In the long-term, JSP participation did not have a significant effect on the employment periods.

III. Effects of GSFS

1. Analysis Data and Summary Statistics

A. Analysis Data

We built the enterprise-level data used in this study based on data provided by the Korea Enterprise Data (KED). The KED data included a wide variety of information on individual businesses, including their basic attributes, financial positions, intellectual properties, and shareholders. The data encompassed businesses across all sizes (large enterprises, SMEs, and microentrepreneurs), which makes them ideal for this study, which requires as many observations as possible in order to define a suitable control group. The KED data provided yearly information on variables that reflected the enterprises' financial positions, such as their yearly revenues, allowing researchers to build panel-type data. However, many other variables on general attributes are provided only for the time when the data were last updated. For data on the GSFS benefit history of individual businesses, we used the service history data of KODIT from 2014 and 2015.^{4,5} Excluding the enterprises of which business registration numbers could not be confirmed, the data included the service history data for 43,798 services in 2014 and 51,710 services in 2015, which were provided to 34,081 enterprises in 2014, and 27,584 enterprises in 2015.

B. Basic Statistics

Table 1 outlines the basic statistics of enterprises that could be matched with the KED data using the business registration numbers included in the KODIT service history data. Table 2 shows the basic statistics of 919,685 enterprises in the KED data that have no service history in either of the years covered by the data.

First, in both years, the percentage of manufacturers in the beneficiary enterprises was similar, at around 38%, with enterprises in the service sector taking up nearly 50% of the matched enterprises. In terms of business location, in both years, enterprises located in the Seoul Capital Area (SCA) accounted for around 50%. The percentage of venture companies

⁴ We would like to express our gratitude to Dr. Jang Woo-hyun, who organized and provided the KODIT data crucial for the analysis in this study.

⁵ In the following paragraphs, we use the terms “KODIT” and “GSFS” interchangeably.

among the matched enterprises was slightly high as well, relative to the basic statistics from the service history data. The average number of years in business was 6.8 years in both years, which is quite high given the fact that startup enterprises exceeded 60% of all companies included in the service history data. As confirmed in Table 1, the beneficiary enterprises matched with the KED data are different from the non-matched enterprises in terms of some attributes, such as the percentage of service enterprises. However, the data seem to be suitable for analysis, considering that most of the enterprises were matched, and diverse characteristics could be observed among the matched enterprises.

Table 1 Basic Statistics of Enterprises Matched with KED Data

Variable	Beneficiaries in 2014		Beneficiaries in 2015	
	Average	SD	Average	SD
Percentage of manufacturers	0.38	0.49	0.39	0.49
Percentage of service companies	0.48	0.50	0.47	0.50
Percentage of enterprises located in SCA	0.49	0.50	0.50	0.50
Percentage of venture companies	0.04	0.19	0.05	0.22
Years in business	6.76	6.39	6.79	6.53
No. of enterprises	29,103		24,390	

Note: The numbers of years in business are as of 2015. Enterprises with no information on starting year or enterprises that started after the service period covered by the data (2014 and 2015) were excluded from the calculation.

Source: KODIT internal data and KED data.

Table 2 shows the basic statistics of enterprises included in the KED data but have no service history in either 2014 or 2015. The percentage of manufacturers was slightly lower than those matched with the service history data, whereas the percentages of service enterprises and those located in the SCA were largely similar. The numbers of years in business were quite larger than the beneficiary enterprises, which indicate the importance of controlling for observable attributes when estimating the treatment effects.

Table 2 Basic Statistics of Enterprises Not Matched with KED Data (non-beneficiaries)

Variable	Average	SD
Percentage of manufacturers	0.30	0.46
Percentage of service companies	0.51	0.50
Located in SCA	0.51	0.50
Venture companies	0.03	0.18
Years in business	11.86	8.43
No. of enterprises	919,685	

Source: KODIT internal data and KED data.

2. Analysis Strategy

This section analyzes the effect of KODIT services on the beneficiaries' revenues, operating profits, and R&D expenses using the propensity score matching. The findings on operating profits and net profits are likely to be highly similar, considering the definitions of the variables. As such, we chose to analyze the operating profits because they are expected to be more closely related with the actual operations of the enterprises.

As mentioned earlier, increasing the years covered by the sample data offers benefits in terms of analysis. However, it may result in the exclusion of many enterprises from the sample, and this exclusion is not random. Therefore, in order to define an appropriate scope of past variables before the years of service to be used in the propensity score estimation, we first estimate the propensity scores for 2013 and the scores for 2011 to 2013, and then compare the results. Next, we obtain the findings for the variables in 2015, 2016, and 2017 using the data from the 2011–2013 period, in which an appropriate control group can be selected using propensity score matching. Ultimately, we used four types of samples in this study, as summarized in Table 3. The treatment years are those in which KODIT provided the GSFS analyzed in this study, and the period represents the years between the treatment year and the time of effect analysis.

The propensity scores are estimated using the following process. In addition to the sample removal criteria detailed in Lee, Ko, and Bae (2021), we winsorized the variables of the enterprises within the top 1% and bottom 1% of revenues, operating profits, net profits, years in business, fixed assets, and R&D expenses with the top 1% and bottom 1% values. Next, using the beneficiary status in 2014 as a dependent variable, we estimated a logit model using the following independent variables: revenue in the previous period and its squared term; operating profits and its squared term; 2013 average revenue at the division level in the industrial classification and its squared term; section in industrial classification; years in

business and its squared term; 2013 R&D expenses and its squared term; enterprise type (stock company, sole proprietor, and others); location (SCA or outside of SCA); and 2013 fixed assets and squared term. In this way, we obtained the predicted propensity scores of individual enterprises by obtaining an estimate from the logit model, and removed propensity scores below 0.05 from the sample as outliers. In addition, we removed a significant number of observations from the sample, as their first-year revenue was recorded as KRW 0.⁶

Table 3_Summary of Sample Structure for Empirical Analysis

Sample type	Treatment year	Period	Years before treatment	Year subject to analysis
1	2014	1	2013	2015
2	2014	1	2011–2013	2015
3	2014	2	2011–2013	2016
4	2014	3	2011–2013	2017

Source: Present study.

Based on the predicted propensity scores for the enterprises included in the samples, we used the nearest neighbor matching match control group enterprises with the most similar propensity scores. In our sample, the number of enterprises that received KODIT services was far larger than for non-beneficiaries. Therefore, we could expect that investigating non-beneficiaries with similar propensity scores as beneficiaries would improve the quality of matching. Considering the fact that our method largely depends on the quality of propensity score matching, we estimated the average treatment effects on those treated. In principle, we matched control group enterprises with the closest propensity scores, and assigned weights if there were multiple enterprises to match. The treatment effect could thus be simply calculated as follows, where i is an enterprise in the treatment group, and i^c is the control group enterprise matched with the treatment group enterprise.

$$\frac{1}{N_T} \sum_{i \in T} (Y_i - Y_{i^c})$$

where Y is the dependent variable to analyze, and N_T is the number of enterprises in the treatment group. The propensity scores were used to match i and i^c . Note that the quality of this matching (selecting enterprises with similar scores) is a key element that determines the reliability of the estimations.

⁶ In the 2011–2015 sample, 1,130 of the 85,027 enterprises reported revenues of KRW 0.

3. Findings

A. Findings on Treatment Effects

Table 4 lists the estimation results regarding the effects of KODIT services. As discussed in detail in Lee, Ko, and Bae (2021), we mainly interpreted the findings for Types 2, 3, and 4, as they seem to aptly control for the previous trends. In general, the services had a positive effect on revenues and a negative effect on operating profits. In the first, second, and third year after the services, there was no clear discrepancy in quality. No significant effect was identified pertaining to R&D expenses.

The findings indicate a largely positive effect on revenues, and either an insignificant or negative effect on operating profits and R&D expenses. Similar findings have been reported in previous studies, and can be attributed to various causes including behavioral changes in the beneficiary enterprises and the resulting increase in long-term operations, and an increase in low-profitability operations. However, identifying the exact causes of these findings exceeds the scope of this study.

Nevertheless, the following should be noted when inferring any causality from these results. 1) The estimation only covers enterprises that were active for three years before the services, and for two to three years after the services, which may incur a bias in the sample-building process. 2) The non-beneficiaries in 2014 and 2015, which are included in the ‘control group’ may have received KODIT services in 2013 or before, or in 2016 or later, or received GSFS from other institutions in any of those years, which may mean that the treatment group and the control group may not be clearly separated. Thus, these and other limitations of our analysis need to be considered when interpreting the estimations.

Table 4. Summary of Policy Effects of New KODIT Services

Sample type	(Log) revenues		Operating profits		R&D expenses	
	Coefficient	P value	Coefficient	P value	Coefficient	P value
1	0.101*** (0.012)	0.000	-19.593*** (5.391)	0.000	-1.058 (1.941)	0.586
2	0.078*** (0.013)	0.000	-13.405** (5.678)	0.018	-2.480 (2.771)	0.371
3	0.103*** (0.013)	0.000	-3.120 (5.497)	0.570	-1.433 (2.107)	0.497
4	0.059*** (0.015)	0.000	-22.482*** (6.879)	0.001	-1.489 (2.569)	0.562

Note: 1. Units are KRW million.

2. Statistical significance levels are *** 1%, ** 5%, * 10%.

Source: Present study, using KODIT data and KED.

B. Heterogeneity Analysis

We analyzed the heterogeneity of treatment effects using available data, considering the possibility that the effects of GSFS may vary depending on the attributes of the beneficiaries. First, we chose attributes that may result in the heterogeneous treatment effects of GSFS. Next, we set thresholds for each attribute (median, 0, or other specific values), and then used the thresholds to divide the samples into those above the thresholds and those below the thresholds. We subsequently used the propensity score matching to analyze the samples below the thresholds and compared the estimated effects. It should be noted that this approach does not allow for accurate information as to the cause of heterogeneity. For example, a group of enterprises with high revenues may be different from a group of low-revenue enterprises in many respects, other than their revenues. Therefore, even if our analysis shows heterogeneous effects, the findings may not tell us much about the cause of those effects. However, as our goal is to establish groundwork for machine learning-powered studies on heterogeneous effects, not to provide accurate conclusions about the cause of the heterogeneity, we went on to analyze the heterogeneous effects using this approach.

The analysis was performed on the 2011–2015 sample, which seems to better control for the previous trends, and the results are outlined in Table 5. The findings show that the positive effect on revenue is greater, and the negative effect on operating profits is less intense, among younger enterprises with lower revenues, lower operating profits, zero R&D expenses, and less fixed assets. As for business types, service enterprises showed better estimation results for operating profits than manufacturing companies. Again, the reason for the heterogeneity is difficult to ascertain because a clear relationship between business types and the variables reviewed above is not readily identifiable. Across different enterprise sizes, the microentrepreneur group reported better results, with high correlations between enterprise size and revenue and other business performance variables.⁷ Therefore, the findings are consistent with the heterogeneous effects across different revenue levels.

Intellectual property ownership may be highly correlated with R&D expenses. However, it is difficult to prove the relationship from our sample, as the R&D expense data are from 2011 and the intellectual property ownership data are from 2010. Nevertheless, our findings show that, in enterprises with no intellectual properties, the services had a more negative effect on R&D expenses and a relatively positive effect on revenues and operating profits. The findings

⁷ For example, the correlation of the dummy variables (revenues and microentrepreneur = 0, and SMEs = 1) was 0.44.

are consistent with the heterogeneity findings regarding R&D expenses, and the expectation that the heterogeneity may be caused by similar underlying causes. The heterogeneity across locations, percentages of shared owned by family members, and exporter status was not as apparent as other attributes.

Our approach for the heterogeneity analysis was limited in some respects. In brief, it lacks the identification of precise mechanisms of how services affect businesses, and includes a smaller number of enterprises, which may lead to concerns about whether the treatment group and the control group are appropriately identified. It is important to assess whether the heterogeneity is statistically significant and to determine what causes it. Also essential is how reliable the estimations are. However, as mentioned earlier, the main goal of the heterogeneity analysis proposed in this chapter is to do groundwork for machine learning-powered studies on heterogeneous effects, not to provide accurate conclusions about the cause of the heterogeneity. Therefore, the findings on heterogeneity in this chapter should be understood as work-in-progress rather than the final conclusions of this study.

Table 5_Summary of Heterogeneity Estimations for New KODIT Services

Heterogeneity	Sample size	(Log) revenues		Operating profit		R&D expenses	
		ATT	P	ATT	P	ATT	P
Years in business (median or higher)	46,808	0.083*** (0.019)	0.000	-10.144 (9.258)	0.273	-0.538 (2.652)	0.839
Years in business (less than median)	36,537	0.106*** (0.017)	0.000	-3.139 (8.634)	0.716	-1.561 (2.092)	0.455
Revenues (median or higher)	41,796	0.037*** (0.012)	0.002	-17.122* (9.127)	0.061	-1.626 (2.688)	0.545
Revenues (less than median)	41,534	0.069*** (0.014)	0.000	-4.726 (3.778)	0.211	-0.654 (1.144)	0.567
Operating profit (median or higher)	41,744	0.040*** (0.015)	0.008	-20.024** (9.771)	0.040	-5.249 (4.755)	0.270
Operating profit (less than median)	41,161	0.115*** (0.017)	0.000	4.828 (5.211)	0.354	-1.159 (2.019)	0.566
R&D expenses (above 0)	14,872	0.052* (0.029)	0.069	-38.108 (23.614)	0.107	10.078 (9.729)	0.300
R&D expenses (0)	68.463	0.090*** (0.014)	0.000	-9.931* (5.721)	0.083	-2.485** (1.226)	0.043
Fixed assets (median or higher)	41,743	0.044*** (0.016)	0.007	-40.784*** (11.403)	0.000	-3.971 (3.743)	0.289
Fixed assets (less than median)	41,587	0.093*** (0.017)	0.000	6.773 (4.511)	0.133	-0.329 (1.316)	0.802

Table 5_Summary of Heterogeneity Estimations for New KODIT Services(continued)

Heterogeneity	Sample size	(Log) revenues		Operating profit		R&D expenses	
		ATT	P	ATT	P	ATT	P
Business type (manufacturer)	41,704	0.059*** (0.018)	0.001	-30.592*** (9.040)	0.001	-3.039 (2.706)	0.261
Business type (service)	36,210	0.085*** (0.019)	0.000	-0.800 (6.841)	0.907	0.061 (2.189)	0.978
Enterprise size (SME)	44,029	0.045*** (0.015)	0.003	-18.532* (9.737)	0.057	-1.292 (3.724)	0.729
Enterprise size (microentrepreneur)	39,078	0.117*** (0.016)	0.000	2.269 (4.273)	0.595	-0.704 (0.960)	0.463
Location (SCA)	43,636	0.076*** (0.018)	0.000	-17.544** (8.225)	0.033	-5.382 (3.319)	0.105
Location (non-SCA)	39,375	0.079*** (0.018)	0.000	-15.366* (8.288)	0.064	1.010 (1.939)	0.602
Intellectual property (owns intellectual property)	6,771	0.023 (0.039)	0.564	-54.982* (33.367)	0.099	15.913 (13.268)	0.230
Intellectual property (no intellectual property)	75,686	0.081*** (0.013)	0.000	-8.696 (5.533)	0.116	-5.427* (2.833)	0.055
Family shares (median or higher)	30,396	0.060*** (0.018)	0.001	-33.464*** (11.163)	0.003	1.894 (2.449)	0.439
Family shares (below median)	29,380	0.056** (0.024)	0.021	-19.462* (11.688)	0.096	-4.344 (4.457)	0.330
Exporter status (exporter)	1,010	0.048 (0.062)	0.436	-0.475 (43.562)	0.991	-5.536 (8.014)	0.490
Exporter status (no export)	42,267	0.063*** (0.016)	0.000	-22.754** (9.604)	0.018	-6.991** (2.981)	0.019

Note: 1. The unit is KRW million.

2. Statistical significance levels are *** 1%, ** 5%, * 10%.

Source: Present study, using KODIT data and KED data.

IV. Use of Machine Learning to Estimate the Effects of GSFS

1. Propensity Score Matching and Causal Forest

A. Propensity Score Matching⁸

Propensity score matching allows researchers to estimate the average treatment effect (ATE) and ATT without bias based on assumptions of unconfoundedness and overlap. However, numerous researchers across diverse disciplines have discussed the limitations of estimating effects using propensity score matching (Imbens, 2014; Shipman et al., 2017; King and Nielson, 2019; Gulen et al., 2020).

First, propensity score matching was found to not be more asymptotically efficient than an estimation that uses all explanatory variables to match the treatment group and the control group (Hahn, 1998). This is because the standard error of estimation can be reduced by controlling for the variables that are not heavily involved in determining the likelihood of treatment, but can explain changes in the results. In other words, in a situation where the sample sizes asymptotically increase, the propensity score matching is not efficient. Nevertheless, the justification for using the propensity score matching can be found in Angrist and Hahn (2004). The authors argued that, in finite samples, propensity score matching may be more efficient than other estimation methods. In finite samples, it is more efficient to use propensity scores after excluding variables that do not significantly affect changes in results.

However, King and Nielson (2019) pointed out two issues posed by using propensity score matching. First, propensity score matching increases imbalance between the treatment group and the control group in terms of explanatory variables. In propensity score matching, especially when estimating ATTs, all observations are removed except for the control group, which have the closest propensity scores to the treatment group. In such cases, the imbalance between the two groups may become worse in terms of explanatory variables, resulting in increased model reliance and inefficiency. Second, when determining the likelihood of treatment, the estimated treatment effects may be highly sensitive to the choice of variables to be used in the logistics model. This leaves room for researchers to choose the model that best offers the results that they prefer. As such, in both cases, caution is required when using propensity score matching.

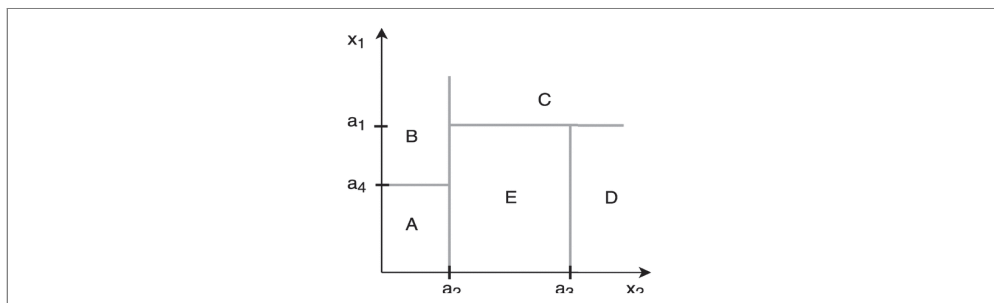
⁸ The discussion on propensity score matching is based on Angrist (2008), Imbens (2014), and Gulen et al. (2020).

In this study, we explore whether the causal forest model can be used to overcome the limitations of propensity score matching. As Gulen et al. (2020) theorizes, the answer seems to be ‘yes,’ because the method can lessen the issue of treatment-control imbalance, by comparing treated observations and controlled observations that are similar in terms of explanatory variables. In addition, the causal forest method seems to minimize the involvement of arbitrary judgement by researchers. Arbitrary judgements are required when researchers do not know which elements affects the likelihood of treatment, or specifically understand the relationship between those elements and the treatment status. In such cases, estimations may vary depending on the researchers’ judgments, as estimations on treatment effects are sensitive to the variables comprising the model. In contrast, as will be discussed later, the causal forest algorithms only choose the most crucial variables for growing the tree, thereby minimizing the room for arbitrariness.

B. Causal Forest

1) Concept and Characteristics of CART

Figure 1_Recursive Binary Classification in a Two-Dimensional Space



Source: Schonnau and Zou (2020), Figure 1.

Figure 1 describes how the CART algorithm uses a recursive binary classification to divide a two-dimensional space into five mutually exclusive spaces. The first classification occurs at $X_2 \geq a_2$, and divides the plane into two spaces, $\{A, B\}$ and $\{C, D, E\}$. The two spaces are again divided by a binary classification. The space on the left ($\{A, B\}$) is divided by $X_1 \geq a_4$ into $\{A\}$ and $\{B\}$, and the space on the right ($\{C, D, E\}$) is divided into $\{C\}$ and $\{D, E\}$ by $X_1 \geq a_1$. Lastly, $\{D, E\}$ is divided into $\{D\}$ and $\{E\}$ by $X_2 \geq a_3$, and the tree stops growing. Then, the result values of an enterprise that is $X_i = x$ is predicted by the average value of the space

x where R_m is located. CART chooses which variable to use to binarily classify a multi-dimensional space of explanatory variables, which value of the variable to use as the threshold for classification, and which variable and threshold minimize the mean squared error (MSE). In other words, CART chooses the combination of value j and threshold s that minimizes the objective function proposed in Equation (1).

$$\min_{j,s} = [\sum_{X_i \in R_1(j,s)} (y_i - \bar{y}_1(j,s))^2 + \sum_{X_i \in R_2(j,s)} (y_i - \bar{y}_2(j,s))^2] \quad \text{Equation (1)}$$

where $R_1(j,s) = \{X|X_j \leq s\}$, and $R_2(j,s) = \{X|X_j > s\}$.

2) Characteristics of Causal Tree and Causal Forest

Athey and Imbens (2016) proposed the causal tree method that uses CART to estimate treatment effects. The causal tree method differs from CART in two respects. First, CART and the causal tree method use different objective functions as criteria for selecting the variables and thresholds to use in the binary classification. The objective function of CART, as shown in Equation (1), looks for the combination (variable and the variable's threshold) that minimizes the squared difference between the actual values and the predicted values. In contrast, a causal tree calculates treatment effects based on the difference in results between the treatment group and the control group included in the last node of the causal tree [Equation (2)], to look for the combination that maximizes the variance of the treatment effect.^{9,10}

$$\hat{\tau}(x) = \frac{1}{i : \{W_i = 1, x_i \in L_i\}} \sum_{\{W_i = 1, x_i \in L\}} y_i - \frac{1}{\{i : W_i = 0, x_i \in L_i\}} \sum_{\{W_i = 0, x_i \in L_i\}} y_i$$

Equation (2)

Another difference between the causal tree method and CART is the use of the honesty approach in training the tree. The data used for algorithm training are randomly divided into the training data (S^{tr}) and the estimation data (S^{est}). The training data are used to grow individual trees, and the estimation data are used to predict treatment effects. A model is adapted by the treatment effect, and treatment effects are estimated by the estimation data. This honesty approach prevents overfitting and minimizes bias.

⁹ Athey and Imbens (2016) showed that maximizing the variance of estimated treatment effects was similar to minimizing MSE in the decision tree.

¹⁰ See Athey and Imbens (2016), pp. 7356–7357 for further discussion on the issue.

A causal forest is built by combining multiple causal trees. The trees are grown by building random samples from the original samples through sampling with replacement. This randomness provides slightly different characteristics to each causal tree. The causal forest method minimizes the variability increased by the honesty approach used in causal trees, using combinations of multiple causal trees. The causal forest grows B trees. The treatment effects $\hat{\tau}(x)$ of x in the causal forest are estimated based on the average value of treatment effects estimated by each causal tree.¹¹

Lastly, the causal forest method can estimate the CATE of businesses of which explanatory variables have specific values under the assumption of unconfoundedness and overlap. Specifically, $\hat{\tau}(x)$ is estimated by the average of the treatment effects estimated in the final nodes of individual causal trees that include $X = x$. Estimated CATEs can be used to calculate ATEs and ATTs; ATEs and ATTs can be estimated using the simple average of CATE. However, in this study, we used the augmented inverse propensity weighted (AIPW) estimations to calculate the treatment effects. Inverse propensity weighted (IPW) estimations, such as simple weighted averages, do not yield good outcomes when a predicted propensity score approaches 0 or 1. In addition, in cases in which an error exists in the design of the likelihood of treatment model and the result model, the AIPW estimations yield better outcomes than IPW estimations (Glynn and Quinn, 2010). In this study, we also estimated the average treatment effect by using an overlap correction (ATP). While similar to the ATE estimation, ATPs are estimated by assigning high weights to nodes where the treatment group and the control group take up similar percentages.

2. Findings

A. Estimation of Policy Effects

1) Validation of Analyzed Data and Hypotheses

In order to estimate the effects of KODIT with the credit guarantee method, we used the 2011–2015 samples mentioned in Chapter III. The dependent variables are revenues and operating profits in 2015. The treatment variable is whether a given business received KODIG services in 2014, and the control group consisted of non-beneficiaries in 2014 and 2015.¹² In

¹¹ $\hat{\tau}(x) = \sum_{b=1}^B \hat{\tau}_b(x)$

addition, as operating profits and net profits are highly correlated, we only used operating profits as the prediction variable.¹³ We used the basic statistics for the 2011–2015 samples listed in Table III-12 from Lee, Ko, and Bae (2021), which consisted of 83,897 businesses. However, in this analysis, we excluded 1,574 observations with inaccurate geographic information when we created the geographic information of the businesses at the Si/Gun/Gu (city/county) levels, resulting in 82,323 observations for the final analysis.

In order to estimate treatment effects using a causal forest with no bias, the overlap condition should be satisfied.¹⁴ Lee, Ko, and Bae (2021) reviewed a situation in which the overlap condition is satisfied when using a causal forest in Figure V-4. The figure confirmed that the beneficiary group and the non-beneficiary group show similar distributions of key explanatory variables. In conclusion, the 2011–2015 sample is highly likely to satisfy the unconfoundedness condition, and satisfy the overlap condition to an extent, if past operating profits and revenues are controlled for.

2) Hyper Parameter Tuning for the Causal Forest

Here, we analyze the treatment effects and their heterogeneity using the *grf package*¹⁵ of *r*. In the package, researchers are required to set hyper parameters. As such, we discuss how we set the hyper parameters before presenting our estimations.

A causal forest can be developed using either the honesty approach or an adaptive approach. In order to minimize bias in the treatment effect estimation, we used a causal forest based on the honesty approach as proposed by Wager and Athey (2019). As such, we used 50% of the 57,382 observations for the model training as training data, and the other 50% as estimation data.¹⁶ In other words, we used 28,691 observations for model training, and other

¹² We used the 2011–2015 samples because, as shown in Figure III-5 from Lee, Ko, and Bae (2021), the assumption of unconfoundedness is likely to be satisfied when the revenues and operating profits in 2011 to 2013 are controlled for.

¹³ The treatment effects estimated using a causal forest that included past net profits were similar to the effects estimated in this analysis.

¹⁴ Regarding the unconfoundedness assumption, in this study, we assumed unconfoundedness after confirming that the treatment group and the control group demonstrate the same trends of results when controlled for past operating profits and revenues.

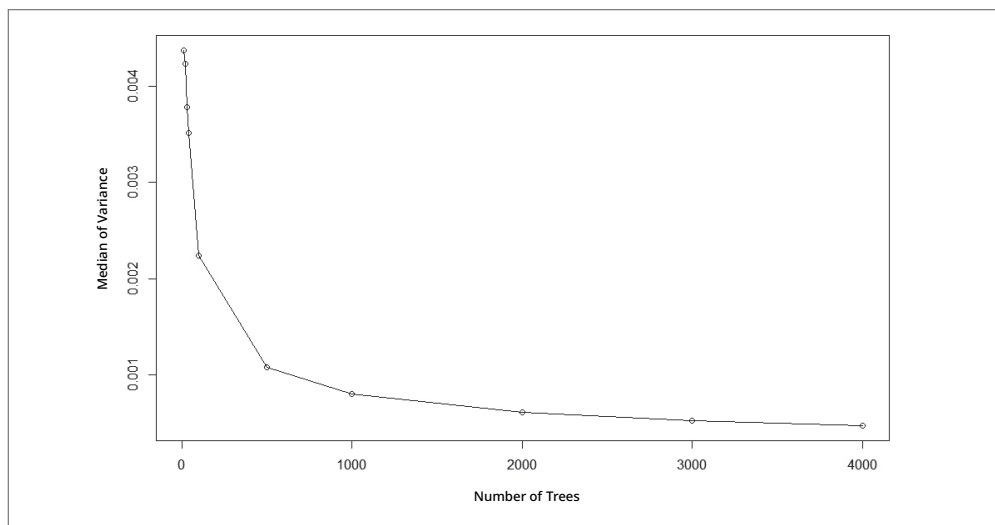
¹⁵ The *grf package* provides researchers with a test to determine the goodness of fit for treatment effects and their heterogeneity. See Lee, Bae, and Ko (2021 pp. 145–147 for a detailed discussion on the goodness of fit.

¹⁶ 30% of the 82,323 observations were used as test data, and the other 70% was used as training data in the traditional sense. We divided the training data in two halves, which we used as training data and estimation data, respectively.

28,691 observations to estimate the treatment effects. As briefly discussed, the honesty approach may not yield good results as it uses a smaller number of data for model training. However, we assigned 28,691 observations to the training data, which we deem as sufficient for model training.¹⁷

The increase in estimation volatility caused by the honesty approach can be lessened by growing multiple trees. As such, researchers need to select how many trees to grow. Granted, growing multiple trees offers the benefit of lower volatility of estimations; however, the time required to train the algorithm proportionately increases. Therefore, in Figure 2, we show how the variance (median) of the estimations changes depending on the number of trees used in the causal forest. Naturally, the variance declines with the number of trees, with the median of the variance rapidly decreasing as the number of trees increases from 10 to 500. However, the reduction effect was weaker when the number of trees was over 1,000. For this reason, we used 1,000 trees to estimate our treatment effects.

Figure 2_Median of Variance Depending on the Number of Trees in a Causal Forest



Source: Present study, based on KED data.

¹⁷ We tested the goodness of fit of the causal forest assigned with 70% of the training data and the causal forest assigned with 50% of the observations, and the two algorithms yielded similar results and similar ATE estimations.

In both the random forest and the causal forest method, when the algorithms use binary classification to grow trees, they randomly select a number of variables for the binary classification instead of considering all variables. In general, the number of randomly selected variables is determined using the following formula.

$$\text{Number of variables used for binary classification} = \min(\sqrt{p} + 20, p)$$

In this analysis, we used a total of 14 explanatory variables. According to the formula, we should use all of the 14 variables. As such, we set the number of variables for the causal forest at 14.

Lastly, the `grf` package allows users to set the minimum number of treated observations to be included in the final node, which we set at 10. As a result, if two nodes generated by a specific node using binary classification have 10 or less treated observations, the algorithm stops growing the tree and the nodes become the final nodes.

3) Effects of GSFS

Table 6 represents the effects of KODIT's GSFS on the beneficiaries' revenues and operating profits, as estimated by the causal forest method. The table lists ATEs, ATTs, average treatment effects on the control (ATCs), and average treatment effects in the overlap (ATOs). First, the KODIT was estimated to have increased revenues in 2015 by 4.45%. The ATT, which is the treatment effect estimated for KODIT beneficiaries, was estimated to be 4.46% at a 1% statistical significance. The ATC, which represents the effect of KODIT on the control group, was estimated to be 4.44% at a 1% statistical significance. The similarity between the ATC and ATT estimations indicate that the treatment group and the control group are comprised of similar businesses, in terms of explanatory variables. The similarity becomes even more apparent when we review the ATO estimation because, in order to better satisfy the overlap condition, CATE is averaged by assigning a lower weight to observations having propensity scores close to 0 or 1, and a higher weight to observations having propensity scores close to 0.5. The estimated ATO was also similar to the ATE, which seems to suggest that the treatment group and the control group show similar distributions of propensity scores, and thus satisfy the overlap condition.¹⁸

As shown in Sample 2 in Table 4, the estimation obtained from the same samples using propensity score matching was 7.8%, which is higher than the causal forest estimation.

Curiously, the ATE from propensity score matching was 13.48%, which is far higher than the ATT. The difference seems to stem from the imbalance between the treatment group and the control group, which was exacerbated by removing observations other than the closest observations based on propensity scores, as pointed out by King and Nielson (2019).

Table 6_ Effects of KODIT on Revenues and Operating Profits

Treatment effect	Estimation	Standard error	Observations
Log revenues in 2015			
ATE	0.0445***	0.0063	57,382
ATT	0.0446***	0.0062	57,382
ATC	0.0444***	0.0064	57,382
ATO	0.0444***	0.0062	57,382
Operating profits in 2015 (KRW million)			
ATE	-1.827	4.793	57,382
ATT	-3.222	4.537	57,382
ATC	-1.672	4.853	57,382
ATO	-3.156	4.579	57,382

Note: Standard errors are represented by the numbers in parentheses, and the statistical significance levels are as follows: ***1%**5%**10%. Source: Present study, based on KED data.

King and Nielson (2019) also drew attention to a limitation of the propensity score matching, which is the high sensitivity of estimated treatment effects to the variables comprising the logit model used to determine the likelihood of treatment. As such, when estimating treatment effects using propensity score matching in Chapter III, we added squared terms of the continuous variables (revenues, operating profits, etc.) when building the logit model, as advised by Dehejia and Wahba (1999). It is worth noting that the estimated ATT was 4.02%, which is far from the estimated effect using the propensity score matching preferred in this study (7.8%). In addition, the estimated result from the propensity score matching shows that the addition of the squared terms led to sensitive changes in the treatment effects. The causal forest seems to be able to supplement the conventional method in this regard, because each causal tree flexibly considers the non-linear relationship between

¹⁸ The balance between the treatment group and the control group seems to have been also improved by only leaving observations including propensity scores when building the 2011–2015 sample, as advised by Crump et al. (2009).

explanatory variables and the likelihood of treatment, and the causal forest averages the results from multiple causal trees (1,000 in this study). It is equivalent to estimating 1,000 different logit models with different variables, and using them to estimate treatment effects and calculate their average. As such, the causal forest method can overcome the limitations of the propensity score model in terms of robustness.

The findings discussed above confirm that KODIT increases the revenues of the beneficiaries. However, we need to further investigate their operating profits in order to verify whether the revenue growth actually improved the businesses' profitability. The causal forest estimation shows that KODIT reduced the beneficiaries operating profits in 2015 by KRW 1.83 million. However, the finding was not statistically significant. However, the ATO was estimated at -3.16, showing a slightly larger negative effect compared with the ATE. However, the finding was not deemed to be statistically significant. There was no clear evidence that KODIT had a negative effect on the operating profits. The finding is vastly different from the estimation for Sample 2 in Table 4 (-13.41), which was statistically significant. Combined with the fact that the causal forest did not yield good results in the goodness of fit test when using operating profits as a dependent variable, these estimations do not provide clear conclusions as to the KODIT's effects. As such, a causal forest using 2015 operating profits as a dependent variable needs additional algorithm training processes and a wider variety of hyper parameter values in order to improve the power of the test.

The findings on treatment effect estimations from the causal forest shows that machine learning can be used for evaluating the effects of programs as well as addressing the prediction problem. Granted, reliable estimations can be developed with the propensity score matching, if researchers observe the guidelines proposed in previous studies (Dehejia and Wahba, 1999; Crump et al., 2009; Imbens, 2014) to satisfy the overlap assumption, closely review the identification assumptions, and experiment with various models when using a logit model in order to determine the likelihood of treatment. However, for researchers, the causal forest offers a clear benefit of easily obtaining estimations that do not rely on a model, because each tree determines the likelihood of treatment and estimate the treatment effects, whereas a robustness test for a logit model can be relatively difficult. Therefore, the causal forest method seems to be highly useful for estimating treatment effects.

B. Heterogeneity of Policy Effects

The grf statistics package also shows how many attribute variables (or explanatory variables) were used to grow trees and their rates. For example, in cases where the causal forest used a binary classification 20 times to grow two trees and used the operating profits in the previous year ten times, the importance of the variable is indicated as 0.5. Table 7 shows the importance of various explanatory variables for tree growth. For trees trained using revenues as a dependent variable, the 2013 operating profits took up the highest percentage of the trees' growth, at 26.7%. The percentages of the 2011 operating profits and the 2011 log revenues are 12.7% and 11.6%, which suggests the importance of past revenues and operating profits in estimating heterogenous treatment effects. In addition to operating profits and revenues, important variables in the heterogeneity estimation included revenues at the industrial division level (6.1%), industrial section (4.8%), fixed assets (5.4%), and location (Si/Gun/Gu) code (4.6%).

Table 7 Importance of Explanatory Variables in Tree Growth

Variable name	Variable label	Dependent variable	
		Revenues	Operating profit
X1	Log revenues in 2013	0.065	0.224
X2	Log revenues in 2012	0.040	0.140
X3	Log revenues in 2011	0.116	0.063
X4	Operating profits in 2013	0.267	0.204
X5	Operating profits in 2012	0.080	0.093
X6	Operating profits in 2011	0.127	0.098
X7	Revenues at the industrial division level	0.061	0.027
X8	R&D	0.034	0.040
X9	Years in business	0.034	0.012
X10	Industrial section	0.048	0.010
X11	Enterprise type	0.004	0.000
X12	Fixed assets	0.054	0.072
X13	Location code	0.046	0.012
X14	Enterprise size	0.024	0.005

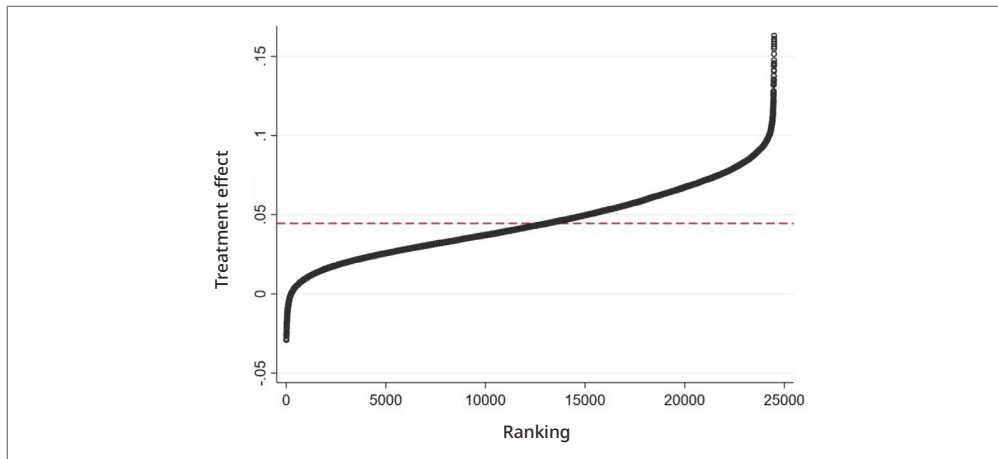
Note: Variables with unspecified years are from 2013.

Source: Present study, based on KED data.

In the algorithm using operating profits as a prediction variable, the 2013 log revenues and the 2013 operating profits were used as key variables for growing the trees. As shown in Table V-3 in Lee, Ko and Bae (2021), only the causal forest that uses revenues as a prediction variable was able to provide statistically significant estimations as to the heterogeneity of treatment effects. For this reason, we analyzed the heterogeneity of treatment effects using only the causal forest that uses revenues as a dependent variable.

Figure 3 lists the treatment effects estimated from the test data comprised of 24,484 observations in ascending order. The previously estimated ATE was 4.45%, as indicated with the dotted lines. The treatment had a negative effect at the left end of the line, and a positive effect of over 10% at the right end. In other words, relative to ATE, treatment effects were overestimated or underestimated depending on the characteristics of the observations.

Figure 3_ The Conditional Average Treatment Effect(CATE) of GSFS



Source: Present study, based on KED data.

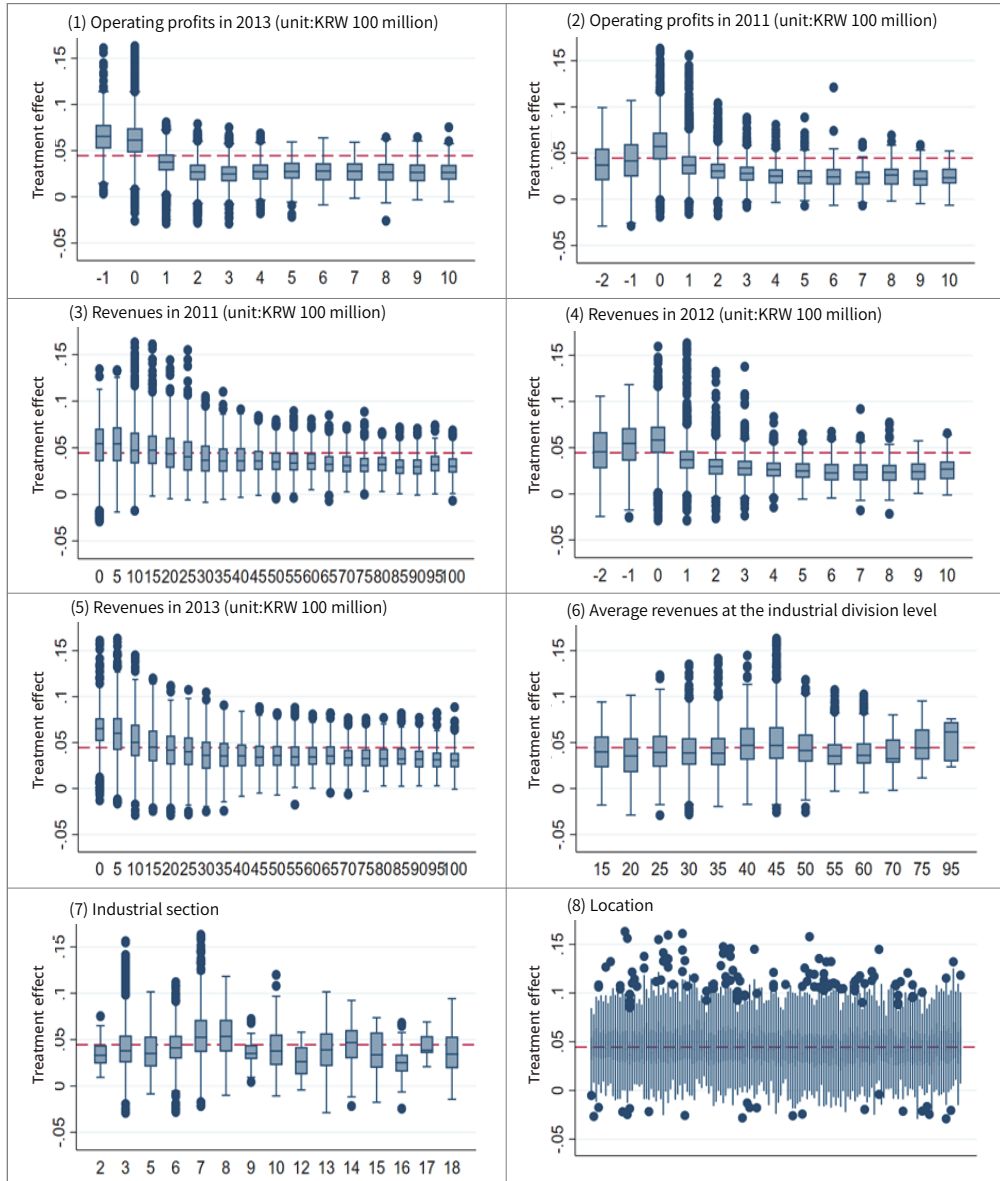
Figure 4 explains which attributes are related to the heterogeneity of the treatment effects, by showing the treatment effects of each explanatory variable using box plots. First, the GSFS had a strong effect on the 2013 operating profits among businesses that reported operating profits between KRW -100 million and KRW 0. The size of the treatment effect among the businesses in the same group was 25%, which is larger than for ATE (4.4%). Overall, the treatment effect on the businesses in the section were higher than for ATE. The treatment effects were larger than the ATE estimates among the businesses in the KRW 0 to KRW 100

million section. The treatment effect on the businesses in the bottom 25% was also larger than for ATE. However, the treatment effect declines below that of ATE as the operating profits increase and remained there.

As for the operating profits in 2011, among the lowest three sections (KRW -200 million to KRW -100 million, KRW -100 million to KRW 0, and KRW 0 to KRW 100 million), a section with higher operating profits recorded higher treatment effect. In higher groups, the treatment effect gradually declined and settled at a certain level. The 2012 operating profits represented a similar pattern.

As for past revenues, using 2013 revenues, small businesses falling under the KRW 0 to KRW 500 million section or the KRW 500 million to KRW 1 billion section reported higher treatment effect than for ATE. However, the treatment effect gradually increased with the revenue, with the treatment effect continuously being estimated low starting with the KRW 350 million to 400 million section. However, the 2011 revenues did not significantly contribute to explaining the heterogeneity of the treatment effects. Lastly, the average revenues at the industrial division level, the industrial sections, and the location (Si/Gun/Gu) did not significantly affect treatment effects. However, the businesses in the industrial section nos. 7 (wholesale and retail) and 8 (transportation and warehousing) reported slightly greater treatment effect relative to businesses in other industries.

Figure 4_Heterogeneity of Treatment Effects by Explanatory Variable



Source: Present study, based on KED data.

However, the box plot method does not tell us which variables are important for the treatment effect. For example, assuming that there is a high correlation between operating profits and years in business, the box plot cannot be used to distinguish whether a large treatment effect observed in a certain range of operating profits originates from the operating profits or the number of years in business. As such, we carried out an additional analysis using the method proposed by Gulen et al. (2020). The method can be characterized as a type of comparative static analysis, because it examines the role of a given variable in the heterogeneity of treatment effect by fixing the value of the other variables. Specifically, in order to examine the heterogeneity of the treatment effect across different levels of operating profits in 2013, we used the data used for the box plot after replacing the values of the variables other than the 2013 operating profits with the medians of the respective variables. We then used the newly developed data to calculate the treatment effects and analyzed them based on the 2013 operating profits. By fixing the values of all variables other than the 2013 operating profits, we made sure that changes in the treatment effect only originate from changes in the operating profits, which allowed us to measure the effect of changes in operating profits on the size of treatment effect.

Figure 5 represents the findings of the comparative static analysis featuring six explanatory variables that appear to play important roles in the heterogeneity of treatment effect (2013 operating profits, 2011 operating profits, 2011 revenues, 2012 revenues, 2013 revenues, and industrial sections), where the X axis represents each explanatory variable and the Y axis represents the estimated treatment effect. As the variables other than those represented by the X axis have been fixed at their median values, each variable represented by the X axis denotes a single treatment effect.

With all the other explanatory variables being fixed at their median values, the treatment effect steadily increases from 6.95% to 7.5% as the 2013 operating profits increases from KRW -500 million to KRW 0. However, the treatment effect rapidly declines after the operating profits exceed KRW 50 million, stabilizing at around 3% after the operating profits reach KRW 225 million. Given the non-linear change of the treatment effect, the effect of operating profits on treatment effect appears to have a pattern that is difficult to identify using a standard linear regression model. The 2011 operating profits and the 2012 operating profits show different patterns of changes in the treatment effect than the 2013 operating profits. However, as was the case with the 2013 operating profits, a large treatment effect was observed at an operating profit of KRW 0.

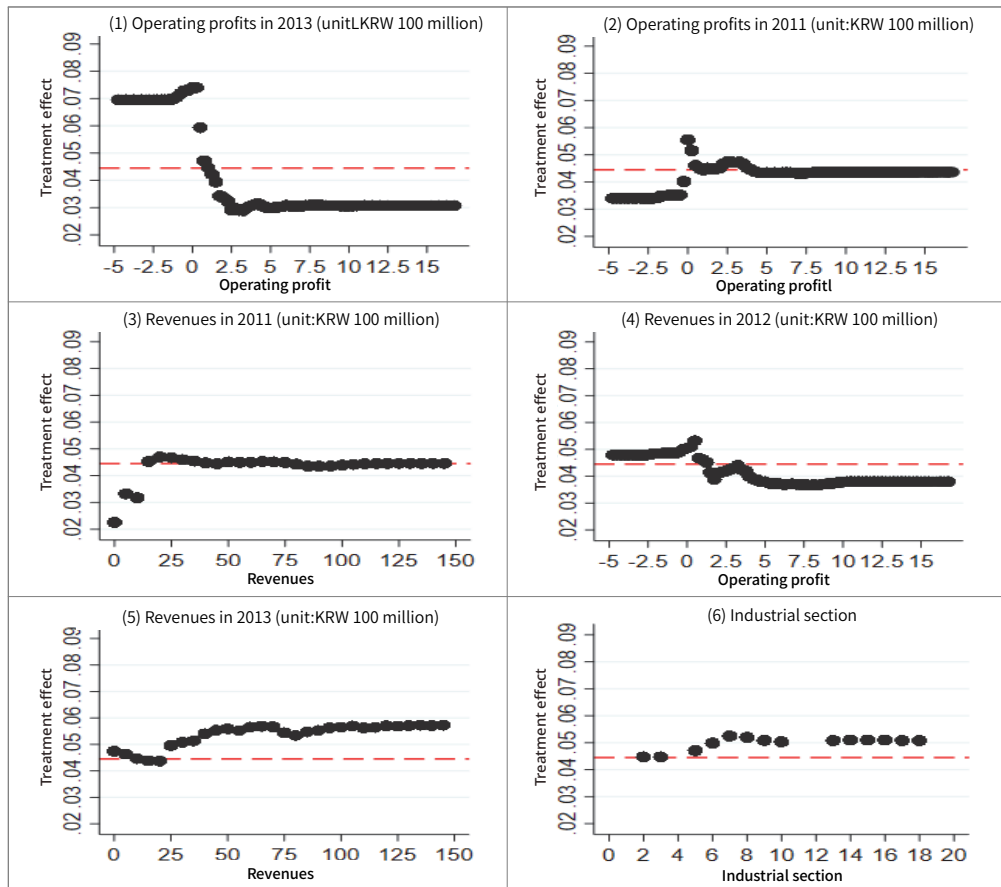
As for the 2013 revenues, the estimated treatment effect was high among businesses reporting 2013 revenues larger than KRW 2.5 billion. However, the estimated treatment effect was larger than for CATE across all revenue levels, which means that changes in the 2013 revenues do not explain the heterogeneity of the treatment effects. The box plot analysis showed larger treatment effects among businesses with 2013 revenues of KRW 1 billion or lower. However, the results of the comparative static analysis were the opposite. This difference indicates the importance of controlling for correlations among variables when analyzing the heterogeneity of treatment effects. Lastly, as for the heterogeneity of treatment effects across industrial sections, as shown in the box plot, the treatment effects were larger in the wholesale and retail and the transportation and warehousing sections. However, no marked difference was identified relative to the other industrial sections. As such, the industrial section does not seem to be an important variable when explaining the heterogeneity of treatment effects.

In Chapter III, when analyzing the heterogeneity of KODIT on the beneficiaries using the propensity score matching, we defined two subgroups by dividing the median operating profits in 2013, and estimated the treatment effect in each subgroup. The treatment effect of the subgroup with operating profits below the median value was 11.5%, and that of the other group was 4.0%. In the heterogeneity analysis in Chapter III, the variable that recorded the largest gap between the two groups was the 2013 operating profits, highlighting the consistency of the heterogeneity analysis results between the two methods. This finding may appear to suggest that a traditional linear model is also capable of identifying variables to explain the heterogeneity of treatment effects. However, the result is purely coincidental because 50% of the businesses earned operating profits of KRW 100 million or below. If the percentage had been only 10%, it would have been difficult to capture the heterogeneity of the treatment effect using the traditional method of dividing subgroups based on median values.

It should be noted, however, that the heterogeneity of treatment effects presented in this study does not provide a sufficient grounds for making strong policy recommendations, because we did not consider the existence of GSFS other than KODIT, and only used the service history of KODIT. However, as the purpose of this study is to explore the applicability of machine learning algorithms to better design GSFS programs, such a limitation does not appear to pose a serious issue. If policy researchers can accurately identify the most beneficiary of GSFS with the machine learning algorithm discussed in this study, they can design an effective GSFS program to achieve the policy goals that they envision. For example, if

researchers want to design a GSFS program to boost business growth (revenues), they can examine the heterogeneous treatment effects using a causal forest where the revenue is a dependent variable. Then, they would be able to tailor the program to select the beneficiaries based on the identified treatment effects.

Figure 5_Heterogeneity of Treatment Effects by Prediction Variable: Comparative Static Analysis



Source: Present study, based on KED data.

V. Conclusions and Policy Implications

In this study, we evaluated fiscal programs using machine learning and explored the applicability of machine learning to improving the efficacy of fiscal programs. Specifically, in order to examine the applicability of machine learning, we assessed the effectiveness of machine learning in estimating the effect of GSFS programs and in selecting beneficiary groups with the highest program effects, by comparing it with propensity score matching, a method widely used in previous literature. This study contributes to the existing body of work by verifying the usefulness of machine learning by comparing the applicability of machine learning algorithms to the estimation of treatment effects and their heterogeneity for fiscal programs such as GSFS by comparing them with existing statistical methods, and thus creating a new foundation for designing fiscal programs and evaluating their performance.

The following policy recommendations can be drawn from this study. First, the Korean government needs to divide GSFS programs into SME support programs for productivity, and SME support programs for public assistance, and revise the criteria for guaranteed eligibility accordingly. In particular, the financial support programs for productive SMEs can be greatly improved by applying machine learning to support programs for those ‘small giant’ SMEs experiencing difficulties with growth on account of market failures. However, it should be noted that the original purpose of GSFS can be undermined if they focus on groups of businesses where the programs are sure to have strong impact, which is all the more reason to implement GSFS programs in two tracks: SME support programs for productivity, and SME support programs for public assistance.

The government also needs to consider using machine learning as a supplementary tool for evaluating the effectiveness of fiscal programs. The government currently evaluates key fiscal programs and applies the findings to its fiscal management, in order to achieve performance-driven fiscal policy management. To achieve the original purpose of performance-centered fiscal policy management, the effectiveness of fiscal programs should be evaluated in a reliable manner. As machine learning algorithms are capable of addressing the limitations of the conventional evaluation methods, the government needs to actively utilize machine learning algorithms in its evaluation activities.

Lastly, due to the lack of available data, we did not consider other GSFS than those previously provided by KODIT, which makes it difficult to select GSFS beneficiaries solely based on the heterogeneity of treatment effects identified using current machine learning algorithms. However, this limitation does not greatly affect the essential implications of this

study, because we explored the applicability of machine learning in relation to the selection of GSFS beneficiaries. If researchers can access the GSFS provision history of KODIT and the Integrated SME Support Program Management System, they can accurately identify overlapping benefits and other aspects of GSFS that are provided to SMEs. We ultimately believe that the machine learning algorithms discussed in this study can be used to develop concrete plans to design relevant policies.

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The Role of Tax Policies for Transition to a Low-Carbon Society

Jaehyun Jung and Dawoon Jung*

I . Introduction

With a view towards building a low-carbon society, the Korean government enacted the Framework Act on Low Carbon, Green Growth, in addition to launching the Emission Trading System (ETS) and the Target Management System (TMS). Furthermore, since its ratification of the 2016 Paris Agreement, the country has also implemented policies in alignment with global standards. For example, the government has established Nationally Determined Commitments (NDCs), a Framework Roadmap on Greenhouse Gas Reduction, and systems to review and assess the implementation of the NDCs. In December 2020, the government submitted its Long-term Low Emissions Development Strategies (LEDS) to the United Nations (UN), and set forth concrete plans in its 2050 Net Zero Strategies.

However, given the growing demand for further efforts for carbon neutrality, including more ambitious NDCs, Korea's current ETS may prove short of achieving its stated carbon neutrality targets, and the country is facing a rising demand for an enhanced carbon pricing system. In light of the current trends, Korea has now included a number of specific targets in its 2050 Net Zero Strategies, including: stronger carbon pricing signals, a new fund for climate response, and the development of carbon neutrality-friendly expenditure programs.

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The target of a stronger carbon pricing signal involves comprehensively reviewing the role of relevant market instruments (including environment taxes, contributions, and ETS), and rebuilding the pricing system to use those instruments as financial sources through funds and other means.

The purpose of this study is to assess the possibility of adopting a carbon tax in Korea in connection with the country's existing ETS. For this task, we assess the adequate level of taxes and charges required, based on a comprehensive review of global standards on carbon prices and other factors, and then analyze the economic effect of carbon tax adoption by focusing on the price pass-through effect.

Specifically, we first assess the benefits and drawbacks of the carbon tax relative to the Korean ETS. Second, we review the experiences of other countries to examine the background, current status, and effect of carbon tax adoption and tax reductions based on the consideration of industrial competitiveness, in order to identify their implications for Korea.

Third, we discuss the possible effect of adopting a carbon pricing system in Korea in order to determine the effect of creating a carbon tax on top of the current trading system, as Korea already has an ETS in place. If we can determine whether Korea can effectively reduce carbon emissions only a single carbon pricing system (that is, the ETS), and identify the amounts of carbon that other countries reduced by adopting a carbon tax, it will provide the country with useful information to guide its policies. As such, we explore the effect of adopting a carbon pricing system by reviewing a collection of latest works that empirically analyze the environmental and economic effects of adopting the system. In the early 2010s, after the Korean government launched its first green growth initiative, many Korean researchers assessed the possibility of taxes and charges related to carbon emissions, and proposed improvements for the overall imposition system. However, since the adoption of the ETS, few researchers have discussed the effect of carbon tax adoption.

Building on the discussions in the previous chapters, the last chapter of this study examines the economic effect of carbon tax adoption under Korea's current economic structure, and then proposes a rationale for adopting a carbon tax. Such rationale can be found in the Pigouvian tax theory, which internalizes external costs in prices. However, in reality, we need to examine how carbon pricing will affect carbon emissions and how economic actors will change their behavior in response to the adoption in both the short and long term. For example, policymakers expect carbon tax adoption to encourage businesses to replace GHG-producing fossil fuels with more eco-friendly production factors, adopt technologies

to reduce emissions, and improve their processes. However, it is equally conceivable that businesses may, at least in the short term, transfer the increase in their production costs to consumers. In addition, one of the main rationales for adopting a carbon tax is that the government can invest the additional revenue into developing carbon reduction technologies and helping businesses transition to low-carbon processes. However, it should be also considered that, if the government does not make such investments, the carbon tax may only increase government revenues, leaving the profit structure of businesses to be undermined, with the resulting costs potentially being transferred to consumers.

Therefore, in this study, we vicariously estimate the economic effect of the carbon tax under Korea's current industrial structure by examining the extent to which a price increase in energy inputs is transferred to consumer prices. Previous discussions on carbon tax adoption in Korea have mostly developed and analyzed various taxation scenarios by focusing on general equilibrium models. However, a micro-level analysis using data from individual firms has been relatively lacking. In addition, among the many considerations regarding carbon pricing system adoption, we analyze the incidence effect from the reinforcement of the carbon pricing system in the industry sector.

II . Carbon Pricing System

1. Social Cost of Carbon

The social cost of carbon serves as a useful benchmark to estimate the cost effectiveness of climate response strategies. If emitting a ton of carbon dioxide (CO₂) incurs a high social cost, it means we have room for paying higher costs to reduce carbon emissions. Once emitted, greenhouse gases (GHGs) remain in the air. In addition, as the global temperature rises, adverse climate events are expected to inflict even greater damage on the economy. As such, we can expect the social cost of carbon to increase in the future.

Calculating the social cost of carbon emissions requires the development of an integrated assessment model. This model should consist of four elements: the prediction of economic growth including demographic changes (economic model); a climate change model based on greenhouse gas accumulation (scientific model); a damage function that takes account of the economic damage caused by global warming and the climate adaptation cost; and the social discount rate, which economically represents a social consensus on resource distribution

between the current and future generations.

International organizations such as the Organisation for Economic Co-operation and Development (OECD, 2021) have set the minimum level of carbon social cost at EUR 30 per ton of CO₂ equivalent (tCO₂e). The minimum carbon price required for reaching Paris Agreement targets is estimated at between USD 40 and 80/tCO₂e by 2020, and between USD 50 and 100/tCO₂e by 2030.¹ A range of other estimates have been proposed in attempts to determine the appropriate level of carbon social cost, using different estimation methods. Although varying in estimation results, organizations widely recognize that the current carbon pricing policies are not delivering carbon price signals that would encourage citizens and businesses to consider climate cost. The current integrated models have failed to properly incorporate the effect of climate change on productivity, growth rate, and ecosystems.²

2. Carbon Pricing System

Key policy instruments for GHG reduction include: regulation, standards, and market instruments such as the ETS and carbon tax. Market instruments reduce CO₂ emissions by fostering carbon-reducing industries and encouraging carbon-reducing processes by granting R&D incentives to clean technologies. In this chapter, we outline the emissions trading system of the European Union (EU-ETS) and compare it with the carbon tax in order to identify the latter instrument's strengths and weaknesses.

A. ETS

One of the main pillars of the carbon pricing system, the ETS is a system in which the government pre-determines the total GHG emissions and grants yearly allowances to businesses (total emission-based regulation). Businesses can then emit or reduce GHGs within their respective allowances, and trade surplus or excess allowances among themselves.

Let's take an example of the EU-ETS, where this type of system was first implemented. The system launched in 2005 and has been scaling up in phases. In the first phase from 2005 to 2007, 25 member states participated in the system. In that year, around 2.2 billion tons of

¹ World Bank, "Report of the High-Level Commission on Carbon Prices," 2017, https://static1.squarespace.com/static/54ff9c5ce4b0a53deccfb4c/t/59b7f2409f8dce5316811916/1505227332748/CarbonPricing_FullReport.pdf, Accessed on January 21, 2021.

² IPCC 4th Assessment Report (AR4).

CO₂ allowances were allocated from among around 12,000 facilities (around 50% of total GHG emissions in the EU). The region is currently in its fourth phase, which began in 2021 and will end in 2030. The price of allowance was generally around EUR 5 throughout the first three phases of the EU-ETS, before quadrupling to EUR 20 in the second half of 2018. The fact that the equilibrium price of the allowance is lower than the commonly perceived social cost of carbon emissions has led academics to propose negative projections as to whether the EU-ETS will remain as an efficient carbon pricing system. However, the European Commission (EC) has predicted that the EU-ETS will restore its normal functions, one of the reasons being the market stability reserve (MSR). The MSR serves the role similar to a central bank, and is expected to stabilize emission prices by allowing the EU to stabilize carbon price with emission allowances.

B. Carbon Tax

The carbon tax is imposed based on the amount of carbon content in oil, coal, and other fossil energies in order to prevent global warming. The purpose of the tax is to internalize the social cost incurred by CO₂ emissions and encourage reduction or efficient use of fossil fuels. Finland began to impose a carbon tax in 1990, followed by Sweden and Norway in 1991 and Denmark in 1992. To date, more than 12 countries (Switzerland, Ireland, Portugal, etc.) have adopted a carbon tax.

Table 1_Carbon Tax and ETS

Item	Carbon Tax	ETS
Benefits	<ul style="list-style-type: none"> - Offers certainty regarding CO₂ prices - Grants long-term and stable incentives for low-carbon technology development - Applies to a wide range of targets, ensuring more equitable carbon prices - Offers higher transparency and predictability of policies 	<ul style="list-style-type: none"> - Offers certainty regarding the final emissions - Possible linkage with the global carbon market - Prepared against inflation
Drawbacks	<ul style="list-style-type: none"> - Uncertainties in final emissions (emissions are sensitive to energy demand and fuel prices) - Tax resistance - Regressive income distribution - Lower real tax rate during inflation 	<ul style="list-style-type: none"> - Uncertainties regarding CO₂ prices - Difficult to apply to households, commercial buildings, transportation, and small and medium worksites - Uncertainties in allowance price may weaken the incentives for low-carbon technology development - Incomplete competition in an ETS market having a low number of participants - Issue with the objectivity of the allocation system - High transaction cost (complex process required for information collection and distribution) and high market entry barrier

Source: Present study, based on Kim et al. (2010).

The ETS pre-determines the upper limit of CO₂ emissions from emission sources participating in the system. In contrast, under the carbon tax system, uncertainties exist regarding the final emissions because emissions are sensitive to the energy demand and fuel prices. The carbon tax may also induce tax resistance and regressive income distribution, which may place political burdens on governments.

Some scholars have argued that, while the ETS (emission-based) and the carbon tax (price-based) are expected to yield similar results when the certainty is guaranteed, the carbon tax may be a better pricing system in situations in which emission volumes are uncertain because it is easier to operate and allows for setting the global bottom limit of carbon prices.

For example, Weitzman (2016) noted that while uncertainties persist under both quantity-based controls and price-based controls, they manifest in different forms. In the ETS, total emissions are certain and prices and (marginal) costs are uncertain, whereas carbon emission prices and (marginal) costs are certain and total emissions are uncertain. Weitzman then argued that the carbon pricing system is a better pricing system than the ETS both in theoretical and empirical perspectives, based on the benefits and drawbacks of the carbon pricing system. He also argued that the carbon tax is easier to manage and offers more transparency in terms setting the low-bound carbon price. Under the global ETS, profits are generated across national borders, which may not be easily acceptable for countries required to spend vast revenues to purchase allowances. In contrast, carbon tax revenues are managed by the respective countries and can be internally redistributed and used to reduce other taxes. However, others still argue that the ETS is a more market-friendly pricing system than the carbon tax, largely based on the political benefits of granting free allowances to carbon-intensive industries.

Korea currently operates its own ETS (K-ETS) and also imposes various taxes on fossil fuels (transportation, energy, environment, and excise taxes). As such, in order to build a carbon pricing system capable of achieving carbon neutrality, the country needs to assess the benefits and drawbacks of adopting a carbon tax by comparing them with other alternatives such as enhancing the existing trading system and instituting an eco-friendly reform of the energy tax regime.

Apart from the existing energy taxes, the evident benefits and drawbacks of the carbon tax include the following. When adopting a new tax, the country can set different tax bases without being confined to the existing tax system. Korea originally adopted energy taxes as luxury taxes and it has been repeatedly pointed out taxation criteria are still vague despite several reforms in terms of incorporating external costs. As such, newly including the carbon

tax may allow Korea to impose appropriate taxes on carbon emissions from different energy sources without adjusting the existing tax bases.

A new carbon tax may also facilitate a further adjustment and calibration of the tax rate system if the government changes and achieves its policy goals for carbon reduction, after the initial adoption. In order to boost the price signals from taxation for carbon reduction, the government needs to adopt a new tax item (carbon tax). Otherwise, the original purpose of the carbon tax may be undermined, as the rates of existing energy taxes are affected by factors other than the price signal function. Lastly, by creating a carbon tax that is separate from existing energy taxes, the government can specifically commit the revenue from the new tax to carbon reduction efforts, which will allow for the efficient management of tax revenues collected. This approach may increase the political acceptability of the carbon tax if used in connection with the preparation against carbon border adjustment currently in talks in the EU.

In contrast, adopting a carbon tax as a new tax item has the potential to somewhat complicate the tax system. However, it should be noted that Korea's energy tax regime is already characterized by its complex taxation system and its focus on earmarked taxes. As such, Korea may consider newly creating an explicit carbon tax in order to greatly enhance the environmental tax aspect of the energy tax system, in order to prevent global warming caused by GHG.

III. Emission Reduction Effect of the Carbon Pricing System

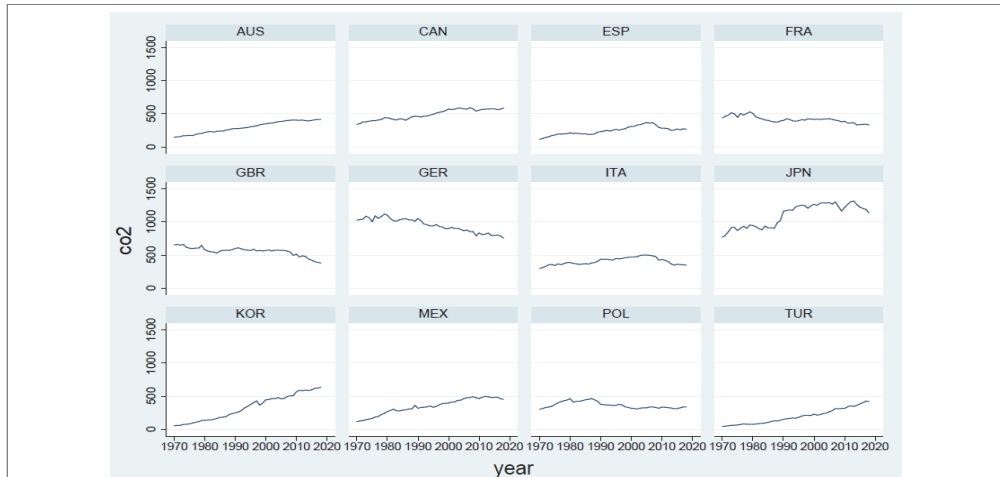
1. Carbon Emission Trends in Major Countries

Above, we reviewed the characteristics of two major market instruments for carbon pricing: the carbon tax and the ETS. We also explored the adoption of these two instruments in major countries, as well as key considerations for adopting a carbon tax. In this chapter, we will discuss whether those carbon pricing systems—carbon tax and ETS—have contributed to reducing GHG emissions. For this task, we review previous literature offering findings on the relationship between the carbon pricing system and GHG emissions. We will first, however, provide an overview of CO₂ emissions in major countries, including the OECD members and Nordic countries that adopted a carbon tax early on.

Figure 1 represents the emission trends between 1980 and 2018 from the top 12 CO₂-emitting countries (other than the US). Most EU members reached an emission peak in

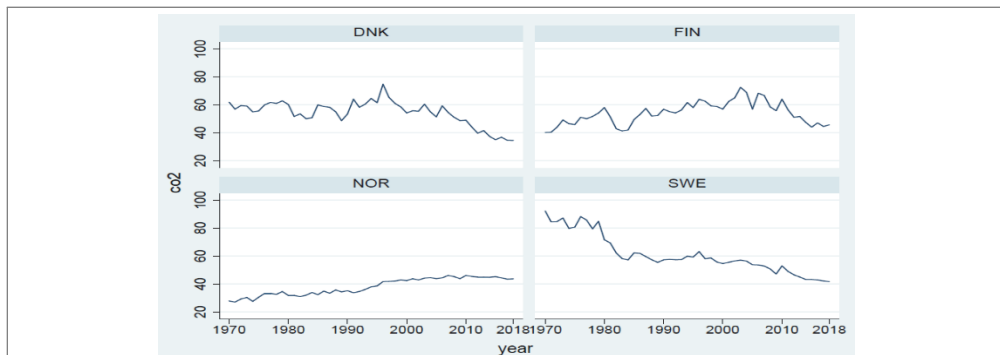
the 1980s and the 1990s, and their CO₂ emissions declined after 2000. However, in non-EU OECD members such as Korea, Turkey, Australia, and Canada, carbon emissions have been continuously rising. The decline in carbon emissions among EU members can be attributed to the EU-ETS launched in 2005. We will further discuss the causality between EU-ETS and emission reduction in the next chapter.

Figure 1_Changes in Carbon Emissions in Major OECD Members (1970–2018)



Note: Changes in yearly carbon emissions in major OECD members other than the United States.
 Source: Our World in Data, <https://ourworldindata.org/CO2-and-other-greenhouse-gas-emissions> (Accessed on October 20, 2021). Present study, based on relevant data.

Figure 2_Changes in Carbon Emissions in Four Nordic Countries (1970–2018)

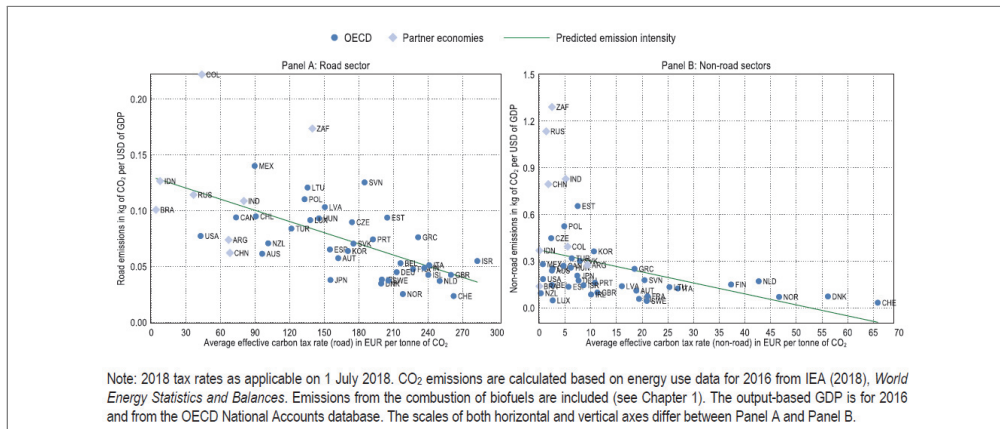


Source: Our World in Data, <https://ourworldindata.org/CO2-and-other-greenhouse-gas-emissions> (Accessed on October 20, 2021). Present study, based on relevant data.

Figure 2 indicates how yearly carbon emissions changed in four Nordic countries (Denmark, Finland, Norway, and Sweden) between 1970 and 2018. These countries adopted a carbon tax in the early 1990s. Carbon emissions are seen to decline in Sweden and Denmark, whereas Finland and Norway reported increasing or fluctuating emissions around 1990.

The OECD (2019) advocated for the efficacy of the carbon pricing system, by arguing that the correlation of national carbon emissions is lower in countries with higher effective carbon tax rates. As shown in Figure 3, in the transportation sector, the CO₂ emissions per unit of gross domestic product (GDP) is lower in countries with higher average effective carbon tax rates, which warrants a closer examination. In particular, owing to their open power markets and high shares of low-emission industries, the Nordic countries first recorded low carbon intensity. As such, people were more accepting of the high carbon tax rates, and the governments were able to adopt and maintain high carbon tax rates. On the other hand, with their highly carbon-intensive industries and reliance on domestically produced power, in terms of acceptability and industrial competitiveness, it is more difficult for Korea and Japan to maintain such high carbon tax rates. Therefore, we need to take a closer look into the causal effect of the carbon tax.

Figure 3_Correlation between Effective Carbon Tax Rates and Carbon Intensity in the Transportation Sector



Source: *Taxing Energy Use 2019*, p. 71, Figure 3.

2. Overview of Previous Literature on the Effect of Emission Reduction from the Carbon Pricing System

In this chapter, we review empirical literature on how the carbon pricing system may affect the reduction of GHG emissions. We begin by discussing studies on the effect of carbon pricing systems such as the ETS and the carbon tax, and then outline literature exploring the effect of each system on carbon reduction.

A. Effect of Carbon Pricing Systems

Somanathan et al. (2014) assessed and compared the climate response policies of different countries. Specifically, they compared the effect of carbon pricing systems on GHG reduction in the energy sector and industries. They found that, whereas the effect of emissions trading varies depending on the country or region, the low level of regulation restricted the overall effect on emission reduction. As for the carbon tax, they concluded that some countries managed to decouple GHG emissions from economic growth by adopting one.

Haites et al. (2018) examined how various carbon pricing systems implemented globally between 1990 and 2015 affected actual emissions reductions. At the time when the study was conducted (2015), 18 countries and regions had implemented a carbon tax, and 55 countries and regions were operating 17 different ETSs. Their findings indicate that, while both systems effectively reduced industrial emissions, the actual emissions are sensitive to fossil fuel prices and economic situations. The study did not single out the effect of the carbon pricing system on the overall emissions reduction. However, the researchers speculated that the 2008 Global Financial Crisis would have significantly affected the emissions reduction.

Best et al. (2020) analyzed 20-year emissions data across 142 countries in order to examine the effect of carbon pricing systems. During the period of 1997 to 2017, 43 of the 142 included in the data adopted and implemented carbon pricing systems. The data were analyzed using the cross section method using a panel fixed effect model based on emissions growth rates, and a panel fixed model based on per capita emissions. The control variables included the carbon tax rate, the gasoline tax rate, per capita GDP, the percentage of fossil fuels in energy consumption, and population growth rates. They found that a EUR 1 increase in the per-ton CO₂ price reduced the annual emissions growth rate by 0.3%. Countries implementing carbon pricing systems reported around a 2% lower yearly CO₂ emissions growth rate than the other countries. However, caution is advised when interpreting the findings of this study because the researchers did not consider ways to control endogeneity, including the tendency in which

countries actively engaged in GHG emissions or having the required technologies are more inclined to adopt carbon pricing systems.

B. Effect of ETS

Previous studies on the effect of an ETS mostly examined the effect of the ETSs implemented in the EU, Japan, and the United States. Bel and Joseph (2015) analyzed the effect of the EU-ETS on GHG emissions from 2005 and 2012. They analyzed 25 EU member states (Bulgaria, Romania, and Croatia, etc.), and used a dynamic panel model that considers the emissions of each relevant business as the dependent variable, and energy consumption (coal, electricity, natural gas, etc.), energy prices, GDP growth rates, and the dummy variable to control the effect of the 2008 Global Financial Crisis. Their findings indicate a GHG reduction of 294.5 MgT between the adoption of the ETS and 2012. However, according to the researchers, most of the reduction (255 MgT) came from the global financial crisis. They also noted that the prices of emission allowances declined due to oversupply in the EU-ETS market, which undermined the incentive for market participants to invest in low-carbon technologies.

Arimura and Abe (2020) examined whether Tokyo's pilot ETS program actually lowered CO₂ emissions. They conducted a survey pertaining to yearly CO₂ emissions, electricity and fossil fuel consumption, employment, building areas of office buildings for a period between 2009 and 2013. They also used data from a total of 414 buildings. According to their analysis, after Tokyo's ETS adoption, the region's CO₂ emissions declined to 13.3% below the other regions. However, only 6.9% of the reduction came from the ETS, and the other half was from the electricity price increase after the 2011 Tohoku Earthquake and Tsunami. However, it should be noted that the findings of the study are restricted by a number of factors, including: possible leakage of carbon to areas outside Tokyo, which may have affected the outcome of the ETS because its implementation was restricted to the Tokyo region; possible measurement errors because emissions were measured based on survey results. The researchers also merely compared the emissions before and after the ETS adoption, which means they did not exclude the effects of other possible factors, including the general trends.

Murray and Maniloff (2015) examined the effect of the Regional Greenhouse Gas Initiative (RGGI) for the northeastern states of the United States. The RGGI was launched in 2009 as an emissions trading consortium comprised of nine states: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont.

The study compared emission fluctuations across 48 states in the country (all states except for Alaska and Hawaii) over two periods (1990 to 2008 and 2009 to 2012), controlling for external effects such as economic recession, other climate response policies, and decline in natural gas prices. They found that the RGGI states reported significant emissions reduction in their power sectors, and a simulation based on a non-RGGI scenario found an around 50% increase in baseline emissions in 2012. However, external effects explained between 12% to 14% of the effects, on average, and after controlling for the external factors the RGGI was found to reduce emissions by around 24%. However, it should be considered that the researchers did not consider carbon leakage to adjacent non-RGGI states.

C. Effect of Carbon Tax

Bruvoll and Larsen (2004) analyzed the effect of the carbon tax on CO₂ emissions in Norway. As Norway created a carbon tax in 1991, the researchers used a general equilibrium model to examine changes in the emissions of three GHGs (CO₂, methane, and nitrous oxide) from 1990 to 1999. While the total emissions increased, the emission per GDP unit declined due to lower energy intensity, changes in the country's energy mix, and lower emissions from industrial processes. However, the carbon tax adoption explained only around 2% of the total emissions reduction of 14%, which the researchers subsequently attributed to the relatively low demand elasticity in areas where the tax is imposed, and the effective tax rates being lower than the nominal rates due to various tax benefits.

Lin and Li (2011) used the difference-in-difference method to analyze the effect of the carbon tax on emissions reduction in five Nordic countries. The study analyzed a period from 1990 to 2010. The treatment group included five countries (Finland, the Netherlands, Norway, Denmark, and Sweden), and the control group consisted of 13 EU members (other than Germany, the United Kingdom, and Italy). After adopting the carbon tax, Finland's GHG emissions declined by around 1.69%. Denmark, Sweden, and the Netherlands also reported declines in emissions after the adoption of a carbon tax. However, their negative coefficients were not statistically significant. In Norway, carbon tax adoption was seen to increase GHG emissions, albeit not to a statistically significant extent. Note that while this study holds significance as an early empirical study on the emissions reduction effect of the carbon tax, its restrictions need to be considered such as the comparability of countries in the control group, and whether the effect of the carbon tax was analyzed over a sufficiently long term. For example, in Norway, emissions seem to have increased after adopting the carbon tax

because the rapid growth of its energy industry prevented the country from controlling a short-term increase in CO₂ emissions in the oil drilling and natural gas development sectors.

Murray and Rivers (2015) analyzed the effect of the carbon tax in British Columbia, Canada on GHG emissions, economy and income distribution. In 2008, British Columbia created the first carbon tax in North America, and the tax rate was CAD 30 per tCO₂e as of 2012. Their analysis revealed that the carbon tax adoption lowered the province's GHG emissions by 5% to 15%. While the carbon tax may create new burdens for low-income earners, the government mitigated the regressive burden through tax credits, and the effect on income distribution was generally not substantial.

Aydin and Esen (2018) used a dynamic panel threshold model to analyze the effect of the environmental tax on CO₂ emissions in five EU member states. For a period from 1995 to 2013, the authors analyzed the effect using the per capita CO₂ emissions as the dependent variable, and the per capital GDP, tax rate to GDP, R&D expenses to GDP, and energy prices as the explanatory variables. They found that the environment-rated tax rates (environmental tax and energy tax) exerted a significant effect on emissions reduction only to a certain threshold, and that those tax rates were not significantly correlated with CO₂ emissions in the transportation sector.

Table 2 summarizes the findings of previous literature on the emissions reducing effect of carbon pricing systems. It should be noted that the estimates provided by these studies are restricted by factors including: the inclusion of countries imposing the carbon tax in the control group; and the inclusion of key predictors of CO₂ emissions as control variables. Other restricting factors included: using the combined emissions of carbon-taxed sectors and the other sectors as an outcome variable; using the price elasticity of demand, which undervalues the environmental efficiency of the carbon tax; and not considering the substitution effects among transportation fuels or modes of transportation.

In the next chapter, we will take a closer look into Bayer and Aklin (2020) and Andersson (2019), who used post emissions data and the synthetic control method to examine the effect of EU-ETS and the carbon tax, to elucidate implications regarding the causal effect of the ETS and the control group on GHG emissions reductions.

Table 2_ Studies on the Efficacy of Carbon Pricing Systems

Country		Carbon pricing system	Analyzed period	Reduction effects
Andersson (2019)	Sweden	Carbon Tax	1960–2005	The CO ₂ emissions in the transportation sector in 14 OECD countries declined by an average of 11% per year
Arimura and Abe (2020)	Japan	ETS	2009–2013	Emissions declined by 13.3% after Tokyo's ETS adoption, half of which came from the electricity price increase; only 6.9% came from the ETS operation
Aydin and Esen (2018)	EU	Carbon Tax	1995–2013	The environment-related tax rates positively affect emissions reduction if the rates exceed a certain threshold, but the effect was minimal in the transportation sector regardless of the tax rates
Bel and Joseph (2015)	EU	ETS	2005–2012	Emissions reduction was caused by economic recession than the EU-ETS
Best et al. (2020)	142 countries	ETS	1990–2017	A EUR 1 increase in price per tCO ₂ e equals around a 0.3% decline in the yearly emissions growth rate. Countries with carbon pricing systems reported around 2% lower annual CO ₂ emissions growth rates than other countries
Bruvoll and Larsen (2004)	Norway	Carbon Tax	1990–1999	Emissions declined by 14%, most of which was caused by lower energy intensity and changes in the energy mix. Carbon tax adoption only explained around 2% of the emissions reduction
Haites et al. (2018)	12 countries and regions	ETS and carbon tax	1991–2015	While both the carbon tax and the ETS reduce emissions, the ETS fared better in terms of environmental efficiency and cost effectiveness
Lin and Li (2011)	16 countries in Europe	Carbon Tax	1990–2010	Significant emissions reduction through carbon tax adoption was observed only in Finland (1.69%), which can be explained by tax rate variations across countries. Countries with a high percentage of energy-intensive industries (Norway) reported an increase in emissions despite carbon tax adoption
Murray and Maniloff (2015)	RGGI, United States	ETS	2009–2012	Emissions in the power sector declined by 24% between 2009 and 2012 (controlling for effect from economy, natural gas prices, and other regulations and policies)
Murray and Rivers (2015)	Canada (British Columbia)	Carbon Tax	2008–2017	Carbon tax adoption reduced GHG emissions by 5% to 15% until 2012
Somanathan et al. (2014)		ETS and carbon tax		The ETS had little effect on emissions reduction, and the carbon tax decoupled economic growth from GHG emissions in some countries
Summer et al. (2011)	12 countries and regions	Carbon Tax	1990–2008	The carbon tax (adopted in the early 1990s) reduced emissions by up to 15%. However, the effect may include the effect of other carbon reduction policies
Murray and Rivers (2015)	Canada (British Columbia)	Carbon Tax	2008–2017	Carbon tax adoption reduced GHG emissions by 5% to 15% until 2012
Narassimhan et al. (2018)	Eight countries and regions including the EU	ETS and carbon tax	2012–2016	The ETS policies may have different effects depending on the country's situation, as well as the gap of knowledge in ETS and the engagement of stakeholders

Table 2_ Studies on the Efficacy of Carbon Pricing Systems(continued)

Country		Carbon pricing system	Analyzed period	Reduction effects
Somanathan et al. (2014)		ETS and carbon tax		The ETS had little effect on emissions reduction, and the carbon tax decoupled economic growth from GHG emissions in some countries
Summer et al. (2011)	12 countries and regions	Carbon Tax	1990–2008	The carbon tax (adopted in the early 1990s) reduced emissions by up to 15%. However, the effect may include the effect of other carbon reduction policies

IV. Economic Effect of the Carbon Tax

In this chapter, we analyze the effect of carbon tax imposition based on the methods proposed by Ganapati et al. (2020). Our empirical analysis uses two methods: a production function estimation for the manufacturing sector and an estimation of the supply side elasticity and demand side elasticity; and an analysis of incidence caused by the energy price increase coming from the tax rate changes. This section uses the 2011–2019 data from the Mining and Manufacturing Survey from Statistics Korea. We use data from six different years, as the 2013 and 2015 data were not included in the dataset. Lastly, we use the two methods to calculate the relative size of consumer and producer burden caused by carbon tax adoption or changes in carbon tax rates.

We use the following empirical models to estimate the energy demand function based on the ideas proposed by Linn (2009).

$$\text{Production: } \ln y_{jnt} = \beta_1^q \epsilon_j^E \ln P_t^E + \beta_2^q S_j \ln P_t^E + \beta_3^q D_j \ln P_t^E + \delta_j^q + \eta_t^q + \epsilon_{jnt}^q \quad \text{Equation (1)}$$

$$\text{Value added: } \ln v_{jnt} = \beta_1^q \epsilon_j^E \ln P_t^E + \beta_2^q S_j \ln P_t^E + \beta_3^q D_j \ln P_t^E + \delta_j^q + \eta_t^q + \epsilon_{jnt}^q \quad \text{Equation (2)}$$

$$\text{Energy demand: } \ln e_{jnt} = \beta_1^q \epsilon_j^E \ln P_t^E + \beta_2^q S_j \ln P_t^E + \beta_3^q D_j \ln P_t^E + \delta_j^q + \eta_t^q + \epsilon_{jnt}^q \quad \text{Equation (3)}$$

where y_{jnt} , v_{jnt} , and e_{jnt} are the output, value added, and energy demand of businesses(n) in the j sector in year t . The output was calculated by dividing the output volume from the

Mining and Manufacturing Survey with the producer price index for each sector. Value added was calculated by dividing the real value added from the Mining and Manufacturing Survey by the producer price index for each sector. As for the energy demand, we analyzed three items from the Mining and Manufacturing Survey: power consumption, fuel consumption, and total energy consumption.

The j sector refers to an industry classification corresponding to the division level in the Korean industrial classification. P_t^E is the energy price (oil, coal, etc.) in year t , and δ_j refers to the fixed effect for the j sector, and η_t is the yearly fixed effect. The basic premise of the model is to use yearly changes in energy price in each sector to examine changes in output based on energy price fluctuations. As defined in Section 2, ε_j^E , S_j , and D_j denote the energy intensity of the j sector, the energy intensity of the intermediate goods industries of the j sector, and the energy intensity of the sector industry when it serves as an intermediate goods industry. To reiterate, δ_j^E represents the direct supply effect, S_j represents the indirect supply effect through industrial input-output, and D_j represents the demand effect through industrial input-output.

In this empirical analysis, we do not consider the endogeneity of energy prices. While we cannot assume energy prices to be completely exogenous, based on Korea's industrial structure, we can assume that a large part of the energy prices (oil, coal, etc.) are exogenously determined. Granted, price exogeneity cannot be guaranteed because they government may control or adjust prices based on policy considerations. Therefore, it would be appropriate to look for external factors affecting coal and oil prices and use the instrumental variable method. Having said that, in this study, we base our analysis on the assumption of exogeneity, and leave an instrumental variable estimation for follow-up studies.

We can estimate Equations (1) to (3) through separate regression analyses. However, it is highly likely that the residuals are not independent from each other. They may share common unobserved factors affecting the final output, value added, and energy demand. As such, the model needs to consider the correlation between these factors. As proposed by Oh (2011), we use the seemingly unrelated regression (SUR) model for the analysis. For the energy demand, we analyze three different demands: power demand, fuel demand, and total energy demand. Therefore, we use the SUR model to analyze a total of five regression equations. On top of the SUR model, we estimate individual equations. If the estimations from the SUR model are not significantly different from the individual estimations, we can conclude that the endogeneity issue has been mitigated. We determine any difference by comparing the coefficients from the models.

We use the SUR model to estimate the five equations and the coefficient value β of each model, and ultimately estimate the effect of energy price variations. In this chapter, we are interested in the total effect of the energy price variations that combines the direct effect and the indirect effect. Following the definition proposed by Oh (2011), we ultimately seek to estimate the following:

$$\text{Total effect: } \beta_1 e^E + \beta_2 S + \beta_\delta D$$

$$\text{Supply effect: } \beta_1 e^E + \beta_2 S$$

$$\text{Demand effect: } \beta_\delta D$$

The total effect is the sum of the supply effect and the demand effect. The coefficient values were calculated using the equation models, and the manufacturing industry-wide means are used for e^E , S , and D . As previously mentioned, while we can estimate the energy intensity, direct supply effect, and demand effect for each sector, we then calculate the total effect using the mean values obtained from across the entire manufacturing industry. We use the industry-wide means because they are useful for gauging the effect of energy price variations on the overall manufacturing industry (Oh, 2011). While Linn (2009) used the manufacturing industry-wide means in the initial year from the analyzed data, Oh (2011) used the means in the latest year. Oh used the Mining and Manufacturing Survey data from 1993 to 2009, though he could not use the same first-year data as Linn (2009) because the Industry Input-Output Table did not have data for that year. As such, he resorted to using the data for the last year in the analyzed period, which was 2019.

To identify the basic information required for the analysis, we reviewed the data in Table 3. Table 3 lists the energy intensity and the percentage of factor cost in each manufacturing sector as of 2008. Column 1 lists the energy intensity calculated based on the Mining and Manufacturing Survey data. Column 2 shows the energy intensity calculated based on the Industry Input-Output Table. Column 3 shows the energy intensity based on the percentage of intermediate goods purchased by a sector from other sectors based on the Industry Input-Output Table, while Column 4 indicates the energy intensity when the output of the relevant sector was used as intermediate goods for other sectors. The first two columns represent the energy intensity of each sector, and are suitable for comparison. The energy intensity of the overall manufacturing industry in the first column (based on the Mining and Manufacturing Survey data) is 5.144, which is slightly different from the intensity of 3.061, based on the Industry Input-Output Table. The third column in Table 3 represents the indirect

supply effect estimated based on the Industry Input-Output Table, which stands at around 1.636. The energy intensity in the fourth column, which is the demand effect based on the Industry Input-Output Table, is the lowest at 0.515.

Table 3_Energy Intensity and Percentage of Factor Cost in 2008

Sector (code)	(1)	(2)	(3)	(4)
Foods (10)	2.187	0.804	0.595	0.107
Beverages (11)	3.588	0.749	0.713	0.017
Tobacco products (12)	1.204	0.099	0.189	0.001
Textiles, except apparel (13)	4.300	4.911	2.229	0.467
Apparel and accessories (14)	0.773	1.034	1.565	0.178
Leather goods, luggage, and footwear (15)	1.058	0.435	0.698	0.140
Wood and wood products, except furniture (16)	2.277	1.928	0.959	0.471
Pulp, paper, and paper products (17)	5.475	3.279	3.211	0.992
Printing and reproduction of recorded media (18)	1.546	0.857	1.748	0.277
Cokes, briquette, oil refining items (19)	73.475	62.073	1.191	2.896
Chemical products, except pharmaceuticals and medical chemicals	4.961	1.871	4.114	1.779
Pharmaceuticals, medicinal chemical and botanical products	2.208	0.740	0.570	0.062
Rubber and plastic products (22)	2.516	1.033	1.340	1.210
Non-metallic mineral products (23)	15.305	3.090	5.118	0.402
Basic metals (24)	9.721	3.091	2.809	2.208
Fabricated metal products, except machinery and furniture	1.516	1.067	2.014	0.985
Electronic components, computer, visual, sound and communication equipment	0.947	0.725	0.372	0.171
Medical, precision and optical instruments, watches and clocks (27)	0.565	0.543	0.618	0.066
Electrical equipment	0.917	0.860	1.089	0.245
Other machinery and equipment	0.683	0.601	1.199	0.738
Motor vehicles, trailers and semitrailers	0.968	0.593	0.915	0.316
Other transport equipment	0.726	0.643	1.521	0.027
Furniture	0.710	0.423	1.357	0.063
Other products (33)	0.912	0.820	1.077	0.030
Manufacturing total	5.144	3.061	1.636	0.515

Note: 1. Mining and Manufacturing Survey: $100 \times \text{energy cost} / \text{total production cost}$.

2. Direct supply effect: $s_i^E (= \text{energy cost} / \text{total production cost}) \times 100$, Indirect supply effect: $S_j (= \sum_i s_{ij}^M s_i^E) \times 100$

3. Demand effect: $D_j (= \sum_k s_{jk}^M s_k^E) \times 100$

Source: Oh (2011), p. 27.

In Table 3, the energy intensity of the cokes, briquettes, and oil refining items sector is 73.475, the non-metallic mineral products sector is 15.305, and the primary metal sector is 9.721, which far exceed those of the other sectors. This finding suggests that these sectors are the top energy consumers in the industry. However, these patterns are not observed in 2019,

which means sector-specific energy intensities changed each year. A high indirect supply effect was observed in the chemical products sector and for non-metallic minerals, and these sectors had a high demand for energy-intense intermediate goods. The high demand effect was observed in the primary metal sector and the cokes, briquettes, and oil refining items sector, because these sectors produce goods that are widely used in the other sectors.

The energy price (P_t^E) was analyzed based on the oil price information from the Yearbook of Energy Statistics, the Dubai oil price released by the Korea Petrochemical Industry Association, and the energy price index compiled by the World Bank. Table 4 shows the empirical analysis results obtained using the SUR model. Using the oil price as energy cost, we found that a 1% increase in the energy price reduces the total output by around 0.044%, which is larger than the 0.021% decline estimated by Oh (2011). However, Linn (2009) theoretically estimated that a 1% increase in the oil price should reduce the output by more than 0.031%. As such, our estimations are consistent with the theoretical predictions, unlike Oh (2011). As for the value added, a 1% increase in the energy cost reduced the value added by around 0.061%, and the energy consumption by around 0.059%. The power consumption and fuel consumption were estimated to decline by 0.074% and 0.041%, respectively, when energy cost increased by 1%. On the supply side, we observed a 0.03% decline in the output and a 0.03% decline in the value added. In contrast, on the demand side, the output and value added declined by around 0.01% and 0.03%, respectively.

Table 4_Empirical Findings 1

Item	Manufacturing Output	Value added	Energy consumption	Electricity consumption	Fuel consumption
$s_j^E \times \ln P_t^E$	-0.9423*** (0.1617)	-1.0743*** (0.1420)	-0.7700*** (0.1133)	-0.8132*** (0.1008)	-0.9029*** (0.0820)
$s_j \times \ln P_t^E$	-0.1019 (0.6833)	0.3996 (0.6003)	1.1471** (0.4787)	0.3975 (0.4260)	-0.4000 (0.3466)
$D_j \times \ln P_t^E$	-2.5692** (1.1373)	-6.7380*** (0.9991)	-10.6059*** (0.7967)	-10.8180*** (0.7090)	-1.2668** (0.5768)
$\ln(Age_{jnt})$	0.1444*** (0.0083)	0.0389*** (0.0073)	-0.2412*** (0.0058)	-0.1977*** (0.0052)	-0.2187*** (0.0042)
$\ln(Age_{jnt})^2$	0.0692*** (0.0020)	0.0756*** (0.0018)	0.1208*** (0.0014)	0.1007*** (0.0013)	0.0806*** (0.0010)
No. of observations	383,466	383,466	383,466	383,466	383,466
Total effect	-0.04374	-0.06105	-0.05942	-0.0741	-0.04071
Supply effect	-0.03051	-0.02635	-0.0048	-0.01839	-0.03418
Demand effect	-0.01323	-0.0347	-0.05462	-0.05571	-0.00652

Note: P_t^E refers to the oil price index.

Source: Estimated by the authors.

Table 5 shows the findings based on Dubai oil prices using the same method. The figures are quite similar to the findings represented in Table 4. A 1% increase in the oil price reduced the manufacturing output by around 0.045%, the value added by around 0.063%, the energy consumption by around 0.061%, the power consumption by around 0.077%, and the fuel consumption by around 0.042%. On the supply side, the output and the value added each declined by around 0.03%. On the demand side, the output declined by around 0.01% and the value added by around 0.04%, indicating similar patterns to Table 4.

Table 5_Empirical Findings 2

Item	Manufacturing Output	Value added	Energy consumption	Electricity consumption	Fuel consumption
$s_j^E \times \ln P_t^E$	-0.9835*** (0.1673)	-1.1195*** (0.1470)	-0.7929*** (0.1172)	-0.8420*** (0.1043)	-0.9300*** (0.0849)
$s_j \times \ln P_t^E$	-0.1086 (0.7073)	0.4227 (0.6214)	1.2123** (0.4955)	0.4088 (0.4409)	-0.3813 (0.3587)
$D_j \times \ln P_t^E$	-2.6184** (1.1773)	-7.0168*** (1.0343)	-11.0187*** (0.8248)	-11.1941*** (0.7340)	-1.3707** (0.5971)
$\ln(Age_{mt})$	0.1444*** (0.0083)	0.0390*** (0.0073)	-0.2412*** (0.0058)	-0.1977*** (0.0052)	-0.2187*** (0.0042)
$\ln(Age_{mt})^2$	0.0692*** (0.0020)	0.0756*** (0.0018)	0.1208*** (0.0014)	0.1007*** (0.0013)	0.0806*** (0.0010)
No. of observations	383,466	383,466	383,466	383,466	383,466
Total effect	-0.04537	-0.06349	-0.06118	-0.07674	-0.04176
Supply effect	-0.03188	-0.02735	-0.00444	-0.01909	-0.03471
Demand effect	-0.01348	-0.03614	-0.05675	-0.05765	-0.00706

Note: P_t^E means the oil import unit price.

Source: Estimated by the authors.

Table 6 represents findings based on the World Bank energy price index. When the energy price increased by 1%, the manufacturing output declined by around 0.0484%, and value added declined by around 0.0781%. The energy consumption declined by 0.091% when energy price increased by 1%. On the supply and demand sides, the output declined by around 0.03% and 0.01%, respectively. The value added declined by 0.04% on both sides. Overall, the effect on the manufacturing output was similar to the findings represented in Tables 4 and 5. All three tables presented findings that were consistent with the theoretical predictions of Linn (2009).

Table 6_Empirical Findings 3

Item	Manufacturing Output	Value added	Energy consumption	Electricity consumption	Fuel consumption
$s_j^E \times \ln P_t^E$	-1.0938*** (0.1842)	-1.2449*** (0.1618)	-0.9186*** (0.1291)	-0.9476*** (0.1149)	-1.0770*** (0.0934)
$s_j \times \ln P_t^E$	0.0005 (0.0085)	0.0076 (0.0075)	0.0188*** (0.0059)	0.0067 (0.0053)	0.0001 (0.0043)
$D_j \times \ln P_t^E$	-2.8950** (1.2981)	-7.7939*** (1.1403)	-12.2902*** (0.9094)	-12.3274*** (0.8092)	-1.7851*** (0.6584)
$\ln(Age_{jnt})$	0.1444*** (0.0083)	0.0390*** (0.0073)	-0.2413*** (0.0058)	-0.1977*** (0.0052)	-0.2187*** (0.0042)
$\ln(Age_{jnt})^2$	0.0692*** (0.0020)	0.0756*** (0.0018)	0.1208*** (0.0014)	0.1007*** (0.0013)	0.0806*** (0.0010)
No. of observations	383,466	383,466	383,466	383,466	383,466
Total effect	-0.04838	-0.07812	-0.09111	-0.09238	-0.04216
Supply effect	-0.03347	-0.03798	-0.02781	-0.0289	-0.03297
Demand effect	-0.01491	-0.04014	-0.06329	-0.06349	-0.00919

Note: P_t^E means the oil import unit price.

Source: Estimated by the authors.

Tables 7 to 9 present the estimation results for each of the five equations obtained without the SUR model. Table 7 lists the findings for each of the five dependent variables based on the oil price information from the Yearbook of Energy Statistics. Tables 8 and 9 list the findings based on the Dubai oil price information obtained from the Korea Petrochemical Industry Association and the World Bank's energy price index, respectively. According to the results, when oil price increased by 1%, the manufacturing output declined by 0.032%. When the Dubai oil price increased by 1%, the manufacturing output declined by 0.033%. When the World Bank energy price index increased by 1%, the manufacturing output declined by 0.051%. These findings are not significantly different from the SUR findings, and remain consistent with Linn's theoretical predictions. On the supply side, the output declined by 0.02%, 0.02%, and 0.03%, respectively. On the demand side, an output decline of 0.02% was observed for each oil price. These figures do not significantly deviate from the model analysis results. Therefore, it seems that these estimations from the individual equations are not likely to suffer from biases. Nevertheless, to confirm the reliability of these results, as previously mentioned, we need instrumental values, which will be obtained in subsequent studies.

Table 7_Empirical Findings 4

Item	Output	Value added	Energy consumption	Power consumption	Fuel consumption
$s_j^E \times \ln P_t^E$	-0.9208*** (0.1477)	-0.9956*** (0.1371)	-0.5298*** (0.1029)	-0.7262*** (0.0929)	-0.8401*** (0.0785)
$s_j \times \ln P_t^E$	0.7414 (0.6328)	0.7885 (0.5687)	1.5115*** (0.4406)	0.7626* (0.3994)	-0.6615* (0.3420)
$D_j \times \ln P_t^E$	-3.1079*** (1.0637)	-7.0607*** (0.9369)	-11.1503*** (0.7407)	-10.4650*** (0.6729)	-1.3203** (0.5800)
$\ln(Age_{jnt})$	0.2237*** (0.0074)	0.0988*** (0.0065)	-0.1587*** (0.0052)	-0.1727*** (0.0048)	-0.2220*** (0.0042)
$\ln(Age_{jnt})^2$	0.0556*** (0.0018)	0.0654*** (0.0016)	0.1030*** (0.0013)	0.0966*** (0.0012)	0.0817*** (0.0010)
No. of observations	453,724	450,682	453,724	440,060	388,585
Total effect	-0.03206	-0.05394	-0.04891	-0.06365	-0.04334
Supply effect	-0.01606	-0.01758	0.00851	-0.00975	-0.03654
Demand effect	-0.01601	-0.03636	-0.05742	-0.05389	-0.0068

Note: P_t^E refers to the oil import unit price.

Source: Estimated by the authors.

Table 8_Empirical Findings 5

Item	Output	Value added	Energy consumption	Power consumption	Fuel consumption
$s_j^E \times \ln P_t^E$	-0.9638*** (0.1531)	-1.0377*** (0.1419)	-0.5454*** (0.1066)	-0.7533*** (0.0962)	-0.8689*** (0.0814)
$s_j \times \ln P_t^E$	0.7674 (0.6560)	0.8289 (0.5893)	1.5984*** (0.4568)	0.7971* (0.4140)	-0.6441* (0.3541)
$D_j \times \ln P_t^E$	-3.2059*** (1.1026)	-7.3657*** (0.9712)	-11.6139*** (0.7678)	-10.8552*** (0.6974)	-1.4355** (0.6005)
$\ln(Age_{jnt})$	0.2237*** (0.0074)	0.0988*** (0.0065)	-0.1587*** (0.0052)	-0.1727*** (0.0048)	-0.2220*** (0.0042)
$\ln(Age_{jnt})^2$	0.0556*** (0.0018)	0.0654*** (0.0016)	0.1030*** (0.0013)	0.0957*** (0.0012)	0.0817*** (0.0010)
No. of observations	453,724	450,682	453,724	440,060	388,585
Total effect	-0.03346	-0.05614	-0.05036	-0.06592	-0.04453
Supply effect	-0.01695	-0.0182	0.00946	-0.01002	-0.03713
Demand effect	-0.01651	-0.03793	-0.05981	-0.0559	-0.00739

Note: P_t^E refers to the oil import unit price.

Source: Estimated by the authors.

Table 9_Empirical Findings 6

Item	Output	Value added	Energy consumption	Power consumption	Fuel consumption
$s_j^E \times \ln P_t^E$	-1.0780*** (0.1687)	-1.1562*** (0.1562)	-0.6379*** (0.1174)	-0.8477*** (0.1061)	-1.0089*** (0.0897)
$s_j \times \ln P_t^E$	0.0113 (0.0079)	0.0131* (0.0071)	0.0239*** (0.0055)	0.0119** (0.0050)	-0.0033 (0.0043)
$D_j \times \ln P_t^E$	-3.5738*** (1.2166)	-8.2225*** (1.0716)	-13.0349*** (0.8472)	-12.0095*** (0.7694)	-1.8655*** (0.6620)
$\ln(Age_{jnt})$	0.2237*** (0.0074)	0.0988*** (0.0065)	-0.1588*** (0.0052)	-0.1727*** (0.0048)	-0.2220*** (0.0042)
$\ln(Age_{jnt})^2$	0.0556*** (0.0018)	0.0654*** (0.0016)	0.1030*** (0.0013)	0.0956*** (0.0012)	0.0817*** (0.0010)
No. of observations	453,724	450,682	453,724	440,060	388,585
Total effect	-0.05122	-0.07752	-0.08626	-0.0876	-0.04054
Supply effect	-0.03281	-0.03518	-0.01914	-0.02575	-0.03094
Demand effect	-0.01841	-0.04235	-0.06713	-0.06185	-0.00961

Note: P_t^E means the oil import unit price.

Source: Estimated by the authors.

To this point, we have estimated the pass-through effect of tax rate variations and the energy price growth. The parameters required to estimate the pass-through effect include: the price pass-through effect of marginal costs ρ_{MC} , the Lerner index on market power, and the elasticity estimated above. These were calculated based on the Mining and Manufacturing Survey data. In this section, using the sector-specific parameters estimated in the previous section, we calculate consumers' burden that originate from the energy price increase caused by tax rate variations.

The first group of calculations is listed in Table 10. In the table, we listed the parameter values and the consumer burden estimated for each sector, and the mean values across the manufacturing industry. We calculated the consumer burden using ρ_{MC} , the demand elasticity, and the Lerner index to calculate I . To reiterate, the consumer burden represents the changes in consumer surplus caused by tax rate changes, and the percentage of producer surplus variations accounted for by the consumer surplus. We calculated the consumer burden using $I/(1+I)$. If I is 0, it means that there is no consumer burden and that producers bear all burdens from the tax rate and energy price increase. If I is 1, consumers bear all burdens from tax rate changes. In other words, consumer bears more burden in sectors with high I values, and a lower burden in sectors with low I values.

According to our estimations, across all sectors, the consumer burden from tax rate

increases does not exceed 100% of the increase. It means that the tax burden is partially transferred to producers and consumers. For example, in the foods sector, around 35% of the energy tax rate change is transferred to consumers in the form of a price increase. The percentage is 87% for the textile sector, and 28% and 43% of the tax rate changes are transferred to consumers in the furniture and primary metal sectors, respectively. Across all manufacturing sectors, the size of consumer burden was between 30% and 60%, which is largely consistent with the estimations of Ganapati et al. (2020). In the pulp, paper, and paper products sector, the percentage of tax burden transferred to consumers was higher, at 94%, and a relatively large consumer burden was estimated for the textile sector as well. In contrast, a lower consumer burden was observed for the electronic components sector, as well as for the medical, precision and optical instruments, watches and clocks sector. Ganapati et al. (2020) estimated the incidence rate of tax rate changes on consumers (in the form of increased energy input price) to be around 46% for the United States cement sector. In the Korean non-metallic mineral sector, which corresponds to the cement sector in Ganapati et al. (2020), the incidence rate was higher at 76%. The findings seem to indicate that Korea's cement industry is less competitive than its American counterpart, which makes it easier to transfer the tax burden from the carbon tax to consumers. In the cokes, briquettes, and oil refining items sector, the consumer burden was estimated to be low, at around 18% of the tax rate changes. The difference seems to stem from the difference in industrial environments, and the use of high-tier industrial classifications in this chapter, which combines wildly different sub-sectors into a single sector.

Table 10_Energy Intensity and Percentage of Factor Cost in 2008

Sector (code)	ρ_{MC}	Demand elasticity	Mean Lerner index	Consumer burden
Foods (10)	0.354	0.033	0.33	0.35
Beverage (11)	0.162	2.239	0.34	0.14
Textile, except apparel (13)	0.876	0.027	0.39	0.87
Clothing and accessories (14)	0.716	0.205	0.17	0.69
Leather, bags, and footwear (15)	0.694	0.813	0.30	0.59
Wood and wood products (non-furniture) (16)	0.222	0.234	0.49	0.22
Pulp, paper, and paper products (17)	0.980	0.103	0.46	0.94
Printing and record reproduction (18)	0.523	0.301	0.59	0.48
Cokes, briquettes, and oil refining items manufacturing	0.180	0.014	0.62	0.18
Chemical products, except pharmaceuticals and medical chemicals	1.77	0.091	0.49	0.29
Pharmaceuticals, medicinal chemical and botanical products	0.426	0.337	0.43	0.40

Table 10_Energy Intensity and Percentage of Factor Cost in 2008(continued)

Sector (code)	ρ_{MC}	Demand elasticity	Mean Lerner index	Consumer burden
Rubber and plastic products (22)	0.138	0.183	0.49	0.14
Non-metallic mineral products (23)	0.768	0.031	0.35	0.76
Basic metals (24)	0.436	0.014	0.25	0.43
Fabricated metal products, except machinery and furniture	0.408	0.098	0.42	0.40
Electronic components, computer, visual, sound and communication equipment	0.116	0.368	0.19	0.11
Medical, precision and optical instruments, watches and clocks (27)	0.108	0.781	0.15	0.11
Electrical equipment	0.66	0.063	0.28	0.65
Other machinery and equipment	0.36	0.320	0.33	0.35
Motor vehicles, trailers and semitrailers	0.354	0.513	0.28	0.34
Other transport equipment	0.546	1.042	0.21	0.49
Furniture	0.276	0.004	0.28	0.28
Other manufacturing (33)	0.384	0.222	0.12	0.38
Manufacturing total	0.498	0.329	0.347	0.47

Source: Estimated by the authors.

To summarize the estimated findings, a lower percentage of energy price increase is transferred to consumers in sectors where a lower percentage of marginal cost is transferred to price. In the textile sector and the pulp, paper, and paper products sector, where high consumer burden was estimated, high percentages of marginal cost were transferred to consumer prices. In contrast, the beverages sector and the medical, precision and optical instruments, watches and clocks sector recorded a lower consumer burden and a lower transfer of marginal costs.

In this chapter, we estimated changes in energy prices and the consumer burden that originate from tax rate changes. For this task, we used the method proposed by Ganapati et al. (2020). This new method estimates price changes and the tax burden transfer based on tax rate changes and simplifies the complex process of estimating the tax burden transfer. It also provides a foundation for an intuitive estimation based on the transfer of marginal costs to consumer prices, markups, and market power. We applied the method to data from the Statistics Korea Mining and Manufacturing Survey to understand how the tax burden is transferred to consumers across different industrial sectors. In addition to the use of this new method, we calculated the demand elasticity of the output, etc. using a widely used method.

Our findings indicated that transfer of tax rate changes to consumers varies depending on the transfer of marginal costs to prices. Larger percentages of tax rate changes were transferred to consumers in the textile and the pulp, paper, and paper products sectors. These

findings suggest that more than 90% of the changes in the prices of intermediate goods (caused by tax rate changes) may be transferred to consumers.

Our analysis in this chapter contributes to the existing body of work in that it used Korean data for the first time. However, this study is limited in many respects. As previously mentioned, the Mining and Manufacturing Survey does not include price information for the specific outputs from each business. As such, applying the method used by Ganapati et al. (2020) requires strong assumptions, which means that we cannot deny the possibility of the parameters being biased. In addition, the regression equations used for the price transfer estimation based on the estimated parameters cannot control for endogeneity. This issue needs to be reviewed in follow-up studies. In addition, the consumer burden from changes in the tax rates and intermediate goods prices was analyzed on the assumption that other conditions remain unchanged. Our analysis needs to be adjusted if energy availability increases due to the use of reusable energy, or an increase in the percentage of nuclear power used in the future. However, as mentioned above, Ganapati et al. (2020) proposes an intricately designed method for estimating the tax burden using the partial equilibrium method, and this is the first attempt to apply the method to Korea.

Global warming has attracted global attention as a serious environmental issue. To address this issue, Korea has set up policies aimed at reducing carbon emissions to 40% below the current level by 2030, and at reaching net zero by 2050. A carbon tax has been considered one of the ways to achieve those goals. However, the adoption of a carbon tax will surely affect output and consumption. For policymakers, the possible drawbacks of a carbon tax include the weakening of Korea's industrial competitiveness, in addition to an additional tax burden on consumers. In this chapter, we estimated the direction and size of the tax burden in the case a carbon tax is adopted. The prospective carbon tax will transfer an additional burden onto producers as well as consumers. As such, additional measures need to be developed in order to prevent any discouragement of economic activities caused by sudden changes in the tax burden.

V. Conclusions and Policy Implications

In this study, we assessed the conditions for the adoption of a carbon tax, one of the instruments being considered for Korea's carbon pricing system reform. First, based on a comprehensive review of global standards on carbon prices and other factors, we assessed an

adequate level of taxes and charges and analyzed the economic effect of carbon tax adoption by focusing on the price pass-through effect.

In order to examine the scope for reflecting carbon prices in the form of a carbon tax, we evaluated whether the current taxation level appropriately reflected the carbon social cost. Our analysis showed that the Korean transportation sector internalizes the social cost of carbon on a level corresponding to major OECD members. In industries and in the power sector, large emitters covered by the K-ETS pay considerable carbon prices. However, the current transport/energy/environment/excise taxes on fossil fuels are determined based not only on the external cost of carbon, but also congestion costs and the external costs incurred by other air pollutants. Therefore, Korea needs to consider the need for a further internalization of carbon prices. In addition, given the EU's recent attempt to link its ETS with the carbon tax system, Korea may also consider imposing a carbon tax on small businesses and on the transportation sector, which have not been included in the K-ETS.

We also discussed the possible effect of adopting a carbon pricing system in Korea. As Korea already has an ETS scheme in place, we needed to examine the effect of imposing a carbon tax on top of the ETS. However, it was difficult to examine the causal effect of linking the two systems because of the lack of countries instituting both systems, the relatively short history of the Korean ETS, and the general complexity of relevant systems. Alternatively, we sought to examine the respective effects of the carbon tax and ETS based on the latest research literature outside of Korea. One of the noteworthy findings from the overseas literature is that, while Sweden has garnered moderate success in reducing GHG emissions by using a carbon tax, the relatively high tax rate encouraged businesses to resort to diesel instead. As for the EU-ETS, its efficacy has been questioned by many researchers because the price was lower than the carbon social cost. However, one study found that the system reduced carbon emissions among the businesses participating in emissions trading. The findings suggest the importance of a government's clear signal to the market that the cost of carbon emissions will be addressed through an ETS.

We then analyzed the economic effect of implementing a carbon tax, focusing on the incidence effect for producers and consumers caused by the new tax. Ganapati et al. (2020) proposed a new way to analyze tax incidence, and we used this method to empirically analyze the Mining and Manufacturing Survey data obtained from Statistics Korea. To analyze the relative tax incidence of producers and consumers, we estimated relevant parameters, including the transfer of marginal cost to prices, the Lerner index, and the sector-specific demand elasticity. Using the estimated parameters, we were able to calculate the relative tax

incidence of producers and consumers for each sector. Our analysis of the sector-specific consumer burden found that the consumer burden from adopting a carbon tax did not exceed 100% in any sector. However, the relative size of the consumer burden markedly varied depending on the sector. The consumer burden was the highest in the pulp, paper, and paper products sector, at around 94%, whereas the consumer burden in the electronic components, computer, visual, sound and communication equipment sector was estimated to be 11%, which is the lowest among the analyzed sectors. These findings indicate that a lower percentage of the energy price increase is transferred to consumers in sectors where a lower percentage of the marginal cost is transferred to the price. This finding is consistent with the intuitive observation that producers transfer higher percentages of their taxes to consumers when it is easier to do so. Our sector-specific analysis produced findings that are quite different from the analytical findings presented by Ganapati et al. (2020). These gaps originate in the differences in market size and market power between the two countries.

If adopted, the carbon tax will add a further burden onto producers and consumers alike. The consumer burden may considerably rise in some sectors. Note that our analysis in Chapter IV contributes strongly to the carbon tax discussion by applying a new method to measure the relative burden on producers and consumers. However, with more data, we would have been able to sufficiently control the endogeneity of energy prices and other factors. As such, the robustness of the current findings needs to be reviewed in follow-up studies. An interesting consideration brought about by this study is that Korea may be able to reduce the expected tax burden by preemptively developing the relevant policies and measures that are informed by the predictions on the relative size of producer and consumer burdens. In addition, follow-up studies are also required in order to analyze industrial classifications below the division level.

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On Alternative Indices of Government Financial Strength

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I. International Discourse on Financial Soundness Indicators

The rapid growth of financial burdens has motivated governments to tighten up their financial affairs, as part of which we have observed the search for alternative indicators to monitor the state of government finances and the risks thereto. This report joins this challenge by reviewing alternative indices of government finances, which can be recommended as providing more detailed and useful information on the position of government finances, especially regarding debts or liabilities incurred by the government. Accordingly, this report will discuss the broadening of our attention to include state claims and state assets, which may help us gauge to what extent they could offset the (gross) debts and liabilities to give a better picture of the true overall “indebtedness”, which ought to give a more accurate indication of the financial risks a government bears. In this chapter, we will begin by providing a summary review of international discussion on financial soundness indicators.

1. Financial situation indicators

Even if no *net* debt standard is yet recognized internationally nor generally among a

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majority of countries, the necessity is widely recognized. Accordingly, individual countries commonly define and use indicators as they deem appropriate, i.e., net debt statistics are compiled and published by numerous countries but are of limited usefulness as they are defined differently by country. For example, the PSDSG standards were adopted by joint agreement among nine major international organizations, following which the IMF has established their own, more specific accounting standards derived therefrom. Some member countries of the IMF subsequently have been using these standards and publicly announce their net debt statistics, but it is still too early to recognize the PSDSG-IMF definition as universally or even popularly adopted as an official or representative index by any individual country's government. Apart from the IMF net debt used for statistical purposes, i.e., rather than count as an "official" indicator of indebtedness, each EU member state adopts and uses a net debt indicator or an indicator similar thereto, each with modifications to suit its own needs. As stated above, these standards can be different among country and thus are not mutually comparable in an international context between countries. However, they may still be taken into consideration as we think over proposals for Korea for measuring state claims and net debt. In brief, they may be summarized as follows:

A. ESA and financial indicators of EU member states

1) Indicators of fiscal deficit and gross debt

The current EU Accounting Standards were introduced in May 2013 and came into effect in September 2014. These standards are known as ESA10, which is an abbreviation thereof and enacted as "Regulation 549/2013", which specifies the EU accounting standards for the state (central government) and local accounting of EU member states. These accounting standards were generally devised to be compliant with the System of National Accounts (SNA) as defined by the UN. The SNA has been revised five times since 1953, when it was first announced by the UN, to 2008. SNA2008 featured a change of focus from organizational or legal designations to institutions as the reporting entity. The purpose of ESA10 is to revise the accounting standards of the EU, bringing them into accord with SNA2008.

In terms of the implementation of these accounting standards, since its establishment in 1994, the Eurostat has compiled and published relevant statistics under its purview by applying the ESA to its member states. The Eurostat provides advice and supervision for its member states, enabling them to reliably prepare their financial statistics under the same standards for all members in order to apply the Excessive Deficit Procedure (EDP) specified

by Article 104 of 1992 Maastricht Treaty and 1994 Treaty of the European Union. In other words, the Maastricht Treaty anticipated the then-future organization of EU and recognized a need to harmonize the financial management among its member states. In particular, as key indicators and reference values, the fiscal deficit and government obligations for a specific fiscal year shall not exceed 3% and 60% of the GDP, respectively. A member state in violation of these rules may be subject to sanctions. Thus, there was a need to ensure objectivity and fairness by employing the same standards and procedures to all member states and to produce comparable statistics. Indeed, this was one of the key rationales that motivated the founding of Eurostat.

The ultimate purpose of the ESA10 is to measure the fiscal balance (deficit) and debt of each member state under objective criteria in order to apply the EDP in a precise manner. As stated above, the ESA up to the current ESA10 was established as a basis for applying compulsory (penalty) provisions, such as the Maastricht Treaty and the EDP in the Treaty of EU, and to determine whether a threshold for deficit and (gross) debt stipulated by the EDP has been violated. On the other hand, no EU provision currently uses a *net* debt indicator and thus there has been no compelling reason to adopt any such indicator in ESA. This is perhaps the most important reason why no official net debt indicator has been set, despite the widespread recognition that there is a significant need to measure the net debt.

In summary, even if the net debt indicator can highlight the financial situation of a member state more accurately than the gross debt indicator, there is not yet any compulsory provision or regulation that requires the net debt indicator in the EDP or other laws, rules, or regulations. Accordingly, even if the EU and the Eurostat have been discussing the possibility of a net debt indicator, no standard has been officially adopted for state claims or measuring the net debt, as such an indicator is yet not required by the laws or regulations of the EU.

2) Net debt and similar indicators

Even if the ESA has not adopted a uniform official standard for net debt, all member states recognize that it is necessary to have a net debt indicator or a better indicator than gross debt for showing a government's liquidity or capacity for overcoming a crisis. This is because the gross debt has increased rapidly, even in EU states during the financial crisis of 2008. The gross debt in 27 EU member states (EU-27) had been around 60% relative to GDP, as measured by the EDP during the period from 2000 to 2007. However, as of the 4th quarter of 2013, the gross debt had ballooned to 87.2% relative to GDP in all 27 member states. Notably, the gross

debt in the 18 member states that use the euro (EU-18) increased from 66.3% relative to GDP at the end of 2007 to 92.6% as of the end of 2013. However, some states have also accumulated substantial financial assets (cash holding and securities). Thus, it has been widely recognized that such information on factors that offset the debt needs to be included in the assessment of the government's financial position when estimating the financial soundness or capacity for responding to a fiscal or financial crisis. In other words, the EU member states are the same as Korea in that they recognize the need to understand their financial position in greater detail. But, as of yet, no common EU standard that reflects such recognition has been adopted.

However, each EU member state has adopted and uses its own indicators, and their approaches may be classified into three types, as follows:

- ① Currently, nine EU member states compile and use their own net debt index, albeit with slight variations in the definition. They are similar to one other in that they adopt an approach which adds and subtracts some items to and from their gross debt. However, the details are different by member state. The table below states in detail the net debt standards they adopted.

For reference, similarly to the net debt standards adopted and used by nine EU member states, as stated above, the Eurostat has proposed “*Gross Debt – AF.2 – AF.33 – AF.4*” as a measure of net debt of general government member states. However, any follow-up discussion thereon has been inconclusive so far.¹

¹ This report attempted to calculate the net debts of EU member states in accordance with the standards proposed by the Eurostat, but restricted the scope of the calculation to the government sector, excluding the public sector. If the public sector is included into the calculation, it would be difficult to evaluate and total the value of various assets to be deducted from the debt. Thus, even in cases where Korea adopt a net debt indicator in the future, there would be a need to continue to produce time series via the old definition (for comparability) that restrict their scope to the central or local governments, before then expanding the scope to include the public sector.

Table 1 Definition of net debt of 9 EU member states

State	Definition of net debt	Evaluation	Competent authorities	Coverage
Estonia	Gross Debt – AF.2 – AF.33	Nominal	Treasury	General government
Ireland	Gross Debt – AF.2 – AF.33 – AF.4	Market	National statistical office	General government
France	Gross Debt – AF.2 – AF.33 – AF.4	Par	National statistical office	General government
Latvia	Gross Debt – Corresponding Assets	Par	Treasury	National treasury
Poland	(AF.2+AF.33+AF.4+AF.7) Debt – AF.2	Par	Treasury	Public debt, treasury asset
Portugal	Gross Debt – Central Government Deposit	Nominal	Central bank	General government
Russia	Gross Debt – AF.2 – AF.511 – AF.52	Market (Par for AF.52)	Treasury	General government
Slovakia	Gross Debt – AF.11 – AF.2 – AF.3 – AF.511 – AF.52	Nominal (AF.11, AF.2: Market)	Treasury	General government
U.K.	Gross Debt – Current Assets	Nominal	National statistical office, Treasury	Public sector

Note: Gross Debt: Maastricht Debt

AF.2 = Cash and deposit, AF.33 = Securities (excluding stock and derivatives)

AF.4 = Loan, AF.6 = Insurance reserve, AF.7 = Other outstanding amount

Source: Prepared by author in reference to the Eurostat (2014).

② Use of government's net financial worth as a proxy

This indicator is calculated by deducting the gross debts from gross financial assets. Many OECD member states use this indicator because they may avoid any complications that may arise from modifying their existing financial statistics – the new index can be calculated conveniently at no extra cost. However, net financial worth is different from the net debt in that it contains, in the debt to be deducted from the financial assets, items other than debt, namely, liabilities. Thus, even if the net financial worth indicates an approximate financial position, it is a concept different from, and not strictly comparable to, net debt. In addition, it should be noted that net financial worth is limited in its accuracy in terms of debt repayment capability. Thus, this indicator is generally similar to the PSDSG-defined indices stated below. However, since liabilities subsume and are therefore larger than debt, net financial worth calculated in the method stated above is usually smaller than the net debt defined in the PSDSG.

Net financial worth is publicly announced by seven EU member states: Belgium, Denmark, Spain, the Netherlands, Austria, Finland, and Sweden.²

² Since the net financial worth is relatively easy to calculate, it is widely used by many other countries. However, it is not an international standard officially adopted.

③ Other approaches

In addition to ①, which deducts financial assets from debts, or ②, which calculates the net financial worth, there are other approaches, none of which appears to be dominant in usage. Among them, this report will review net worth, a concept that is relatively well established. This reflects the view that considers not only state claims and financial assets, such as equity stocks, etc. that are not included in the claims (negative debt; debt that is owed by non-government entities to the government) but also non-financial assets, such as real estate, etc. whose liquidity is low. However, it shall be noted that the reliability of this indicator is also limited to a certain degree, because the value of some assets can drastically fluctuate at times of crisis.

B. Financial indicators of international organizations

The three types of indicators examined above include what are defined and implemented by individual EU state, i.e., not by common agreement or by an international organization. In this chapter, this report will explain the standards proposed by international organizations. Currently, the Public Sector Debt Statistics: Guide for Compilers and Users (PSDSG) proposes a single standard for net debt based on the agreement of nine international organizations, such as BIS, Commonwealth Secretariat, ECB, EC, IMF, OECD, Paris Club, and the World Bank. In this chapter, only essential attributes will be introduced, based on the PSDSG definition of net debt that deducts the following items from the gross debt. The PSDSG defines the net debt indicator as the “financial assets corresponding to financial instruments.” In other words, the net debt is computed by deducting, from the gross debt, all financial assets held in a form of financial instruments.

The PSDSG recognizes the fact that the coverage and the evaluation method of assets and debts may differ by country, and thus there is a certain degree of flexibility in implementation by different countries – the precise definition by country may differ to a certain degree notwithstanding the PSDSG. In response thereto, as its accounting standard the IMF announced, the External Debt Statistics: Guide for Compilers and Users, which is based on the existing PSDGS but attempts to impose more specificity. The IMF totals and announces net debts of some member states in accordance with the Guide. However, Korea has never been included in the aggregation and announcement of net debts by the IMF.

In addition, the Guide explains that the net debt is calculated for the central government, general government, and public sector of countries for which the statistics are produced.

2. Indices in international discourse

Before further analysis of net debt, this report will explain the differences between the concept of claims and debt in Korea, as opposed to their usage in international standards and statistics. In terms of the concept of gross debt, the followings include the generally recognized standards: Maastricht debt, ESA 95 debt, etc. Notably, the IMF totals and announces the net debt statistics of the general government for some member states. In addition to the IMF's indicators, the Public Sector Debt Statistics: Guide for Compilers and Users (PSDSG) prepared by a council of nine international organization states a definition of net debt. The IMF totals the net debt of its member states with relevant statistics in accordance with the PSDSG, in which Korea is not included, as stated above.

However, please note the fact that the term “state claim”, which this report intends to deduct from the gross debt to define the net debt, is not defined or even mentioned by international standards or dealt with in international discourse – what Koreans designate as a “claim” does not appear to have a separate nomenclature in English, but is only referred to as negative debt, i.e., debt owed by non-government entities to the government. (The terminology simply does not exist in English, unlike in Korean or some other languages.) This may be because the international organizations' definition of debt and liabilities simply follows accounting standards rather than considering legal aspects. In other words, a net debt is defined in the discourse of international organizations as a deduction of debt instruments among financial assets (as being held) from gross debt. Here, the term “debt instruments among financial assets” corresponds to claims, or, simply negative debt in terms of accounting.

Thus, it bears emphasizing that such negative debt, or claims, cannot be found as an explicit term or concept in international discourse, although it is the key component when defining and measuring net debt. Much clarity and brevity could be gained if there actually were a distinct term indicating the concept of negative debt, or “claim” as the nearest, though unofficial, approximation.³

³ The Korean word for debt, in direct translation, is “borrowing-lending obligation,” owed to the lender by an entity. Claims, as discussed here, would be negative debt, or “borrowing-lending rights/entitlements,” owed and therefore payable by the borrower to the entity.

3. Understanding of financial indicators

A. Relation among key indicators

The practical utility of alternative indicators presented above has not been well understood or evaluated, because one often finds it difficult to correctly understand exactly what each indicator means. This has unfortunately triggered several acrimonious controversies in the past in Korea, concerning whether the government's published figures were "correct" or perhaps intentionally misleading to the public, regarding the classification and measured size of government spending, size of government debt and liabilities, etc. This shows the difficulty of establishing a "proper" or "good" indicator to measure a state's financial situation. There is no clear agreement yet on an international level, either. And even if a majority of countries use one definition or standard of indicators, it is a different matter whether it would be reasonable for any particular country to use those indicators without some type of customizing modification. Since the claims or debts of Korea are very different from those of other countries, it would be more proper to use other indicators to understand their financial situation and to determine the direction of financial management in a more appropriate way, even if the standard used in another country may be used for a simple comparison. In such cases, it would also be required to apply several standards concurrently, depending on the purpose, rather than stick to a single standard unconditionally.

Thus, there is a need to understand what the alternatives to be reviewed in this report mean precisely, and whether the candidates under consideration actually show solid logical consistency in terms of concept. To this end, this chapter will explain what different candidate indicators of net debt are and how they are related to one another. In addition, this chapter will introduce the historical context and theoretical background of key indicators. However, what this report wants to point out first is that, even if the same term is used, its meaning and perspective may be different depending on what background the discourse has taken place in. Attention shall be paid to the differences of perspectives in the following three cases. Where the difference is not clarified, the meaning of indicators may be misunderstood, and thus it may be wrongly determined whether the indicators are appropriate for their intended purpose, which, again, may have been left unstated or inadequately clarified. Similarly, misunderstandings and unproductive controversies we have seen in the past may well repeat, from either knowingly or erroneously objections, simply from the fact that "our" indicators are different from those in common international use.

1) Fiscal indicators

Various concepts used in public finance, i.e., budgeting, or indicators for measuring such concepts numerically have long featured a strong preference for a cash-oriented nature and were in use long before the modern budget system was established. First, parties involved in budgeting commonly deal with such concepts as revenues, expenditures, balances. The revenues and expenditures are usually regarded as *ex ante* figures for planning the following year's finances, and they can be understood as the *flow* of budgetary transactions. Thus, the balance is calculated as the difference between the two categories of fiscal transactions: $\text{balance} = \text{revenue} - \text{expenditure}$. In the fiscal indicators of Korea, the scope of public finance is set to include budget accounts (general + special) and state funds. Peculiarly, health insurance is generally excluded from fiscal statistics in Korea, unlike other countries. In addition, one should bear in mind that the scope of "off-budget" is defined differently by country.

The concept of debt that is of interest in this report may be deemed as a concept corresponding in general to the cumulative sum of deficits. In other words, the annual change in the level of debt during a fiscal year is generally equivalent to the budget balance for such year. Debt is calculated as the sum of outstanding national bonds, as well as other borrowings and treasury disbursements of the central government. Thus, debt corresponds to the numerical measure of *stock* that results from the accumulation of annual deficits, or the *flow*.

2) Macro statistics (national accounts)

The term "general government" is defined as being the total government, from the perspective of the production of macro statistics, as one of the key sectors in the economy (however, note that this does not include the public sector). Since the perspective of fiscal management mentioned above is focused on (preliminary) planning, the input/output of funds, or "flow" is given the main attention. In contrast, macro statistics regards the stock figures or concept as being more important.

The most important point for us is that the EU (Maastricht or EDP provisions) and the early IMF Guide (1985) defined a government based on a national accounts perspective. This context naturally is oriented toward aggregate, macro statistics, and accordingly defined indicators without very much attention to the public sector. One specific problematic result is that, unlike the majority of OECD member states that do not have a substantial public sector, the few outlier countries (including Korea) with a substantial public sector ought to

include the public sector in their debt and liability statistics, in the sense that the public sector may not officially be counted as government, but, as an extension of the latter, is yet important in measuring the financial position of the government. Another feature of macro statistics is that it does incorporate some aspects of accrual accounting, but because the system of national accounts was defined mainly in the mid-and-late 1900s, it has a strong orientation toward cash basis accounting.

3) Government accounting standard

The government accounting standard is defined as a combination of two criteria. One of them covers different definitions of the scope of the reporting entity for government statistics, i.e., it asks us what exactly we mean by government. The other asks what accounting standard shall be used: cash or one of the different ways to implement accrual accounting. Each of such two criteria offers the choice of four alternatives. Thus, a total of 16 combinations can be generated theoretically, each of which would be a valid definition of how government statistics will be implemented. In other words, negating the several acrimonious controversies in the past, there is actually not much grounds for arguing that the government accounting standard of Korea is “wrong”, because it diverges from “the (single and universally accepted) international standard or any standard of another country.”⁴

As illustrated in Figure 2, the scope of government is a criterion that can be set to one of four levels, from a narrow sense to a broad sense. For example, when a government in a narrow sense is selected as the standard for calculating an indicator and fiscal rules, etc., the indicator so calculated may cause the government to find ill-advised motivation to produce rosier figures by shifting some of its financial burdens to the public sector, which is not covered by the government indicators. To overcome this kind of distortion, the definition of the scope of government in accounting standards explicitly provides an alternative that (properly) counts even the public sector as a part the government, in a broad sense.⁵

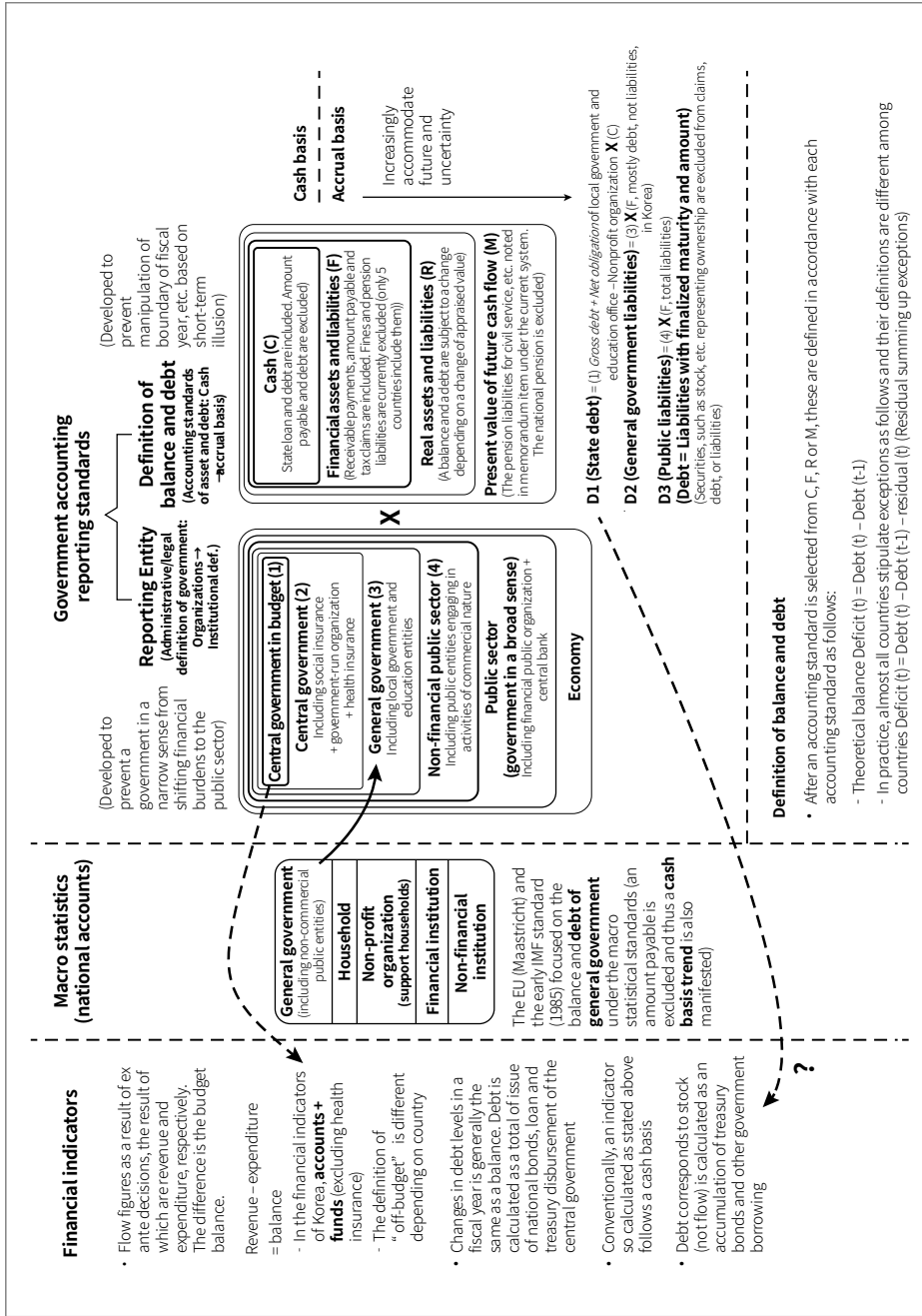
⁴ Theoretically, at least 16 reasonable accounting standards can be adopted. And as illustrated in a diagram, Korea currently adopts and applies 3 accounting standards with regards to gross debt or obligation. Even if there are 16 alternatives theoretically, international organizations and other countries generally adopt the 3 standards that Korea has adopted.

⁵ However, even in the U.K., which is exemplary in terms of financial management and indicator aggregation, some argued that the gross debt of a public sector shall be construed restrictively, as its finances were aggravated in the financial crisis of 2008.

Separately from the scope of government, the other criterion stipulates that there is a need to select 1 of 4 alternatives (cash basis, or one of the 3 accrual basis standards) as the accounting standard to be applied when calculating assets and debts. Here, the accrual basis is further divided into three levels so that future events and uncertainty can be incorporated on an incrementally wider basis. Since indicators are not immune from some intentional manipulation under a cash basis regime (e.g., by shifting current expenses to the next period or vice versa, to produce a more favorable figure), efforts have followed to promote the accrual basis in the government accounting to make the financial position more transparent. However, the stronger this aspect of accruals is incorporated, the greater the role of assumptions such as the discount rate, etc. would be in tabulating future streams of financial figures. Thus, even with accrual accounting, one must be vigilant against the possibility of biases or distortions still influencing the numbers.

Figure 2 briefly explains the basic purpose of two criteria. In detail, each country has many exceptions, and virtually no country fully conforms to these theoretical definitions. In other words, even advanced countries virtually have no case in which the definitions of indicators are identical such that they can be compared in a truly strict sense. Furthermore, even the time series of one country is difficult to aggregate in the same way for 10 years or more (IMF, 2015).

Figure 2_ Comparison of financial soundness indicators



Source: Prepared by author in reference of related materials.

B. Analysis of variant definitions of net debt

The scope of government (reporting party) which is the first criterion asked by government accounting reporting standards has the following characteristics as illustrated in Figure 3. First, among the four alternatives for the scope of government, the prevalent choice is the general government: this is true among the previously discussed three types of indices used among EU member states, as well as the PSDSG endorsed by international organizations. However, there remains a need to consider the fact that a non-government public sector accounts for a large portion in Korea compared to other countries, and it is commonly known that the financial position of the public sector is questionable, such as public enterprises, etc. Thus, at least in Korea there is a need to look beyond simply following international practice and keep to a financial strength index based on general government only. One needs to also take into account the financial position of public entities, etc.

Second, by reviewing other countries' accounting standards (cash and accrual bases), the following summary can be offered. The following diagram illustrates the fact that the alternative represented as ① and ④ among foreign cases, i.e., the net debt of general government, as tabulated by some EU member states and by the PSDS (and the IMF therefrom), is defined in a very similar way to each other. This can be verified using the results of a calculation in the next chapter. However, the claims (excluding stocks and derivatives; as they are assets that do not involve lending or borrowing) held by the national pension, etc. and included in the general government are included in the calculation of net debt, and they are of substantial size. Thus, in light of the underlying rationale of accruals (M), it is not clear whether it would not be advisable to measure financial strength after excluding the claims held by the national pension. Similarly, even for the annual budget balance, a supplementary index called the managed fiscal balance has been adopted in Korea for concurrent use with the classically defined budget balance. The new variant recognizes the fact that the pension's assets, which contribute positively to the budget balance, and substantial as they may be, must ultimately go toward pension payments in the future, and thus in an accruals spirit cannot count toward a "true" balance. To elaborate, even if the claims held by the national pension are used to repay some obligations in the future, the burden of pension payments continues to exist thereafter. Thus, it is questionable to conclude that the claims held by the national pension are resources available to repay other obligations.

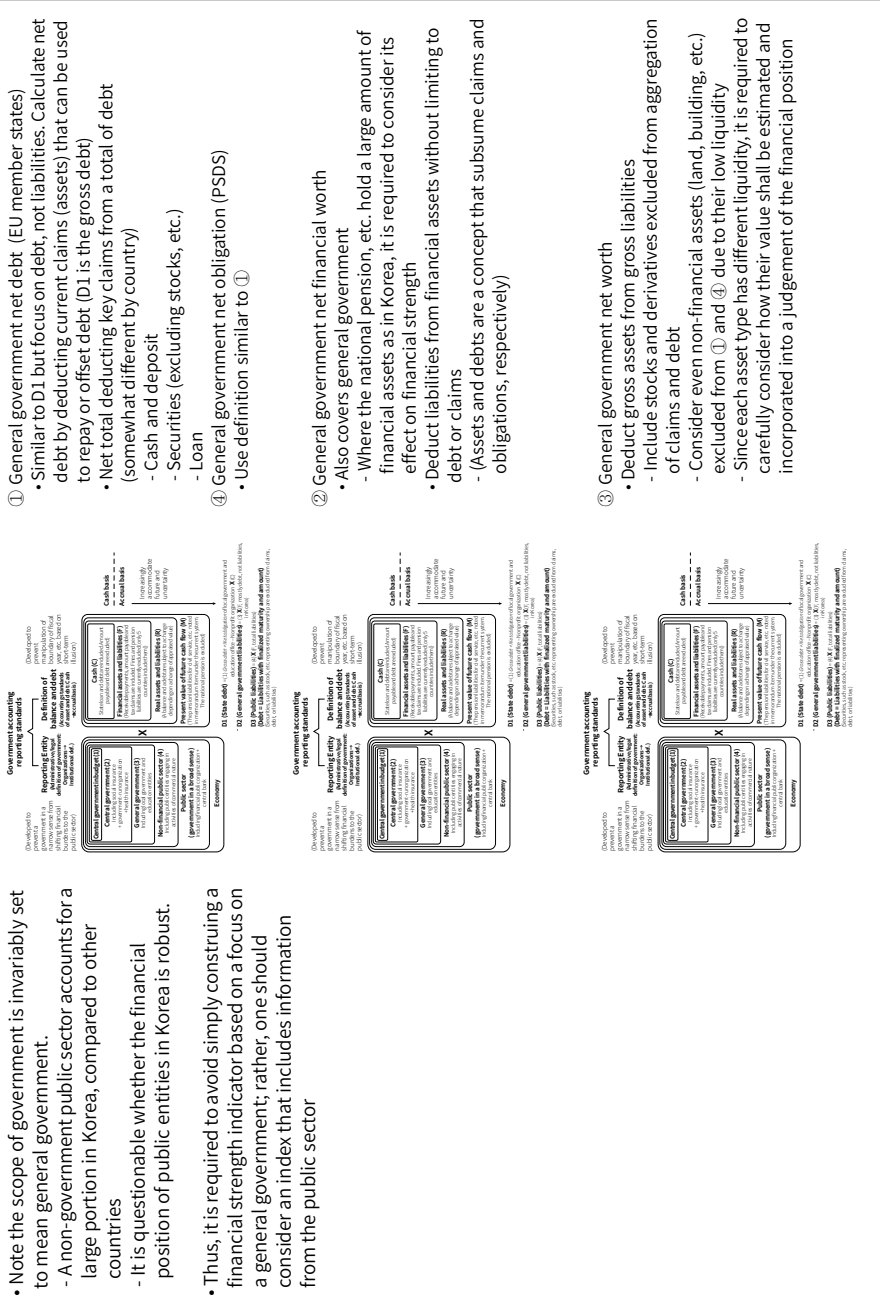
In addition, among alternatives in foreign cases, ② and ③ are susceptible to similar problems, i.e., where the financial strength is estimated based on the net financial worth or net

worth. Not only claims but also stocks, derivatives, etc. fall under these assets. If ② and ③ are adopted, the total holding of stocks and derivatives are included in calculating an indicator. This is the case with the national pension, which holds non-claim securities (instruments of ownership, rather than debt), etc. in a substantial scale. In other words, it would be unreasonable to calculate an indicator of debt repayment capability that includes such non-debt assets. The other problem is that, were these assets used to repay obligations, their value is likely to fall drastically in a crisis situation. Thus, it may be necessary to entertain methods for applying suitable discounts to their normal value when calculating their capacity to be used for repayment in a crisis situation.

Among the four alternatives that may be considered from foreign cases, ③ net worth is the most comprehensive in scope. Thus, superficially it may seem that ③ net worth would be the most appropriate for use in determining the financial soundness. However, for reasons similar to those stated above, it is not altogether clear that ③ net worth is distinctly superior to the other alternatives. As explained above, ③ net worth has the following problems: the public sector is excluded from the target category in the definition of an indicator; since the national pension holds a substantial portion of financial claims and other financial assets (including equity shares, etc.), it is likely that the indicator would not sufficiently consider the exclusion, and it may be difficult to sell the assets held in a crisis situation. Lastly, even if all the problems stated above are resolved, the future uncertainty is not reflected sufficiently and thus a risk that may be reflected in the financial situation may be underestimated in the indicator. In particular, future financial burdens may be underestimated insofar as to the predictions of economic growth, population changes, discount rate, etc., or which may even be wholly omitted in some cases.

Figure 3_Comparison of characteristics of alternatives to net debt indicator

- Note the scope of government is invariably set to mean general government.
- A non-government public sector accounts for a large portion in Korea, compared to other countries
- It is questionable whether the financial position of public entities in Korea is robust.
- Thus, it is required to avoid simply construing a financial strength indicator based on a focus on a general government; rather, one should consider an index that includes information from the public sector



Source: Prepared by author in reference of related materials.

II . Possible Supplementary Indicators

At the end of the previous discussion, we briefly presented an intuitive evaluation of the indices of government finances and government accounting mainly in use, and produced sample figures for Korea and key foreign countries using several different alternative indices.⁶ We now probe deeper into the pros and cons of the suggested alternative indices. i.e., minding both their theoretical considerations and practical ease of calculation. This report will now review key indicators of finances and government accounting. This will be followed in the last chapter by a summary of our findings, provided for the convenience of readers.

1. Supplementary accounting indicators

The primary factor for judging the “suitability” of alternative indices will be whether the netted figures for debt or liabilities, etc. will show a result that can markedly diverge from its gross-figure counterpart – that is, will the new, alternative or supplementary index provide new information that would help us, and perhaps even compel us to, reassess our impression of a government’s fiscal position? Did the usual gross-term figures prove to be quite limited or even misleading? The netted figures would necessarily be smaller than the gross indices, but then again, is there a marked difference in Korea compared to other countries in how large the gap is between the net and gross numbers? If so, this would suggest that Korea, or any country similarly positioned, may want to consider adopting alternative or supplementary indices besides those in common use internationally. In particular, we will be paying special attention to the need to introduce a supplementary additional indicator that reflects how much the Korean government’s future debt stream is sensitive to population aging and social welfare expenditures, since her population has been known to undergo rapid aging at a pace that is unprecedented in comparison with other countries.

2. Review of liquidity-based indicators

Let us consider an indicator that goes beyond simple, strict compliance with the accounting standards and definitions, and is geared toward providing useful information about a country’s overall financial position. Our query proceeds with a focus on the claims

⁶ Due to space restrictions, this summary report will not present the results of the calculation obtained in the original report, but will only mention the main contents thereof in the relevant sections.

available to repay debts during a crisis, as suggested by the case of U.K. First, a supplementary indicator may be thought of as supplementing an accounting indicator. This indicator may be based strictly on an accounting basis and provide additional information as to which claims are classified as being liquid or a risk factor. Furthermore, one may also consider separately an indicator that can additionally incorporate information on ease of conversion into cash, i.e., the liquidity of assets. This is because the liquidity of assets or abrupt fluctuations in their value, etc. may have to be considered in an urgent debt repayment scenario. The liquidity of claims and classification by risk factor shall be reflected therein, as mentioned above, and the possibility of large-scale fluctuations of exchange rates, etc. shall also be reviewed.

3. Additional calculation of supplementary indicators

From our review of international statistical guides (such as the GFSM and PSDS) and country cases, we note that special care is required in interpreting the results especially in a comparative context, because the scope and composition of financial assets that are to be deducted from gross debt differ from country to country. Each country calculates its net debt in its own way. For example, the U.K. separately calculates its net debt by deducting financial assets with high liquidity from its gross debt. On the other hand, Latvia calculates and manages its indicator by deducting all assets (financial and non-financial) from its gross debt. Thus, this report will calculate supplementary indicators by subdividing Korea's financial assets that could be deducted from its gross debt. In addition, this report will analyze the meaning of each indicator by calculating it with non-financial assets, etc.

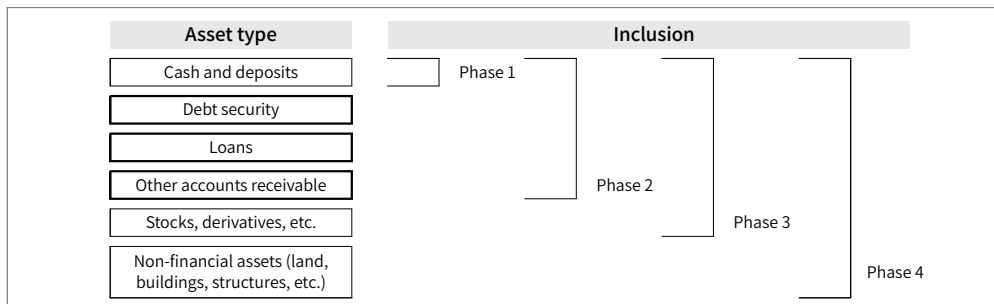
A. Phased alternative definitions of supplementary indicators

In this chapter, an additional indicator is calculated and each country is compared and analyzed by introducing four different definitions of consecutively broader scope at each phase. I.e., we differentiate among types of financial assets and non-financial assets and then review the implications of deducting them from gross debt as we expand the subset of offsetting assets.

- (Phase 1) Cash and deposits are resources immediately available to repay a debt. A net debt with high liquidity is calculated by deducting the cash and deposits from the gross debt.
 - Since the cash and deposits are financial assets that are immediately available for any purpose, they could be used as an indicator that conservatively evaluates the financial

- position.
- (Phase 2) Net debt is calculated by aggregating financial assets under the PSDS, which includes debt instruments such as cash and deposits, debt security, loans, other accounts receivable, etc.
 - Since they are financial assets that fall under debt instruments, excluding stocks and derivatives from among the entirety of financial assets, they can be used to repay a debt relatively easily.
 - (Phase 3) The net financial worth is calculated by aggregating the financial worth under the GFS, in which stocks and derivatives are added to the financial worth under the PSDS.
 - Marketable stocks, such as listed stocks, etc. could be easily cashed in through selling.
 - However, in Korea, most are an investment in public enterprises, except for social security funds, such as the national pension, etc. and thus it is relatively unlikely for them to be sold.
 - (Phase 4) The net worth is calculated by offsetting the aggregate gross asset. In particular, the latter figure shall also include non-financial assets, such as land, buildings and structures, machines and devices, etc.
 - Non-financial assets are less likely to be used to repay a government debt through asset sales. However, they could be used as an indicator of the state's net assets.
 - In the governmental sector, a positive net asset refers to a means to transfer an object of worth to future generations.
 - A negative net asset means for a worth to be transferred from future generations, and thus they will bear severe financial burdens.

Table 2_ Details of phased financial assets and non-financial assets



Source: Prepared by author.

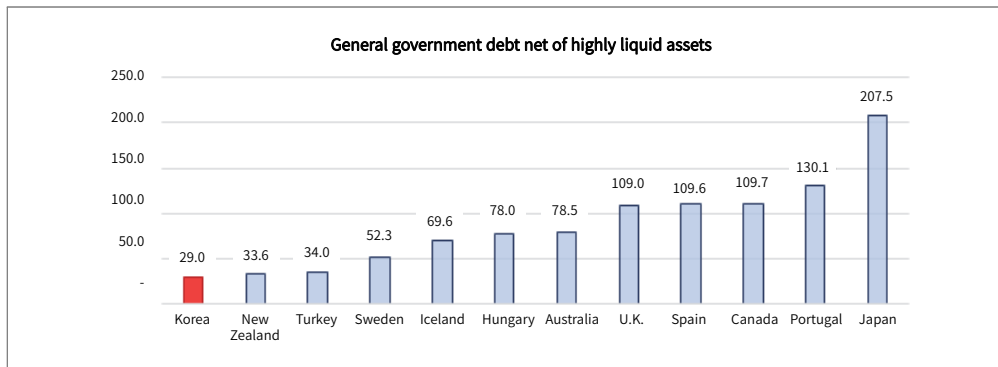
Various supplementary indicators can be calculated based on the detailed statistics of gross debt and financial assets, and then compared with OECD member states as follows.

B. Debt net of highly liquid assets

The result of calculating the net debt of highly liquid assets of OECD member states is as follows. The net debt of highly liquid assets is calculated by deducting, from gross debt, financial assets held as financial instruments having the highest liquidity. It is assumed that, in most countries, the financial assets with high liquidity are composed only of cash and deposits that are immediately available. Compared with the results of the calculations for OECD member states, in 2019 Japan was the highest at 207.5% against GDP. And Portugal, Canada, and Spain were 130.1%, 109.7%, and 109.6%, respectively. Korea was 29.0% relative to GDP, the lowest among countries that publicly announced their net debt of highly liquid assets, which can be interpreted as showing Korea's financial position in a very favorable light.

Figure 3_ International comparison of general government net debt of highly liquid assets (2019)

(Unit: % compared to GDP)



Source: IMF, <http://data.imf.org>, date of search: 2021. 7. 5. In the case of Korea, prepared by the Government Accounting and Finance Statistics Center.

Table 3_Trend of net debt of highly liquid assets by OECD member state

(Unit: % compared to GDP)

Year	Australia	Canada	France	Korea	Sweden	U.K.	U.S.
2000		111.7			61.8	41.0	
2001	40.3	111.1			62.9	39.8	
2002	38.4	109.5			63.7	42.6	
2003	38.0	104.9			63.2	41.9	
2004	35.0	101.0			62.9	44.9	
2005	33.8	99.6			63.3	45.3	
2006	33.7	96.4			56.7	44.3	
2007	31.0	91.9			51.5	46.1	
2008	29.2	91.3			49.1	58.1	
2009	38.3	106.6			53.6	70.2	
2010	43.1	109.3			51.5	81.6	
2011	44.9	111.9			51.1	94.8	
2012	58.7	115.4		21.4	52.5	98.3	
2013	55.7	111.6		24.6	55.6	93.9	
2014	61.1	111.8		27.0	59.8	104.4	
2015	65.9	117.6		27.7	58.6	103.9	
2016	74.4	116.7		27.9	58.1	110.2	
2017	70.3	111.0		27.4	56.0	107.7	
2018	71.4	110.0		26.1	55.4	104.4	
2019	78.5	109.7		29.0	52.3	109.0	

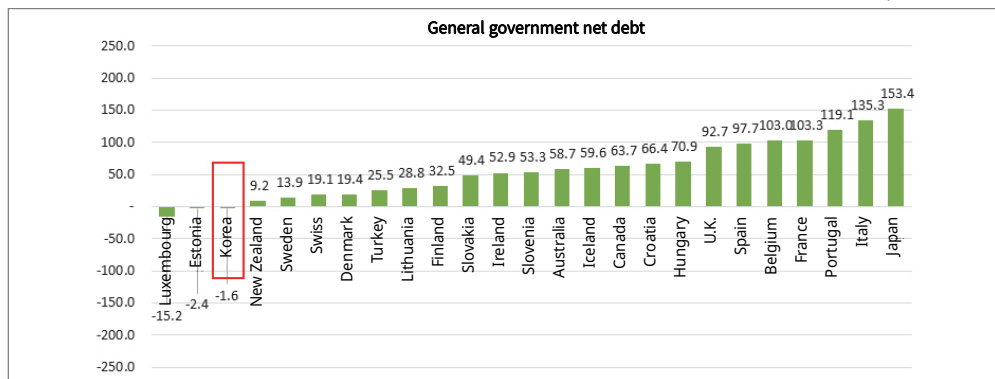
Source: IMF, <http://data.imf.org>, date of search: 2021. 7. 5. In the case of Korea, prepared by the Government Accounting and Finance Statistics Center.

C. Net debt

The result of the calculations of net debt by OECD member states is as follows. The net debt is calculated by deducting, from gross debt, financial assets corresponding to debt instruments, which includes all financial assets and debts held as debt instruments (financial assets and debts excluding stocks, investment fund stocks, derivatives, stock options, etc.). From the calculations for OECD member states in 2019, Japan was at 153.4% against GDP, which was the highest. And Italy, Portugal, and France were at 135.3%, 119.1%, and 103.3%, respectively. Korea was at -1.6% relative to GDP, the third lowest among countries that publicly announced their net debts.

Figure 4_Comparison of general government net debt (2019)

(Unit: % compared to GDP)



Source: IMF, <http://data.imf.org>, date of search: 2021. 7. 5. In the case of Korea, prepared by the Government Accounting and Finance Statistics Center.

Table 4_Trend of net debt by OECD member state

(Unit: % compared to GDP)

Year	Australia	Canada	France	Korea	Sweden	U.K.	U.S.
2000		77.9	52.1		36.2	33.0	
2001	26.6	76.8	51.7		36.1	32.3	
2002	25.3	75.7	54.6		37.9	35.0	
2003	25.0	72.1	58.0		37.2	34.3	
2004	21.5	68.1	61.0		36.5	37.0	
2005	19.2	63.8	62.8		34.0	36.9	
2006	16.8	60.3	59.8		27.9	35.8	
2007	12.1	56.2	58.5		21.8	37.5	
2008	10.9	55.1	62.5		20.9	46.4	
2009	19.7	64.2	71.7		21.1	57.4	
2010	26.5	66.9	76.6		19.6	64.3	
2011	29.4	70.1	79.3		20.6	78.0	
2012	43.1	72.3	88.1	-4.7	21.0	81.7	
2013	39.1	68.5	88.3	-2.8	20.9	78.1	
2014	43.8	68.9	96.8	-2.8	22.3	88.4	
2015	48.3	71.5	97.3	-1.2	20.1	87.9	
2016	55.9	71.4	102.7	-0.8	18.5	93.0	
2017	50.3	66.8	101.4	-0.7	15.6	91.4	
2018	51.8	65.7	100.3	-2.6	14.6	87.9	
2019	58.7	63.7	103.3	-2.0	13.9	92.7	

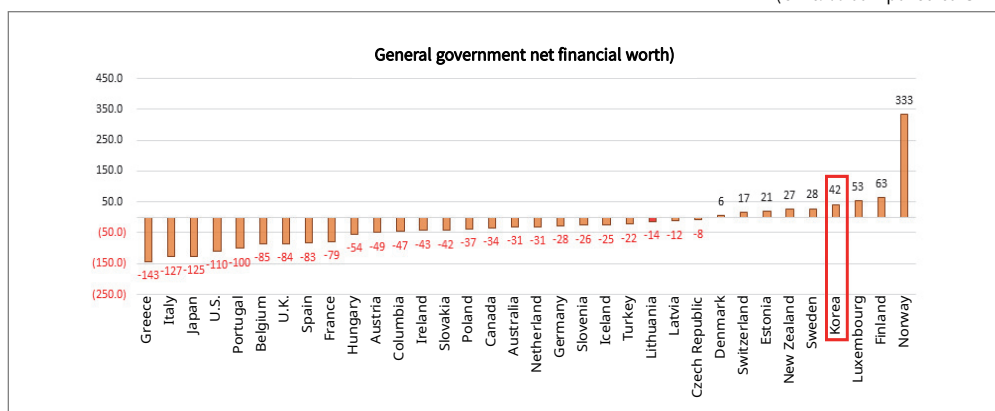
Source: IMF, <http://data.imf.org>, date of search: 2021. 7. 5. In the case of Korea, prepared by the Government Accounting and Finance Statistics Center.

D. Net financial worth

The results of calculations of net financial worth for OECD member states are as follows. The net financial worth is calculated by deducting the stock of debts from the stock of financial assets⁷ and, unlike the net debt, all types of financial assets, such as stocks, investment fund stocks, derivatives, etc. are added. Compared with the results of calculations for OECD member states, in 2019 Norway was the highest at 333% against GDP. And Korea was at 42%, making it the 4th highest from among countries that publicly announced their net financial worth. Some countries whose net debt and net financial worth were calculated concurrently showed a difference in their rankings, which was deemed to be caused mainly by the stocks held by governments.

Figure 5_ International comparison of general government net financial worth (2019)

(Unit: % compared to GDP)



Source: IMF, <http://data.imf.org>, date of search: 2021. 7. 5. In the case of Korea, prepared by the Government Accounting and Finance Statistics Center.

⁷ It shall be noted that, unlike the net debt of highly liquid assets and the net debt, the net worth is calculated by deducting debts from assets, and its sign shall be construed to be opposite the calculation.

Table 5_ Trend of net financial worth by OECD member state

(Unit: % compared to GDP)

Year	Australia	Canada	France	Korea	Sweden	U.K.	U.S.
2000	-4.9	-66.4	-32.6		-9.9	-25.1	
2001	-1.7	-63.8	-34.8		-5.7	-24.1	-55.7
2002	-2.6	-63.9	-39.7		-12.3	-26.5	-61.3
2003	-0.7	-59.0	-41.7		-9.1	-25.6	-62.6
2004	2.9	-54.4	-43.1		-6.9	-27.9	-70.8
2005	4.6	-49.0	-41.1		-1.0	-27.1	-69.9
2006	8.0	-44.1	-35.6		8.5	-27.1	-67.1
2007	9.0	-40.3	-32.3		13.5	-29.3	-67.3
2008	10.5	-41.8	-41.8		8.2	-37.3	-80.6
2009	4.8	-48.1	-49.1		14.8	-46.0	-91.9
2010	-1.7	-49.9	-54.3		16.5	-52.1	-100.6
2011	-4.6	-52.9	-59.0		17.5	-67.3	-107.9
2012	-19.7	-53.5	-66.8	29.7	19.4	-69.2	-110.2
2013	-14.8	-48.3	-65.8	29.3	19.0	-67.0	-112.2
2014	-17.1	-47.1	-73.5	30.8	18.0	-77.6	-112.3
2015	-20.3	-46.3	-75.0	31.7	17.2	-78.2	-112.6
2016	-27.7	-44.9	-79.3	33.3	20.8	-84.4	-113.3
2017	-22.2	-37.9	-77.6	35.9	24.0	-82.6	-110.5
2018	-22.8	-36.3	-77.4	36.5	24.0	-79.7	-111.4
2019	-30.8	-33.5	-78.5	41.9	28.4	-84.3	-109.7

Source: IMF, <http://data.imf.org>, date of search: 2021. 7. 5.

The trend of net financial worth in major countries shows that the net financial worth has increased in Korea, Canada, and Sweden. On the other hand, the net financial worth has continued to decrease in Australia, France, the U.K., and the U.S.

E. Calculation of net worth

The result of calculating the net worth for OECD member states is as follows. The net worth of a specific institutional unit or a group thereof is a debt calculated by deducting the total amount of outstanding debt from the total amount of assets they hold. The formula for calculating the net worth is as follows:

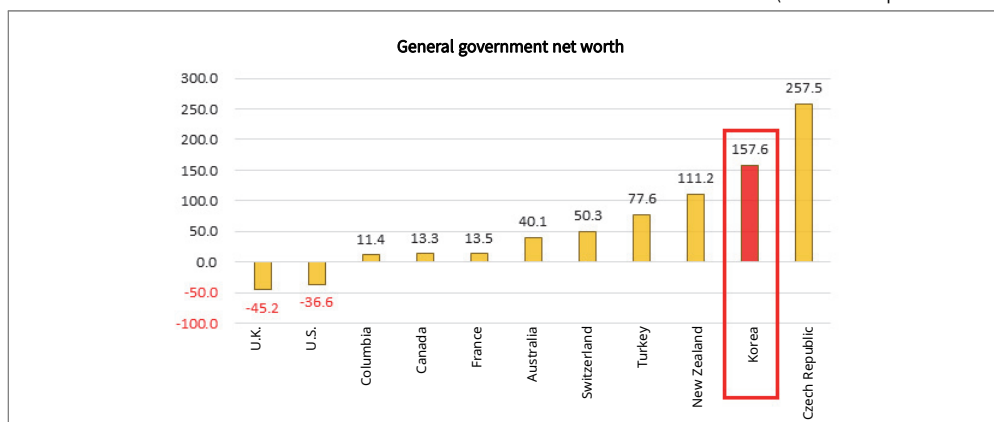
- Net worth = Non-financial assets + Financial assets – Financial debt

Compared with the results of calculations for OECD member states, in 2019 the Czech

Republic was the highest at 257.5% compared to the GDP. And Korea was 157.6%, making it the 2nd highest among countries that publicly announced their net worth. The U.K. was at -45.2% compared to the GDP, which was the lowest; the U.S. was at -36.6%.

Figure 6_ International comparison of general government net worth (2019)

(Unit: % compared to GDP)



Source: IMF, GFSMAB_04-05-2021 13-36-43-44_timeSeries. In the case of Korea, prepared by the Government Accounting and Finance Statistics Center.

The government's non-financial assets are mainly "general-type" assets, social infrastructure, resident amenities, land, buildings, structures, roads, port facilities, etc. Since, in most cases, these non-financial assets are not likely to be sold but are held to provide public services for a long period of time, it is preferable to exclude them from financial soundness indicators when considering the likelihood of encashment. However, as an indicator it is meaningful to review them to be a result of the management of the state from a cumulative perspective (balance of net worth of the government). In other words, a positive net worth could be construed not as the capability to repay debts, or of the financial strength itself, but as the capability to leave net assets to future generations.

Table 6_Trend of net worth by OECD member state

(Unit: % compared to GDP)

Year	Australia	Canada	France	Korea	Sweden	U.K.	U.S.
2000	50.9	-23.2	29.1		71.9	3.7	0.0
2001	56.1	-28.5	28.6		76.7	5.3	6.7
2002	55.0	-25.7	27.2		70.8	2.9	1.8
2003	56.5	-22.1	30.7		73.8	3.8	0.2
2004	59.3	-15.3	35.3		80.7	3.8	-5.5
2005	62.0	-5.6	44.6		88.1	5.8	-3.0
2006	65.2	-3.5	53.8		97.4	6.8	2.4
2007	66.2	3.7	58.1		97.8	3.4	4.3
2008	72.2	-1.5	44.2		94.7	-6.6	-5.6
2009	73.7	-1.5	41.6		105.5	-14.2	-15.2
2010	67.6	-1.5	41.3		105.5	-18.1	-23.7
2011	61.2	-2.0	37.5		105.9	-32.6	-29.8
2012	47.1	-8.6	28.6	156.7	108.9	-34.9	-32.9
2013	52.8	1.3	27.6	153.9	111.1	-32.2	-35.1
2014	50.8	-0.5	16.4	153.1	108.6	-40.7	-36.8
2015	50.4	-3.8	12.5	150.3	103.8	-41.4	-38.9
2016	44.9	1.8	8.9	150.3	109.6	-47.7	-39.5
2017	48.9	9.4	11.4	149.6	113.4	-43.8	-36.9
2018	48.3	11.5	12.6	149.7	114.9	-40.4	-38.0
2019	40.1	13.3	13.5	157.6	0.0	-45.2	-36.6

Source: IMF, <http://data.imf.org>, date of search: 2021. 7. 5.

According to the trend of net worth shown above, the net worth of Korea continued to decrease since these statistics were initially calculated, and then increased in 2019. The net worth continued to decrease in Australia, France, the U.K., and the U.S., whereas it continued to increase in Canada and Sweden.

F. Summary of supplementary indicators

The IMF presented various indicators depending on the coverage of financial assets. Since Korea has announced no data on its gross debt, debt net of highly liquid assets, and net debt, this study includes unofficial but still authoritative figures for Korea, calculated by its Government Accounting and Finance Statistics Center according to the same definitions and procedures used by the IMF for its published results on select member countries. When analyzing the data, further attention should be paid to the following. Where the net financial worth and net worth in which debts are deducted from assets is positive, it shall be construed that the financial strength is high; and where the liquid assets and net debt in which assets are

deducted from debts is positive, it shall be construed that the financial strength is low.

As to the implication presented by the aggregated results, where the financial soundness and financial strength are evaluated only using the gross debt, it would be impossible to consider the repayment capability, such as the related financial assets and non-financial assets, etc. On the other hand, it is possible to conduct an additional analysis by using supplementary indicators calculated in light of the related assets.

In the case of Finland, the gross debt was 69.5% compared to the GDP and it is in the middle, in terms of the scale of debts, among countries that publicly announced their gross debts (15th highest). On the other hand, its net financial worth was 63.2% relative to GDP (the higher the value, the higher the financial strength), making its financial strength the second highest after Norway. In other words, in light of the financial worth and gross debt, Finland would have a financial worth almost 63.2% relative to GDP, even after repaying its gross debt. In conclusion, it was confirmed that the financial strength could be analyzed differently than when it was analyzed based only on either the gross debt or comprehensively on financial worth as a whole.

Table 7_ Result of calculation of supplementary indicators by OECD member state (2019)

(Unit: % compared to GDP)

Country	Gross debt	Phase 1 (current debt)	Phase 2 (net debt)	Phase 3 (net financial worth)	Phase 4 (net worth)
Australia	80.7	78.5	58.7	-30.8	40.1
Austria	89.7	-	-	-49.3	-
Belgium	121.0	-	103.0	-85.1	-
Canada	115.3	109.7	63.7	-33.5	13.3
Columbia	-	-	-	-46.5	11.4
Czech Republic	37.7	-	-	-7.7	257.5
Denmark	51.9	-	19.4	6.3	-
Estonia	13.3	-	-2.4	21.1	-
Finland	69.5	-	32.5	63.2	-
France	124.0	-	103.3	-78.5	13.5
Germany	68.2	-	-	-27.6	-
Greece	196.1	-	-	-143.4	-
Hungary	82.9	78.0	70.9	-54.3	-
Iceland	79.7	69.6	59.6	-25.3	-
Ireland	68.9	-	52.9	-43.2	-
Italy	154.8	-	135.3	-127.1	-
Japan	225.8	207.5	153.4	-125.4	-
Korea	42.0	29.0	-2.0	41.9	157.6
Latvia	-	-	-	-11.7	-

Table 7_ Result of calculation of supplementary indicators by OECD member state (2019)(continued)

Country	Gross debt	Phase 1 (current debt)	Phase 2 (net debt)	Phase 3 (net financial worth)	Phase 4 (net worth)
Lithuania	44.9	-	28.8	-13.7	-
Luxembourg	30.0	-	-15.2	53.0	-
Netherland	62.5	-	-	-30.6	-
New Zealand	39.7	33.6	9.2	26.6	111.2
Norway	-	-	-	333.3	-
Poland	63.8	-	-	-36.7	-
Portugal	136.9	130.1	119.1	-100.0	-
Slovakia	63.2	-	49.4	-42.0	-
Slovenia	81.6	-	53.3	-26.1	-
Spain	117.3	109.6	97.7	-82.7	-
Sweden	55.6	52.3	13.9	28.4	-
Switzerland	42.2	-	19.1	17.0	50.3
Turkey	37.2	34.0	25.5	-22.3	77.6
U.K.	113.7	109.0	92.7	-84.3	-45.2
U.S.	-	-	-	-109.7	-36.6

Source: IMF, <http://data.imf.org>, date of search: 2021. 7. 5.

4. Additional analysis of social security funds

There is a need to consider the possibility of excluding social security funds in calculating financial worth for Korea, in light of its scale and somewhat peculiar situation. The national pension, etc. holds a large sum of financial assets as a part of managing social security funds, etc. Thus, when the social security fund is included in the calculation of the net debt, it is likely that the calculated net debt would show a misleadingly optimistic picture. In addition, since the purpose of the social security fund is to reserve the funds required to pay annuities in the future, it is questionable whether any surplus assets can be properly counted as usable for repaying debt other than future pension payments. Thus, if the net debt is calculated by including the social security funds, the result is likely to misrepresent the government's readiness to repay or service its debt. In light of this fact, it is recommended that social security finances be separated from measures of the government's financial position and be considered separately.

The social security funds (national pension, private school teachers pension, employment insurance, occupational health, and safety insurance) hold the following financial assets. The gross financial assets⁸ of the social security funds amounts to KRW 780 trillion (40.6% relative to GDP) and is composed as follows: national pension fund of KRW 727.1 trillion; private school teachers pension fund of KRW 20.9 trillion; employment insurance fund of KRW 9.5

trillion; and occupational health and safety insurance fund of KRW 22.5 trillion. In terms of the types of financial instruments, the financial worth is composed as follows: share and investment fund stocks of KRW 477.0 trillion; debt security of KRW 274.7 trillion; cash and deposits of KRW 15.7 trillion; loans of KRW 8.9 trillion, etc.

Table 8_ Financial worth of social security fund in fiscal year 2019

(Unit: Billion won, % compared to GDP)

Type	National pension	Private school teachers pension	Employment insurance	Occupational health and safety insurance	Total
Cash and deposit	14,060	377	630	596	15,664
Debt security	268,921	5,784	-	-	274,706
Loan	5,074	2,551	367	937	8,929
Other accounts receivable	1,686	73	1,181	776	3,716
Share and investment fund stock	437,363	12,103	7,304	20,228	476,998
Derivatives	9	10	-	-	19
Total	727,114	20,898	9,483	22,537	780,032
(% of GDP)	37.9%	1.1%	0.5%	1.2%	40.6%

Source: Ministry of Economy and Finance, prepared by author based on “2019 fiscal year national account data,” 2020.

For comparison, a survey of OECD member states shows that the scale of financial assets held by social security funds in most countries is 5% or less relative to GDP. In contrast, the scale of financial worth of the social security fund was large in the following countries: Finland (86.1%); Luxembourg (37.2%); Sweden (30.5%); Canada (24.2%).

Table 9_ Financial worth held by social security fund in OECD members

(Unit: % compared to GDP)

Country	2014	2015	2016	2017	2018
Australia	3.83	4.03	4.07	4.14	4.21
Belgium	5.20	5.13	5.13	5.15	4.93
Canada	17.28	21.49	21.32	22.83	24.21
Czech Republic	0.89	0.81	0.96	1.15	1.41
Denmark	0.16	0.17	0.17	0.16	0.14
Estonia	4.26	4.29	4.18	4.19	4.19
Finland	86.50	88.62	90.09	93.75	86.10
France	15.43	15.54	15.72	16.21	15.17

- 8 Aggregated based on financial worth when calculating the net financial debt (add a share compared to the financial worth, investment fund stocks, and derivatives when calculating the net debt).

Table 9_ Financial worth held by social security fund in OECD members(continued)

Country	2014	2015	2016	2017	2018
Germany	4.20	4.19	4.36	4.67	5.02
Greece	11.29	11.37	11.90	13.68	14.27
Hungary	1.30	1.32	1.34	1.28	1.21
Iceland	1.60	1.55	1.94	1.31	1.40
Italy	4.94	5.08	5.21	5.37	5.54
Japan	45.85	43.97	45.45	47.13	
Latvia	2.28	2.39	2.31	2.56	3.26
Lithuania	1.63	1.93	2.02	1.70	2.42
Luxembourg	34.82	35.88	37.15	38.15	37.22
Netherlands	2.75	3.32	3.63	3.74	4.07
Poland	3.32	3.39	3.48	3.76	4.23
Portugal	10.27	10.54	10.72	11.82	
Slovakia	2.03	2.48	2.17	2.39	2.06
Slovenia	4.51	4.45	4.22	4.30	4.17
Spain	7.08	5.77	4.03	2.94	3.04
Sweden	32.67	30.79	31.97	32.50	30.48
Switzerland	6.29	6.19	6.30	6.54	5.86
Turkey	6.75	5.70	5.88	5.60	5.17

Source: IMF, <http://data.imf.org/?sk=E86E9088-3830-4CA3-B240-1B0EC5E15221>, date of search: 2021. 7. 5.

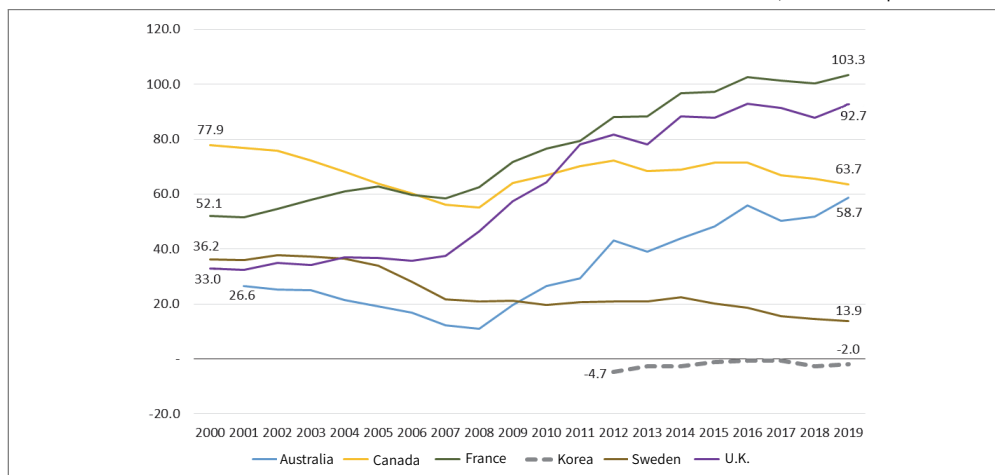
5. Summary: Results of calculations and review by key alternatives

A. Net debt

First, the trend of net debt (based on the definition of EU member states) in OECD member states will be reviewed here. The net debt is the stock of net financial assets, derived by deducting debt instruments from gross debt and includes all financial assets and debts held as debt instruments (i.e., financial assets and debts, but excluding stocks, investment fund stocks, derivatives, stock options, etc.). Calculated using this definition, the net debt of Korea was -2.0% compared to the GDP in 2019, which is very low. It is thus necessary to conduct careful further review before deciding to encourage rapidly increasing fiscal expenditures in the future.

Figure 7_Trend of net debt (based on EU standards) by OECD member state

(Unit: % compared to GDP)



Source: IMF, <http://data.imf.org>, date of search: 2021. 7. 5. In the case of Korea, prepared by the Government Accounting and Finance Statistics Center.

This calculation could be considered for use to further assess the financial strength based on the net debt statistics of the IMF. The data were subsequently aggregated in accordance with the PSDS, and it could be confirmed that they are similar to the net debt (EU). The net debt standards of the IMF were then calculated in light of their corresponding assets and thus could help us understand the substantive capability to repay debts in an effective way.

Table 10_ General government net debt, prepared by the IMF

(Unit: % compared to GDP)

Country	2014	2015	2016	2017	2018
Australia	44.18	48.76	56.37	50.80	52.40
Belgium	112.37	109.11	109.52	103.32	101.57
Denmark	26.59	25.50	25.68	22.66	22.11
Estonia	-5.11	-4.92	-4.45	-3.43	-2.82
Finland	24.21	25.72	29.73	28.06	29.95
France	96.75	97.18	102.66	101.13	101.01
Hungary	86.89	85.26	84.59	79.65	73.52
Iceland	66.82	63.64	55.55	53.33	47.98
Ireland	98.76	74.35	72.53	64.57	58.33
Italy	135.47	137.46	135.49	133.74	128.96
Japan	147.45	154.15	152.45	152.18	

Table 10_ General government net debt, prepared by the IMFContinued)

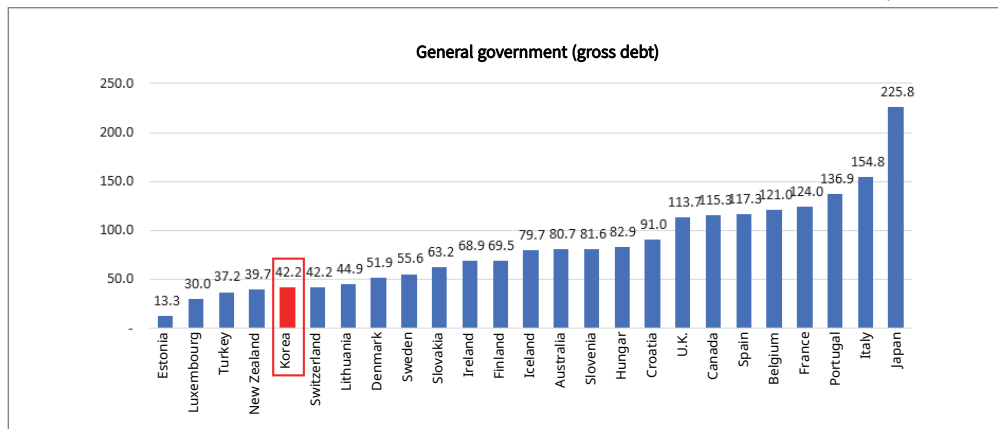
Country	2014	2015	2016	2017	2018
Latvia	40.01	39.14	37.50	31.79	28.78
Luxembourg	-11.64	-12.71	-12.51	-12.68	-12.90
New Zealand	15.72	13.77	14.00	11.96	10.41
Portugal	127.61	128.26	122.64	125.62	
Slovakia	53.35	52.34	53.66	51.02	49.21
Slovenia	59.79	64.04	65.15	60.77	53.10
Spain	96.25	95.91	97.63	95.90	94.05
Sweden	22.46	20.25	18.50	15.53	14.43
Switzerland	23.13	23.33	22.86	21.65	20.06
Turkey					21.77
U.K.	89.40	89.02	97.78	95.49	92.20

Source: IMF, <http://data.imf.org/?sk=E86E9088-3830-4CA3-B240-1B0EC5E15221>, date of search: 2021. 7. 5.

Comparing the gross debt and net debt of Korea and OECD member states shows that the gross debt (5th among countries) and net debt (3rd among countries) are not too worrisome. However, if the social security funds are excluded from the calculation of net debt, Korea's ranking of net debt becomes a bit higher, as it increases to 16.1% compared to the GDP. In addition, it is required to remember the fact that the public sector was not exceptionally well reflected.

Figure 8_ International comparison of general government gross debt (2019)

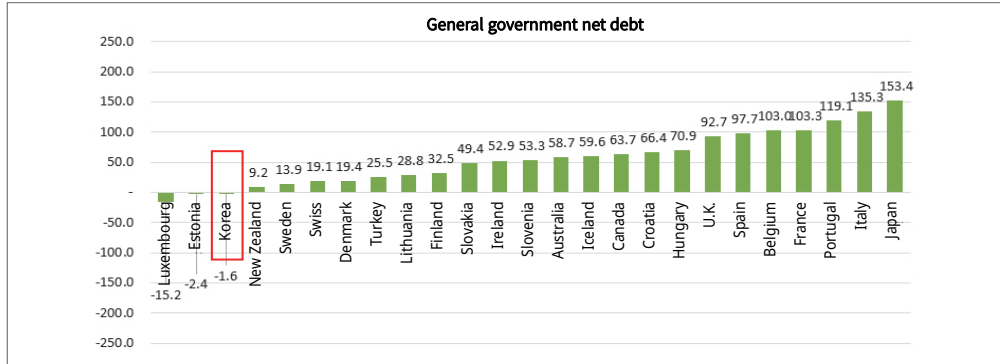
(Unit: % compared to GDP)



Source: IMF, GFSMAB_04-05-2021 13-36-43-44_timeSeries. In the case of Korea, prepared by the Government Accounting and Finance Statistics Center.

Figure 9_International comparison of general government net debt (2019)

(Unit: % compared to GDP)



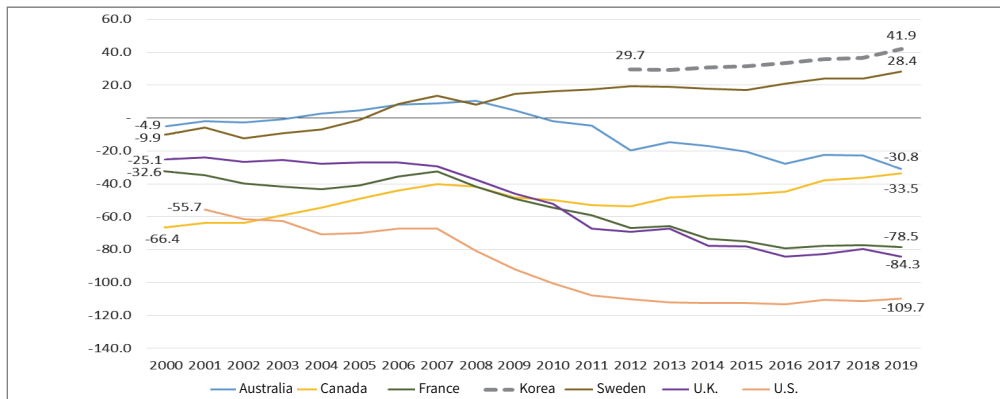
Source: IMF, GFSMAB_04-05-2021 13-36-43-44_timeSeries. In the case of Korea, prepared by the Government Accounting and Finance Statistics Center.

B. Net financial worth

This indicator is calculated by deducting the stock of liabilities from the stock of financial assets and, unlike indicators that are limited to debt, includes equity stocks, etc. Here, the concept of liabilities subsumes and is broader and therefore larger in size than the concept of debt. It is thus necessary to additionally pay attention to the omission of the public sector, a large proportion of the national pension, etc.

Figure 10_Trend of net financial worth by OECD member state

(Unit: % compared to GDP)



Source: IMF, <http://data.imf.org>, date of search: 2021. 7. 5. In the case of Korea, prepared by the Government Accounting and Finance Statistics Center.

C. Net worth

This is the most comprehensive of indices in that the financial position incorporates all information on the government's balance sheet, even non-financial assets. The net worth of a specific institutional unit or group thereof can be calculated by deducting the total amount of outstanding liabilities from the total assets held. Its formula is as follows:

$$\bullet \text{ Non-financial assets} + \text{ Financial assets} - \text{ Financial debt} = \text{ Net worth}$$

The government's non-financial assets are mainly general type assets, social infrastructure, resident amenities, land, buildings, structures, roads, port facilities, etc. Since, in most cases, the non-financial assets are not likely to be sold, but are held to provide public services for a long period of time, it is preferable to exclude them from financial soundness indicators when considering the likelihood of encashment. However, as an indicator it is meaningful to review them to be a result of the management of the state, from a cumulative perspective (balance of worth). Note that attention must be paid to the fact that this indicator is also restricted to a general government.

Table 11_Trend of net worth by OECD member state

(Unit: % compared to GDP)

Country	Australia	Canada	France	Korea	Sweden	U.K.	U.S.
2000	50.9	-23.2	29.1		71.9	3.7	0.0
2001	56.1	-28.5	28.6		76.7	5.3	6.7
2002	55.0	-25.7	27.2		70.8	2.9	1.8
2003	56.5	-22.1	30.7		73.8	3.8	0.2
2004	59.3	-15.3	35.3		80.7	3.8	-5.5
2005	62.0	-5.6	44.6		88.1	5.8	-3.0
2006	65.2	-3.5	53.8		97.4	6.8	2.4
2007	66.2	3.7	58.1		97.8	3.4	4.3
2008	72.2	-1.5	44.2		94.7	-6.6	-5.6
2009	73.7	-1.5	41.6		105.5	-14.2	-15.2
2010	67.6	-1.5	41.3		105.5	-18.1	-23.7
2011	61.2	-2.0	37.5		105.9	-32.6	-29.8
2012	47.1	-8.6	28.6	156.7	108.9	-34.9	-32.9
2013	52.8	1.3	27.6	153.9	111.1	-32.2	-35.1
2014	50.8	-0.5	16.4	153.1	108.6	-40.7	-36.8
2015	50.4	-3.8	12.5	150.3	103.8	-41.4	-38.9
2016	44.9	1.8	8.9	150.3	109.6	-47.7	-39.5
2017	48.9	9.4	11.4	149.6	113.4	-43.8	-36.9
2018	48.3	11.5	12.6	149.7	114.9	-40.4	-38.0
2019	40.1	13.3	13.5	157.6	0.0	-45.2	-36.6

Source: IMF, <http://data.imf.org>, date of search: 2021. 7. 5. In the case of Korea, prepared by the Government Accounting and Finance Statistics Center.

D. Further analysis

1) Status of non-financial assets

The analysis of net worth showed the fact that the net worth of Korea is substantially high. Thus, it shall be reviewed whether it could be further construed that its financial strength is also high. Only a few countries announce their position statements that include non-financial assets. The non-financial assets account for a substantially large portion in Korea. Of 38 OECD member states, only 11 countries publicly announce this information. Korea has prepared and submitted the related statistics to the IMF since 2012. The non-financial assets are classified into fixed assets, inventory assets, value storage assets, and non-productive non-financial assets. Of them, the fixed assets and non-productive non-financial assets account for the largest portion.

Of countries that publicly announce their statistics pertaining to non-financial assets, the Czech Republic accounts is at 265.0% compared to the GDP, which is the largest in terms of scale. Korea is at 116.0% compared to the GDP, which is the 2nd largest after the Czech Republic. Since non-financial assets are low in liquidity in times of crisis, it is difficult to deem that the net worth estimate of Korea accurately reflects its financial strength. In addition, non-financial assets have decreased gradually in Korea, whereas they are generally increasing in other countries.

Table 12_ Status of non-financial assets by OECD member state

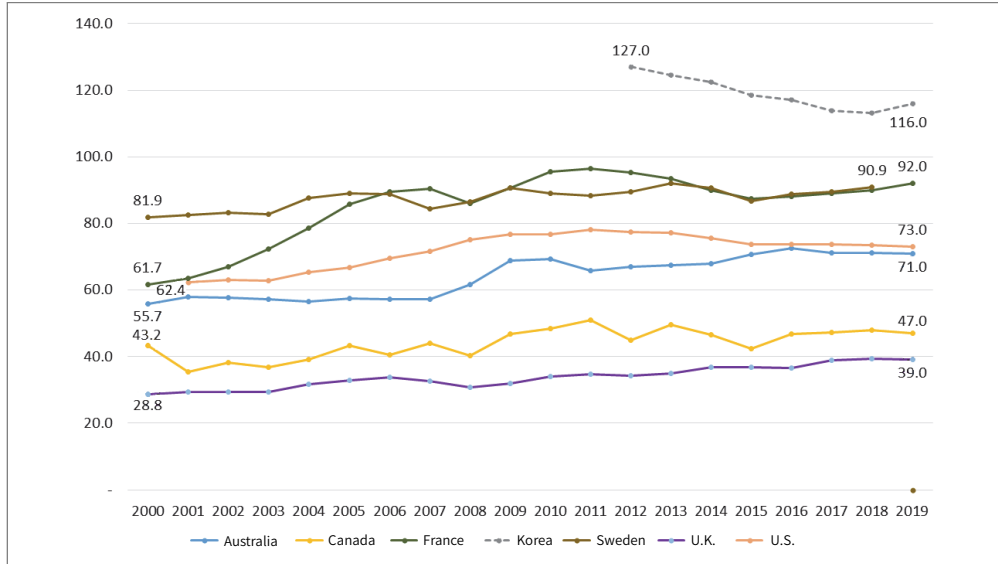
(Unit: % compared to GDP)

Country	Non-financial asset	Fixed asset	Inventory asset	Value storage asset	Non-productive non-financial asset
Australia	71.0	49.0	1.0	1.0	20.0
Austria	-	58.0	-	-	-
Belgium	-	41.0	-	-	-
Canada	47.0	-	-	-	-
Columbia	58.0	26.0	1.0	-	31.0
Czech Republic	265.0	95.0	3.0	-	168.0
Denmark	-	49.0	-	-	-
Finland	-	59.0	1.0	-	-
France	92.0	52.0	1.0	-	39.0
Korea	116.0	64.0	1.0	-	51.0
New Zealand	85.0	61.0	-	-	23.0
Switzerland	33.0	28.0	1.0	-	4.0
Turkey	100.0	20.0	-	-	79.0
U.K.	39.0	29.0	-	-	12.0
U.S.	73.0	73.0	-	-	-

Source: IMF, <http://data.imf.org>, date of search: 2021. 7. 5.

Figure 11_Trend of non-financial assets by OECD member state

(Unit: % compared to GDP)



Source: IMF, <http://data.imf.org>, date of search: 2021. 7. 5.

2) Social security fund

Social security funds are typically included in a general government, but there is a need to review an approach that excludes them from the coverage of financial assets, in light of their special context and scale in Korea. Social security funds, such as national pension, etc., require a substantial amount of financial assets in order to operate the funds. Thus, where the social security funds are included in the coverage of net debt, it is likely that the net debt would be calculated optimistically.

In addition, since the purpose of the social security funds is to reserve a fund to supply annuities in the future, it is difficult to use the funds in repaying a debt. Thus, if the net debt is calculated by including the social security funds, the fitness for the purpose of the net debt is likely to deteriorate. Thus, it is required to consider such facts separately.

Currently, the burden of benefits that the national pension, etc. shall provide in the future is not properly reflected in the official debt statistics. Thus, if only a reserve for future provisions is deducted when calculating the net debt, it is likely to distort its calculation.

On the other hand, the social security funds (national pension, private school teachers

pension, employment insurance, occupational health and safety insurance) hold the following financial assets. The gross financial assets⁹ of social security funds amount to KRW 780 trillion (40.6% compared to the GDP) and is composed as follows: national pension fund of KRW 727.1 trillion; private school teachers pension fund of KRW 20.9 trillion; employment insurance fund of KRW 9.5 trillion; and occupational health and safety insurance fund of KRW 22.5 trillion. In terms of the types of financial instruments, the financial worth is composed as follows: shares and investment fund stocks of KRW 477.0 trillion; debt security of KRW 274.7 trillion; cash and deposits of KRW 15.7 trillion won; and loans of KRW 8.9 trillion.

In other words, if the net debt calculated above, or the financial worth of the social security funds from the positional statement is deducted, it could be adjusted up to about 40% compared to the GDP. For reference, the result of a survey by OECD member state shows that the scale of financial worth held by the social security funds in most countries is 5% or less compared to the GDP. On the other hand, the scale of financial worth of the social security fund was large in the following countries: Finland (86.1%); Luxembourg (37.2%); Sweden (30.5%); and Canada (24.2%).

Table 13_ Status of financial worth held by social security funds in fiscal year 2019

(Unit: Billion won, % compared to GDP)

Type	National pension	Private school teachers pension	Employment insurance	Occupational health and safety insurance	Total
Cash and deposit	14,060	377	630	596	15,664
Debt security	268,921	5,784	-	-	274,706
Loan	5,074	2,551	367	937	8,929
Other accounts receivable	1,686	73	1,181	776	3,716
Share and investment fund stock	437,363	12,103	7,304	20,228	476,998
Derivatives	9	10	-	-	19
Total	727,114	20,898	9,483	22,537	780,032
(% compared to GDP)	37.9%	1.1%	0.5%	1.2%	40.6%

Source: Ministry of Economy and Finance, prepared by the author based on “2019 fiscal year national account data,” 2020.

⁹ Aggregated based on financial worth when calculating the net financial debt (add shares compared to financial worth, investment fund stocks, and derivatives when calculating the net debt).

Table 14_ Financial worth held by social security funds in OECD member states

(Unit: % compared to GDP)

Country	2014	2015	2016	2017	2018
Australia	3.83	4.03	4.07	4.14	4.21
Belgium	5.20	5.13	5.13	5.15	4.93
Canada	17.28	21.49	21.32	22.83	24.21
Czech Republic	0.89	0.81	0.96	1.15	1.41
Denmark	0.16	0.17	0.17	0.16	0.14
Estonia	4.26	4.29	4.18	4.19	4.19
Finland	86.50	88.62	90.09	93.75	86.10
France	15.43	15.54	15.72	16.21	15.17
Germany	4.20	4.19	4.36	4.67	5.02
Greece	11.29	11.37	11.90	13.68	14.27
Hungary	1.30	1.32	1.34	1.28	1.21
Iceland	1.60	1.55	1.94	1.31	1.40
Italy	4.94	5.08	5.21	5.37	5.54
Japan	45.85	43.97	45.45	47.13	
Latvia	2.28	2.39	2.31	2.56	3.26
Lithuania	1.63	1.93	2.02	1.70	2.42
Luxembourg	34.82	35.88	37.15	38.15	37.22
Netherlands	2.75	3.32	3.63	3.74	4.07
Poland	3.32	3.39	3.48	3.76	4.23
Portugal	10.27	10.54	10.72	11.82	
Slovakia	2.03	2.48	2.17	2.39	2.06
Slovenia	4.51	4.45	4.22	4.30	4.17
Spain	7.08	5.77	4.03	2.94	3.04
Sweden	32.67	30.79	31.97	32.50	30.48
Switzerland	6.29	6.19	6.30	6.54	5.86
Turkey	6.75	5.70	5.88	5.60	5.17

Source: IMF, <http://data.imf.org/?sk=E86E9088-3830-4CA3-B240-1B0EC5E15221>, date of search: 2021. 7. 5.

III. Summary and Policy Implications

1. Summary of key findings

A. Indicators of financial strength

As it is often misunderstood that key indicators related to state finances are clearly defined and that there is a single universal international standard, unnecessary and unproductive controversies may (and have) ensue from such misconceptions. For some basic indicators,

such as debt and liabilities, used in government accounting, there are indeed clear, universal definitions and standards for tabulation. Earlier we confirmed the fact that, even with indicators such as debt and liabilities, established in terms of accounting are similar, even under international standards, there are still divergences stemming from differences in originating motivation and thus it is impossible to directly compare them in a precise sense.

Specifically, there is a single standard, the PSDS, upon which nine international organizations have agreed as a government accounting standard. However, no country has formally adopted the PSDS as its official indicator. Indeed, the PSDS is not yet binding, nor is it used as a reference in defining and adopting an official indicator. In other words, each country currently prescribes its own exceptions to the “international standards” in its official indicators. Since these exceptions differ from country to country, they cannot be compared in a simple manner. In particular, the state accounting standard is typically stated in a relatively complicated way, compared to other standards, such as financial indicators, macro statistics indicators, etc. Thus, there have been unnecessary and wasteful controversies over the standards or indicators used in Korea.

As stated above, some indicators are not well defined and there are other indicators having similar terms but different definitions. In addition, indicators are subject to continuous changes due to the following reasons. When measuring a financial situation by applying an indicator, it not only improves the accuracy of measurement but also induces the target entity to which it is applied (government, in our case) to change its behavior. In such cases, the result of the measurement may be interpreted in a manner that is quite different from the original intention. Thus, a new supplementary indicator may be suggested in light of such facts. In other words, the indicator itself may be supplemented or modified in response to resolving such side effects.

Were a specific standard of the past be strictly followed, a side effect would be that it would become harder and harder to guarantee that the soundness of state finances is accurately presented. The principles and standards followed in the development of indicators have subsequently evolved into a comprehensive and abstract form in an attempt to control the same. However, such principles and standards also created additional uncertainties and distortions due to side effects that undermine the intent to improve indicators. For example, as a principle of accrual basis is reinforced, it could be improved to reflect a future event that is necessary to determine the financial soundness. However, it may be more likely to be paradoxically encourage errors or distortions, because assumptions and estimates that cannot be objectively confirmed are often introduced in such a process, such as when setting of

discount rate required to calculate indicators, long term forecasts of the population, and other factors.

Based on such reasons, in 2015 the IMF pointed out that no international government accounting indicator has been produced under the strictly same standards, and that it is even difficult for a single country to produce its own government accounting indicators under consistent standards, including time series that are medium-term or of longer duration. Thus, there is a need to construe and compare with other indicators or other countries, especially in light of the differences, descriptions, etc. of all financial indicators explained in this report.

2. Assessment and policy proposal

The results of the review of Korea's financial soundness indicators (D1, D2, and D3) are as follows: Even in light of the limitations of these indicators in relation to international comparisons, as stated above, it may be deemed that the gross debt or gross obligation indicators of Korea are relatively exemplary in terms of aggregation and reporting, compared to other countries. In particular, Korea's indicators are deemed to be reasonably accurate and compliant with international practice, for purposes of international comparison of numerical results compiled with the same standards and methods.

However, if the purpose of an indicator is not the accuracy of an international comparison but the determination of financial soundness, further attention should be paid to several matters. First, for purposes of international comparison, as explained above, indicators have been established and operated very well. However, the financial soundness should be further determined and reflected in terms of financial operation, in light of the idiosyncrasies of Korea in regard to non-financial public enterprises and social security funds.

Specifically, almost all indicators currently used or suggested for international comparison have been developed for general government. It is thus likely that these indicators may lead to Korea's financial soundness being miscalculated optimistically. Attention should be paid to the fact that, in most OECD member states, non-financial public enterprises not included in the general government are relatively small, whereas such sectors account for a substantial portion in Korea. In particular, since the financial burden of the government has often been criticized as having been passed on to the public sector, it would be unreasonable to determine the financial soundness or financial strength only based on the financial situation of the general government.

In addition, this report intended to point out another matter. Even where attention is

restricted to only the general government, it is necessary to determine the financial soundness or financial strength using the net debt or net liabilities that exclude claims and financial assets (stocks, etc.) held by the social security funds. In the case of the annual budget balance among fiscal indicators, the managed fiscal balance has been additionally adopted as a supplementary indicator. Similarly, in some cases, it may be considered to not only deduct the financial assets held but also accommodate considerations about even the future payments or burdens to cover which the currently accumulated assets are insufficient. In such cases, omitting claims or assets from the netting of debt or liability figures could possibly result in adjusting net debt or net financial worth up to a maximum of 40% of GDP. This is because of the sheer scale of financial assets held by the social security funds, including the national pension, etc., which is a matter warranting further deliberation.

The proposals stated above relate to the Korean government's accounting indicators that have been set with a focus on the current gross debt or obligation. They can be reinforced by adopting the net debt or other similar indicators in order to determine the debt repayment capability or the true financial soundness.

When it comes to the supplementation and revision of financial soundness indicators, the following bears emphasis: it is difficult to understand the government accounting standards; and even if the definitions of D1, D2, and D3 are internationally recognized as a relatively exemplary case, issues have been arisen from time to time due to misunderstandings thereof. Thus, there remains apprehension about triggering off additional unnecessary misunderstandings if one were to directly replace or revise D1, D2, and D3, which are the financial soundness indicators currently being used in the government accounting offices. Thus, it would be reasonable to avoid revising or replacing these key indicators. However, since the financial assets of non-financial public enterprises or social security funds may become a problem in the calculations of financial soundness, it would be an important endeavor to deliver such information accurately, perhaps in the form of supplementary indices.

In practice, when it comes to the fiscal information currently being announced, such information is being provided as a part of memorandum information or government accounting statistics. However, it is not being sufficiently explained as to how such information impacts the judgement or perception of financial soundness. Thus, this information is not fully meaningful, unless the nature of the indicators presented in this report can be properly or adequately explicated and thence understood.

In some cases, it would not be so different from the situation in which such additional information is not provided. Thus, it is important and urgent to explain the meaning of this

additional information and how the financial soundness could be determined based on this information, rather than settle for the present situation in which such additional information is simply being provided. For example, it would be important not to simply announce the memorandum information as it is done presently, but to explain the nature of the indicators, and to help readers sufficiently understand the memorandum information, and to then review financial soundness from various perspectives.

As a proactive approach, one may also consider going beyond simply supplementing the memorandum information to additionally introduce new, separate indicators and sufficiently explain their purpose and nature. Specifically, as in case of the managed fiscal balance, key indicators could be maintained as they are and supplementary indicators would then be added to help determine the financial soundness. In particular, it is recommended to devise an approach that reflects the debt status of non-financial public enterprises and excludes the financial assets of social security funds from the statistics.

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A Study on the Ethics of the Employees at Public Institutions

Sejeong Ha, Hanjun Park, and Yoon Jik Cho*

I. Introduction

A number of employees of public institutions have recently aroused social criticism, as it was found that they used information that was produced and to be used only within their institutions for use pertaining to their personal interests.

Where public institutions that enforce the government policy in an exclusive way can lose public trust due to corruption, the government can potentially lose an important means to promote important policies, resulting in public services not being provided for the people without troubles.

Thus, there is a need to reinforce employees' ethics in order to eradicate corruption, promote ethical behaviors, and to then design a monitoring system based thereon. Ideally, it would be desirable to eradicate the source of corruption within institutions by securing employees with high ethics through a system to select, train, and reward them. In addition, it would be possible to prevent corruption within institutions by inducing employees to act ethically and to establish a system to uncover instances of corruption—if any—quickly.

To devise policy measures, it is necessary to first determine factors that have an effect on

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the ethics of employees of public institutions, improve employee ethics by managing these factors, and to devise measures with which the employees could control corruption by themselves. In addition, there is a need to determine factors, such as whistle-blowers, etc., that have an effect on the prevention of corruption within institutions and to then present measures for managing the factors.

The first purpose of this study is to measure how each employee of public institutions evaluates their level of ethics and to thus measure how much they intend to contribute or cooperate with the ethical decision-making process and the prevention of corruption within institutions. For this task, this study presents a series of ethical conflicts and then asked how employees made decisions thereon.

To identify factors that have an effect on the ethics of employees in public institutions and governments, this study systematically categorizes such factors and identifies them by type by analyzing preceding research and consulting with experts. Moreover, this study will elucidate, through regression analyses, etc., how the factors so identified generally affect the decisions of respondents with respect to ethical conflicts.

II . Theoretical Arguments

1. Concept of ethics

Ethics is defined lexically as the morality that shall be performed or followed righteously as a human being. It may be deemed that the ethics of employees in public institutions fall under the realm of professional ethics, a concept of ethics as the basis for morality that shall be followed in a process to perform a given duty.

Yoo Ji-yeong (2014: 33) deems that the ethical level required for employees of public institutions is perceived as being similar to a level required for public officials, and that the scope and level of ethics required for public officials are identical to the scope and level required for employees of public institutions based on the reality in which a level almost identical is applied to those two groups in terms of external audits, etc. This study regards that such an argument is persuasive.

Yoo Ji-yeong (2014: 41) argues that the ethics necessary for employees of public institutions shall include not only the intent to maintain integrity but also the intent to perform their duties in an active and fair manner. It seems that such ethics are essential in order to

provide high-level public services in an efficient way.

Previous research has a common inclusion of the ethics of integrity, which is thus recognized as essential for service. This study also focuses on the corruption of employees in public institutions, such as the pursuit of private interests, etc., and thus will discuss the ethics of integrity among the realm of professional ethics.

2. Factors having an effect on ethics

Factors affecting ethics have not been established theoretically. Preceding researchers have conducted the following: to identify factors by thinking intuitively and examining inductively, and to analyze empirically whether such factors actually have had an effect and what the direction of such effects would be. Accordingly, these researches presented different factors affecting ethics that have deviated to a certain degree.

A substantial amount of research classifies factors affecting the ethics into internal and external characteristics, with a focus on each public official or employee of a public institution. The former refers to individual characteristics and the latter may be regarded as the environmental characteristics surrounding an individual. Individual characteristics may be further classified into demographic characteristics, such as gender, age, etc., and job-related characteristics, such as job motivation, experience of ethical decision-making in a workplace, etc. On the other hand, the environmental characteristics may be classified into internal and external characteristics of an institution. The external characteristics of an institution may be regarded as the social atmosphere for integrity. That said, the internal characteristics of institution can be further divided into the integrity-related system (audit, integrity reward, punishment against corruption, etc.) and the culture or atmosphere (peer influence, ethical atmosphere in institution, ethical leadership of superior, etc.).

Table 1 Factors affecting the ethics of public officials

High level	Intermediate level	Low level
Individual characteristics	Demographic characteristics	Gender, age, etc.
	Job-related characteristics	Job motivation, experience of ethical decision-making within a workplace
External environmental characteristics	Internal characteristics of institution	Integrity-related system (audit, integrity reward, punishment against corruption, etc.)
		Integrity-related culture or atmosphere (peer influence, ethical atmosphere in institution, ethical leadership of superior, etc.)
	External characteristics of institution	Integrity-related social atmosphere, the people's level of awareness of integrity, etc.

Source: Written by Author.

III. Study Design

1. Study model

A. Dependent variable: Ethics

This study will proceed with a discussion by focusing on the integrity ethics of employees of public institutions. As shown by the recent deviant behavior from employees of public institution, where such employees violated the integrity ethics, and where such violation evokes public indignation and requiring the government to respond thereto. This is because it is intuitive to determine whether the integrity ethics are violated. Thus, it is urgently required to conduct a study thereon.

B. Independent variable: Factors having an effect on ethics

The following factors have an effect on the ethics and level of corruption prevention acts, and will be examined accordingly: 1) individual level (motivation for public service, individual characteristics); 2) institutional level (audit, whistle-blow, ethical training); and 3) institutional culture level (merit system, institutional politics, authoritarianism).

1) Individual level

It has been determined that the motivation for public service, from among individual characteristics, has the most significant effect on the ethics. It seems reasonable to anticipate that, where the motivation for public service reveals an altruistic mind to serve others or pursue a public interest, a person with such strong mentality and attitude whether inherently or acquired would have a high level of integrity ethics. In addition, it is required to control, as independent variables, the following: demographic characteristics, such as age, gender, etc.; and position, rewards, duty field, etc.

2) Institutional level

It is expected that the existence of a system that uncovers, suppresses, or punishes corruption, and a level of effectiveness thereof, would have an effect on the effort or manner of eliminating corruption. In addition, the understanding or experience, direct or indirect, of

the laws based on which an internal punishment is imposed (e.g., Improper Solicitation and Graft Act, etc.) could have a positive effect on the displayed ethics.

Moreover, if a system in which any corruption can be reported with no repercussions is established, and a system in which the identity of a whistle-blower is protected is designed and operated efficiently, it is likely that an ethical decision would be made desirably in a conflict related to corruption committed by others within an institution.

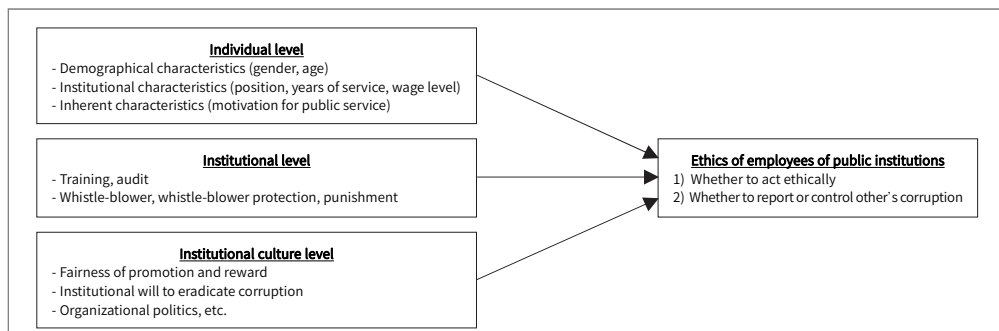
3) Institutional culture level

Since a system that suppresses or punishes corruption is ultimately operated by people, it is necessary to support the system with an institutional culture in order to operate the system in an effective way. As to the institutional culture related to corruption, the following may be taken into consideration: the integrity culture of an institution in general; institutional will to eradicate corruption; how to report corruption within an institution; friendly institutional atmosphere for whistle-blowers; fairness of promotions and rewards; organizational politics, etc.

C. Analysis model

A relation between factors that have an effect on the ethics as stated and the ethics of employees of public institutions can be illustrated as an analysis framework, as shown in Fig. 1.

Figure 1_ Framework for analysis of factors affecting ethics of employees of public institutions



Source: Written by Author.

2. Definition of variables

A. Experimental survey used to measure ethics

This study will, through an experimental survey, measure how the employees of public institutions would make ethical decisions in a hypothetical situation in which corruption, such as false business trips, embezzlement, corruption in personnel policies, corruption in contract examinations, etc., could be committed.

As cases in which a respondent shall make a decision in a direct ethical conflict, the following five violations of the integrity ethics were selected: 1) false business trip; 2) unapproved additional position; 3) improper solicitation in relation to a third party; 4) corruption in promotion examination; and 5) corruption in contract examination.

Table 2_ Questionnaire items on selection of one's own corrupt acts

Type	Details of experimental survey
False business trip	<p>You feel so tired, because you have worked overtime at night for several days together with your coworkers. Your coworker proposed that you apply for a business trip and take a rest at the destination of the business trip.</p> <p>Would you go on a business trip with your coworker? 1. Yes, 2. No</p>
Unapproved additional position (YouTube)	<p>You open a YouTube channel for cooking, which you had previously done for fun, to earn a little additional income. However, you found out later that you should have obtained your company's approval for opening and operating the YouTube channel. However, you might not obtain the approval and be submitted to disciplinary measures due to your unapproved acts in YouTube. Since you recorded the YouTube videos with your face covered, the company has not known the fact that you have a YouTube channel.</p> <p>What would you do? 1. Inform the company of such facts and continue to do YouTube videos. 2. Check how to obtain approval for an additional position. If it seems difficult to obtain the approval, continue to do YouTube without approval. 3. Do not inform the company of such facts and discontinue to record YouTube videos. 4. File an application for an additional position without delay, and submit to the company's decision, including disciplinary measures, etc. 5. Others ().</p>
Improper solicitation in relation to third party	<p>You work on the Facility Management Team. This Team is also entrusted with the operation of an in-house store. Since the existing contract was recently terminated, a new operator will be selected. The entrusted operator would make a profit of 50 million won every year.</p> <p>The entrusted operator is selected by examining applicants through an open competitive bid. The leader of the Team and external panel appointed by the leader would examine the applicants.</p> <p>Your cousin who saw the public announcement of the selection of a new operator contacted you that they want to operate the in-house store. Since you have been very close to the leader, your cousin is likely to receive high scores in the examination, provided that you ask the leader of a favor for your cousin.</p> <p>Would you ask the leader of Team of a favor for your cousin? 1. Yes, 2. No</p>

Table 2_ Questionnaire items on selection of one's own corrupt acts(continued)

Type	Details of experimental survey
Corruption in promotion examination	<p>You, as a middle manager of your company, shall determine 1 out of 5 subordinate candidates in the regular personnel reshuffle in Fall 2021. Your superior has told you several times to promote A, who had gone to the same university with them. However, A does not have strong points compared to other candidates.</p> <p>Would you promote A? 1. Yes, 2. No</p>
Corruption in contract examination	<p>You work in a contracting department. Your company will replace about 30% of all computers in the near future and five suppliers made tended bids. You will select, through a documentary examination, three suppliers which then will be submitted to a 2nd examination. Your superior has praised several times Supplier A, to which they had usually been close. It seems that it is strongly implied to have Supplier A pass the documentary examination. However, Supplier A has poor reputation in terms of A/S quality and customer service.</p> <p>Would you have Supplier A pass the documentary examination? 1. Yes, 2. No</p>

Source: Written by Author.

As cases in which a respondent shall make a decision whether to file a report after perceiving corruption within a company, the following six violations of integrity ethics were selected: 1) false business trip; 2) unapproved additional position; 3) pursuit of private interests with inside information; 4) corruption in promotion examination; 5) corruption in contract examination; and 6) embezzlement. It was designed that a respondent shall provide an answer to each case, as to whether to report or not the corruption of their coworker that they became to know.

Table 3_ Questionnaire items on reporting of corrupt acts by co-workers

Type	Details of experimental survey
False business trip	<p>Your coworker who joined a company at the same time as you complained that they felt so tired, because they had worked overtime at night for several days. They went on a business trip early in the morning to have a discussion with a customer and did not return to the office for the rest of the day. A few days later, you found out, while talking over the telephone, that they just visited, on the date of business trip, the client without special business and then left a little later.</p> <p>Would you inform such fact to the company in some way? 1. Yes, 2. No</p>
Unapproved additional position (YouTube)	<p>You came to know the fact that your coworker operated a YouTube channel for cooking. Even if their face was not shown, you could identify them as the person, due to their clothes, voice, interest in cooking, etc. However, no application has been filed for an additional position to record these YouTube videos. It would be safe for them to obtain approval for additional position. However, they may not obtain such approval, even if they apply for the additional position. In addition, they may be submitted to disciplinary measures due to their activities in YouTube that had been recorded so far.</p> <p>Would you inform such fact to the company in some way? 1. Yes, 2. No</p>
Pursuit of private interests with inside information	<p>You work in the purchase contract department. This department, early in the year, collects demands for materials or external services expected in the year from business departments and then establishes an annual contracting plan. This plan details articles to be purchased, qualifications of suppliers, contracting schedule, etc. You came to know by chance that an ex-coworker who recently retired invested a small amount of money in a supplier under someone else's name and provided a part of the plan to the supplier.</p> <p>Would you inform such fact to the company in some way? 1. Yes, 2. No</p>
Corruption in promotion examination	<p>Manager A, who is your coworker, promoted Employee B out of 5 subordinates in the regular personnel reshuffle in Fall 2021. However, the company evaluated that Employee B was behind the other competitors. Recently, while you had a meal with Employee B, you came to know the fact that their father was a close friend of Manager A and asked them to go easy on them in the promotion examination.</p> <p>Would you inform such fact to the company in some way? 1. Yes, 2. No</p>
Corruption in contract examination	<p>You work in the contracting department. Your company will replace about 30% of all computers in the near future and five suppliers have tended bids. Your coworker selected, through documentary examination, three suppliers. However, Supplier A, which is one of the three selected suppliers, has a reputation in terms of poor A/S quality and customer service that is worse than the reputation of two eliminated suppliers. Ultimately, you came to know the unfair close relationship between your coworker and Supplier A.</p> <p>Would you inform such fact to the company in some way? 1. Yes, 2. No</p>
Embezzlement	<p>You came to know the fact, through a documentary examination, that your coworker falsely drafted a disbursement document and embezzled 3 million won. The company evaluated this coworker as being sincere and competent. If the embezzlement is known to the company, the coworker would be eliminated from the promotion examination and submitted to severe disciplinary action. Only you know about the coworker's embezzlement.</p> <p>Would you inform such fact to the company in some way? 1. Yes, 2. No</p>

Source: Written by Author.

B. Factors having an effect on the ethics

Based on preceding research, factors identified as having an effect on ethics, etc. are classified into: 1) individual factors, 2) corruption-related institutional factors, and 3) institutional culture factors.

1) Individual level

As to the motivation for public service, five survey questions used in Kim et al. (2013: 92) were selected and used. Specifically, the following were asked: desire for public service; resolution of social problems; consideration for future generations; sympathy; and spirit of sacrifice.

Table 4 _Questionnaire items on motivation for public service

Type	Survey question
Motivation for public service	Public service is meaningful to me.
	I want to actively participate in the resolution of social problems.
	It is important to consider an interest for future generations, when establishing a public policy.
	I feel sorry for people having difficult situations.
	I am ready to sacrifice myself for public interest.

Source: Kim et al. (2013), p. 92.

It is expected that the following would contribute to the prevention of committing corruption or to the reporting of corruption committed by others: satisfaction with remuneration, promotion, duty, etc.; or a sense of belonging or loyalty to the organization. Thus, this study further investigated these factors.

Table 5 _Questionnaire items on satisfaction and belonging to organization

Type	Survey question
Sense of satisfaction and belonging to organization	I am satisfied with my remuneration.
	I am satisfied with my promotions to date.
	I am satisfied with my job.
	I feel a strong sense of belonging to my company.
	I do not feel obliged to continue to belong to my company.
	My company deserves my loyalty.

Source: Written by Author.

This study investigated external factors, such as promotion, monetary rewards, etc., with which an individual may be motivated in job and life within an organization. Extrinsic motivation was measured using three detailed factors: motivation, annual salary, and recognition from colleagues.

Table 6_ Questionnaire items on extrinsic motivation

Type	Survey question
Extrinsic motivation	Receiving a promotion is one of the important reasons for why I work.
	An annual salary increase is one of the important factors for why I work.
	I strongly desire to be recognized by others.

Source: Written by Author.

2) Institutional level

This study investigated how respondents perceive the existence and effectiveness of measures the institution adopted to eradicate corruption within the organization in terms of institutional level.

Table 7_ Questionnaire items on anti-corruption training

Type	Survey question
Training on corruption	My company frequently trains employees on corruption avoidance.
	My company encourages all to participate in anti-corruption training.

Source: Written by Author.

The following were investigated through the awareness of respondents: whether a whistle-blower system is established as a means to eradicate corruption; and how actively public institutions use such a system.

Table 8_ Questionnaire items on reporting of corruptive acts

Type	Survey question
Encouragement of reporting of corruption	My company frequently promotes and explains to employees how to report corruption.
	My company encourages employees to report corruption.

Source: Written by Author.

If the identity of a whistle-blower is protected and reported corruption is handled in a fair and transparent way, it is highly likely for an individual to report corruption, if witnessed. Thus, this study investigated, through the awareness of respondents, whether a process to handle corruption is operated reasonably in terms of the protection of anonymity of the whistle-blower.

Table 9_ Questionnaire items on reliability of handling of corrupt acts

Type	Survey question
Reliability of handling of corruption	I believe that my company would protect the anonymity of a whistle-blower.
	I trust in the process with which my company handles a report of corruption.

Source: Written by Author.

If an individual does not expect that an organization would punish a person who commits corruption, they would not report the corruption for public interest. It is expected that, if any corruption is severely punished, an individual would not commit corruption or that an individual would report other's corruption. Thus, this study investigated, through the awareness of respondents, whether public institutions impose punishment in terms of monetary interest and personnel affairs.

Table 10_ Questionnaire items on level of punishment against corrupt acts

Type	Survey question
Level of punishment against corruption	My company would impose a sufficient disadvantage in terms of personnel affairs on a person who commits corruption.
	My company would impose a sufficient monetary disadvantage on a person who commits corruption.

Source: Written by Author

It is expected that, if an organization frequently conducts internal and external audits and that any internal corruption is often discovered, an individual is not likely to commit corruption. Thus, this study investigated, through the awareness of respondents, the frequency and effectiveness of internal and external audits.

Table 11_ Questionnaire items on effectiveness of audits

Type	Survey question
Effectiveness of audits	It seems that my company conducts internal audits too often.
	It seems that my company is frequently subjected to external audits.

Source: Written by Author.

3) Institutional culture level

As factors having an effect on ethics in terms of institutional culture, this study investigated the positiveness of response to corruption, fairness of evaluation and promotion within institution, and degree of organizational politics.

It is expected that, the stronger an institution is against corruption, the more an individual would not be motivated to commit corruption. Thus, this study investigated the will to respond to corruption by a member of the institution.

Table 12_ Questionnaire items on institutional culture against corruption

Type	Survey question
Institutional culture against corruption	The CEO of my company would actively respond to reports of corruption.
	My immediate supervisor would actively respond to reports of corruption.
	Employees of my company would actively respond to reports of corruption.

Source: Written by Author.

It is expected that the fairness of personnel affairs, such as promotions, performance evaluations, placement, etc. would weaken an individual's motivation to prevent corruption.

Table 13_ Questionnaire items on fairness of personnel affairs

Type	Survey question
Fairness of personnel affairs	Employees of my company are promoted in a fair manner.
	The performance of employees is fairly evaluated in my company.
	Personnel affairs, such as promotions, performance evaluations, placements, etc. are fairly rendered in my company.

Source: Written by Author.

The severity of organizational politics in public institutions may also have an effect on whether an individual directly commits or neglect corruption, if any.

Table 14_ Questionnaire items on organizational politics

Type	Survey question
Organizational politics	In my company, the tie in terms of school and territory is very influential.
	In my company, personal connections are very influential.

Source: Written by Author.

IV. Factors having an effect on ethical decision-making

This chapter will examine individual characteristics, institutional characteristics, and institutional culture characteristics that have an effect on the following: the level of ethics of employees in public institutions; and the ethical decision-making made by such employees.

1. The ethics of employees in public institutions

In general, most survey respondents have made ethical decisions, though some respondents still made unethical decisions. Thus, it could be known that the ratio of ethical decision-making differs depending on the significance of a matter, as recognized by the respondents. Overall, the more respondents that recognize a matter as corruption could inflict a direct loss to a company, the less they respond that they would make unethical decisions.

When comparing employees of public institutions with those of private companies, the former tended to make relatively better ethical decisions. It could be inferred that the more employees of private companies perceive a matter as severe corruption, the more they make the correct ethical choice.

Table 15_ Proportion of corrupt acts

Type of corruption	Public institutions	Private companies	Difference
False business trip	45.1	51.8	-6.7
Unapproved additional position	19.0	37.2	-18.2
Third-party related improper solicitation	10.9	26.4	-15.5
Corruption in promotion examination	9.1	16.6	-7.5
Corruption in contract examination	8.5	12.1	-3.6

Source: Written by Author.

Proportions of respondents who answered to report were different depending on the type of corruption. The proportion of respondents who selected to report is relatively low in cases that are recognized as relatively minor corruption, such as false business trips, unapproved additional positions, etc., as cases in which a respondent is directly involved in corruption. Overall, less than 50% of respondents answered to report those two types of corruption. However, as to serious corruption, such as corruption in contract examination and embezzlement, a relatively high proportion, close to 80% of employees in private companies and public institutions answered to report.

In many cases, employees of public institutions and private companies did not show a big difference in the decision not to report others' corruption. Out of the six types of corruption, employees of the two types of institutions displayed a difference in three types of corruption, such as unapproved additional positions, pursuit of private interests with inside information, and corruption in promotion examinations. It is inferred that this is because employees of public institutions evade corruption in which they are directly involved, but respond to the reporting of others' corruption relatively passively.

Table 16 Proportion of reporting of corrupt acts

Type of corruption	Public institutions	Private companies	Difference
False business trip	34.4	30.6	3.8
Unapproved additional position	42.7	36.5	6.2
Pursuit of private interest with inside information	70.8	64.2	6.6
Corruption in promotion examination	65.4	55.7	9.7
Corruption in contract examination	81.4	78.8	2.6
Embezzlement	81.0	76.5	4.5

Source: Written by Author.

In summary, employees of public institutions tended to make more ethical decisions compared to employees of private companies. However, such a difference was more prominent in cases in which they are personally involved. Notably, this difference was not statistically meaningful in cases where they report others' corruption.

Table 17_ Proportion of ethical acts by employees of public institutions

Type of corruption	Evasion of corruption	Reporting of corruption	Difference
False business trip	54.9	34.4	20.5
Unapproved additional position	81.0	42.7	38.3
Corruption in promotion examination	90.9	65.4	25.5
Corruption in contract examination	91.5	81.4	10.1

Source: Written by Author.

2. Cases in which employees are directly involved in corruption

A. Hypothesis about factors having an effect

This study intends to propose relevant hypotheses, by dividing factors having an effect on whether to select corruption in a situation to be able to be involved in corruption in terms of the integrity ethics into three types: individual level, institutional level, and institutional culture level.

1) Individual level factors

Hypothesis 1: The more employees of public institutions are motivated to provide public service, the less they are likely to commit corruption.

Hypothesis 2: An employee with high satisfaction and sense of belonging to an institution is less likely to commit corruption.

Hypothesis 3: An employee with high extrinsic motivation is less likely to commit corruption.

2) Institutional level factors

Hypothesis 4: The more public institutions actively provide anti-corruption training and encourage employees to participate therein, the less employees of public institutions are likely to commit corruption.

Hypothesis 5: The more public institutions conduct internal and external audits, the less employees of public institutions are likely to commit corruption.

Hypothesis 6: The more public institutions handle any report of corruption fairly, the less employees of public institutions are likely to commit corruption.

Hypothesis 7: The more punishment against corruption is appropriate, the less employees are likely to commit corruption.

3) Institutional culture level factors

Hypothesis 8: The more public institutions are against corruption, the less their employees are likely to commit corruption.

Hypothesis 9: The more personnel affairs are handled fairly, the less employees of public institutions are likely to commit corruption.

Hypothesis 10: The more public institutions engage in organizational politics, the more their employees are likely to commit corruption.

B. Major variables

1) Major variables

Based on the above hypotheses, the independent variables were set as follows: individual factors (① motivation for public service, ② satisfaction and belonging to institution, ③ extrinsic motivation); institutional factors (① anti-corruption training, ② punishment against corruption, ③ effectiveness of audits, ④ reliability on procedures for handling of corruption); and institutional culture factors (① atmosphere against corruption, ② fairness of personnel affairs, ③ organizational politics).

This study adopted a method to create a single variable corresponding to the nature of relevant variables by combining independent variables with high correlations through a factor analysis and to then control the single variable as an independent variable.

2) Selection and measurement of variables

The group of variables used in this study is classified into individual level, institutional level, and institutional culture level. This study first selected measurement tools that measure the same concept at each level, and then verified whether these measurement tools distinguish different variables through a factor analysis. Where it was verified that the different variables are distinguished at each level, factor scores were then calculated in order to obtain a value for each variable, and this value was used for the regression analysis. The summary statistics for each variable, such as dependent variable, etc. are as stated in Table 18.

Table 18_Summary statistics

	Variable name	Sample count	Average	Standard deviation	Minimum value	Maximum value
Dependent variable	False business trip	506	0.451	0.498	0	1
	Unapproved additional position	500	0.192	0.394	0	1
	Third-party solicitation	506	0.109	0.312	0	1
	Corruption in promotion examination	506	0.091	0.288	0	1
	Corruption in contract examination	506	0.085	0.279	0	1
Individual level	Motivation for public service	506	0.136	0.858	-3.437	2.016
	Belonging and satisfaction	506	0.028	0.912	-3.050	1.816
	Extrinsic motivation	506	-0.028	0.724	-3.393	1.941
Institutional level	Positiveness in anti-corruption training	506	0.399	0.712	-2.392	2.198
	Appropriateness in punishment	506	-0.043	0.917	-2.641	1.974
	Audit frequency	506	0.117	0.666	-2.515	2.023
	Appropriateness of handling	506	0.010	0.932	-2.670	1.984
Institutional culture level	Anti-corruption culture	506	0.173	0.879	-2.663	2.288
	Fairness in personnel affairs	506	-0.077	0.938	-2.821	1.984
	Organizational politics	506	0.016	0.860	-2.252	2.090
Gender	Male	506	0.504	0.500	0	1
	Female	506	0.496	0.500	0	1
Age	20s	506	0.055	0.229	0	1
	30s	506	0.302	0.460	0	1
	40s	506	0.375	0.485	0	1
	50s	506	0.243	0.429	0	1
	60s	506	0.024	0.152	0	1
Highest level of education	High school graduate or lower	506	0.038	0.190	0	1
	Junior college graduate	506	0.089	0.285	0	1
	College graduate	506	0.593	0.492	0	1
	Graduate school	506	0.281	0.450	0	1
Position	Staff and assistant manager	506	0.506	0.500	0	1
	Manager and deputy manager	506	0.370	0.483	0	1
	Senior manager	506	0.105	0.307	0	1
	General manager	506	0.020	0.139	0	1
Contract business	Yes	506	0.166	0.372	0	1

Table 18_Summary statistics(continued)

	Variable name	Sample count	Average	Standard deviation	Minimum value	Maximum value
Annual salary	< 30,000,000 won	506	0.109	0.312	0	1
	> 30,000,000 won – < 50,000,000 won	506	0.336	0.473	0	1
	> 50,000,000 won – < 70,000,000 won	506	0.265	0.442	0	1
	> 70,000,000 won – < 100,000,000 won	506	0.217	0.413	0	1
	> 100,000,000 won	506	0.073	0.261	0	1
Type of institution	Public institution	506	0.328	0.470	0	1
	Semi-government agency	506	0.267	0.443	0	1
	Other public institution	506	0.405	0.491	0	1
Scale of personnel	Less than 200 employees	506	0.156	0.363	0	1
	> 200 employees – < 500 employees	506	0.138	0.346	0	1
	> 500 employees – < 1,000 employees	506	0.107	0.309	0	1
	> 1,000 employees – < 5,000 employees	506	0.281	0.450	0	1
	> 5,000 employees	506	0.318	0.466	0	1
Type of industry	Energy	506	0.142	0.350	0	1
	Finances	506	0.030	0.170	0	1
	Employment welfare	506	0.128	0.335	0	1
Type of industry	Education research	506	0.176	0.381	0	1
	Industry	506	0.055	0.229	0	1
	Public safety	506	0.099	0.299	0	1
	SOC	506	0.091	0.288	0	1
	Culture	506	0.061	0.240	0	1
	Others	506	0.217	0.413	0	1

Source: Written by Author.

C. Analysis findings

In general, the motivation for public service was found to be negatively correlated with the selection of the five types of corruption. However, it was deemed statistically meaningful in cases in which dependent variables included an unapproved additional position or corruption in the contract examination.

The sense of belonging to and satisfaction towards the institution were seen to be small in terms of the size of the coefficient, had no tendency in the direction, and had no cases that were statistically significant.

The extrinsic motivation showed a positive correlation with all five cases. However, among them, only false business trip and improper solicitation from a third party were statistically meaningful in terms of traditional criteria. As presented by the hypotheses, it can thus be concluded that it is difficult to confirm the fact that a person with strong extrinsic motivation evades corruption due to apprehension of the loss of such motivation. The findings of this analysis show that some corruption has a positive correlation seem to be in accordance with the inference that a person with strong extrinsic motivation can make unethical selection in terms of the means or process in pursuit of a result favorable to themselves in a situation in which the motivation for public service is controlled.

In an institutional level, a public institution's positiveness for anti-corruption training showed a negative correlation with types of corruption in a highly coherent way. A relatively high correlation was shown in false business trip, unapproved additional position, improper solicitation from a third party, and corruption in the promotion examination. However, in terms of corruption in contract examination it was not deemed to be statistically significant. The false business trip, unapproved additional position, etc. showed a negative correlation with not only the positiveness for anti-corruption training but also many institutional level variables, such as appropriateness of punishment, frequency of audits, reliability of the handling process, etc. Such a finding implies the fact that the institutional measures to suppress corruption are in fact effective.

The variable of organizational politics, among variables of the institutional culture level, showed a highly coherent positive correlation. This means that the decision-making based on school ties, regionalism, and intimacy could have an individual consider the formation or maintenance of private relations to be more important than the compliance with norms, such as ethics, procedures, etc. Thus, the individual could even come to commit corruption. As a result, it seems necessary to take measures to resolve such organizational politics in order to create an ethical foundation.

Unlike what was presented in the hypotheses related to anti-corruption culture, the hypotheses are not correlated, or are even contradictory, to the most selection of corruption. This is because the anti-corruption culture has an indirect effect on corruption by having an institution establish and reinforce its anti-corruption system. It seems that they do not have an independent effect, however, when they are included into the regression analysis model together with the variables of institutional level.

Table 19_ Findings of analysis of major corrupt acts

Variable name	(1) False business trip	(2) Unapproved additional position	(3) Solicitation for a third party	(4) Corruption in promotion examination	(5) Corruption in contract examination
Motivation for public service	0.028	-0.436**	-0.042	-0.050	-0.564**
Belonging and satisfaction	0.113	0.144	-0.171	0.419	-0.020
Extrinsic motivation	0.391**	0.173	0.394*	0.094	0.033
Positiveness of anti-corruption training	-0.581***	-0.721***	-1.042***	-0.674**	-0.294
Appropriateness of punishment	-0.157	-0.311*	-0.210	-0.211	-0.305
Audit frequency	-0.443***	-0.257	-0.307	-0.140	-0.272
Reliability of handling process	-0.384**	-0.445**	-0.321	-0.481	0.237
Anti-corruption culture	0.314*	0.152	0.175	-0.351	-0.360
Fairness of personnel affairs	0.283*	0.064	0.080	0.376	0.269
Organizational politics	0.137	0.508*	0.499**	0.488*	0.894*

Note: ***($p < 0.01$), **($p < 0.05$), *($p < 0.1$)

Source: Written by Author.

2. Cases of corruption whistle-blowers

A. Hypothesis about factors having an effect

This study intends to propose relevant hypotheses by dividing factors having an effect on whether an employee reports witnessed corruption into 3 types: individual level, institutional level, and institutional culture level.

1) Individual level factors

Hypothesis 1: The more an employee is motivated for public service, the more they are likely to report corruption

Hypothesis 2: An employee with high satisfaction and sense of belonging to an institution is more likely to report others' corruption.

2) Institutional level factors

Hypothesis 3: The more public institutions actively provide anti-corruption training and encourage employees to participate therein, the more employees of public

institutions are likely to report corruption.

Hypothesis 4: The more public institutions encourage their employees to report corruption, the more employees are likely to report any instances of corruption.

Hypothesis 5: The more public institutions handle any report of corruption in a transparent and reliable manner, the more their employees are likely to report others' corruption.

Hypothesis 6: The more public institutions punish corruption sufficiently, the more their employees are likely to report others' corruption.

3) Institutional culture level factors

Hypothesis 7: The more public institutions are against corruption, the more their employees are likely to report corruption.

Hypothesis 8: The greater the organizational politics in public institutions, the more their employees are likely to report corruption.

Hypothesis 9: The more institutions handle personnel affairs fairly, the more their employees are likely to report corruption.

B. Major variables

The independent variables were set as follows: individual factors (1) motivation for public service, 2) satisfaction and belonging to institution); institutional factors (1) anti-corruption training, 2) encouragement of report of corruption, 3) reporting of corruption and reliability thereon, 4) punishment against corruption); and institutional culture factors (1) atmosphere against corruption, 2) organizational politics). The summary statistics for each variable, such as dependent variable, etc. are as stated in Table 20.

Table 20_Summary statistics

	Variable name	Sample count	Average	Standard deviation	Minimum value	Maximum value
Dependent variables	False business trip	506	0.344	0.475	0	1
	Unapproved additional position	506	0.427	0.495	0	1
	Corruption in promotion examination	506	0.654	0.476	0	1
	Pursuit of private interest with inside information	506	0.708	0.455	0	1
	Embezzlement	506	0.810	0.392	0	1
	Corruption in contract examination	506	0.814	0.389	0	1
Individual level	Motivation for public service	506	0.136	0.858	-3.437	2.016
	Belonging and satisfaction	506	0.028	0.912	-3.050	1.816
Institutional level	Positiveness of anti-corruption training	506	0.399	0.712	-2.392	2.198
	Positiveness of encouragement in reporting of corruption	506	0.003	0.503	-1.882	2.000
	Reliability in handling of report of corruption	506	0.010	0.932	-2.670	1.984
	Appropriateness of punishment	506	-0.043	0.917	-2.641	1.974
Institutional culture level	Anti-corruption culture	506	0.173	0.879	-2.663	2.288
	Fairness in personnel affairs	506	-0.077	0.938	-2.821	1.984
	Organizational politics	506	0.016	0.860	-2.252	2.090
Gender	Male	506	0.504	0.500	0	1
	Female	506	0.496	0.500	0	1
Age	20s	506	0.055	0.229	0	1
	30s	506	0.302	0.460	0	1
	40s	506	0.375	0.485	0	1
	50s	506	0.243	0.429	0	1
	60s	506	0.024	0.152	0	1
Highest level of education	High school graduate or lower	506	0.038	0.190	0	1
	Junior college graduate	506	0.089	0.285	0	1
	College graduate	506	0.593	0.492	0	1
	Graduate school	506	0.281	0.450	0	1
Position	Staff and assistant manager	506	0.506	0.500	0	1
	Manager and deputy manager	506	0.370	0.483	0	1
	Senior manager	506	0.105	0.307	0	1
	General manager	506	0.020	0.139	0	1

Table 20_Summary statistics(continued)

Variable name		Sample count	Average	Standard deviation	Minimum value	Maximum value
Contract business	Yes	506	0.166	0.372	0	1
Annual salary	< 30,000,000 won	506	0.109	0.312	0	1
	> 30,000,000 won – < 50,000,000 won	506	0.336	0.473	0	1
	> 50,000,000 won – < 70,000,000 won	506	0.265	0.442	0	1
	> 70,000,000 won – < 100,000,000 won	506	0.217	0.413	0	1
	> 100,000,000 won	506	0.073	0.261	0	1
Type of institution	Public institution	506	0.328	0.470	0	1
	Semi-government agency	506	0.267	0.443	0	1
	Other public institution	506	0.405	0.491	0	1
Scale of personnel	< 200 employees	506	0.156	0.363	0	1
	> 200 employees – < 500 employees	506	0.138	0.346	0	1
	> 500 employees – < 1,000 employees	506	0.107	0.309	0	1
	> 1,000 employees – < 5,000 employees	506	0.281	0.450	0	1
	> 5,000 employees	506	0.318	0.466	0	1
Type of industry	Energy	506	0.142	0.350	0	1
	Finances	506	0.030	0.170	0	1
	Employment welfare	506	0.128	0.335	0	1
	Education research	506	0.176	0.381	0	1
	Industry	506	0.055	0.229	0	1
	Public safety	506	0.099	0.299	0	1
	SOC	506	0.091	0.288	0	1
	Culture	506	0.061	0.240	0	1
	Others	506	0.217	0.413	0	1

Source: Written by Author.

C. Analysis findings

The satisfaction towards and sense of belonging to an institution in individual level factors showed a statistically meaningful positive correlation with the reporting of corruption. This implies that institutions need to encourage a sense of belonging, satisfaction, loyalty, etc. to public institutions in order to have their employees report corruption in a positive way.

The motivation for public service also has a positive correlation, in general. However, only the unapproved additional position and embezzlement are positively correlated in a statistically meaningful way. It is difficult to determine a structural difference between corruption in which the motivation for public service is correlated with the dependent variables and corruption in which the motivation for public service is not correlated with the dependent variables. However, it was found—at least—that the motivation for public service encourages employees to report, in some types of corruption.

Among the four variables in an institutional level, an institution's fair and reliable response in the procedures for handling of the report of corruption seemed to have a statistically meaningful positive correlation with the report of corruption in general. This means that protecting the anonymity of reporter and showing the reliability of process to handle reports is required in order to encourage employees to report corruption in a positive way.

The positiveness of anti-corruption training showed a statistically meaningful correlation with the reporting of three types of corruption, such as unapproved additional position, pursuit of private interest with inside information, and corruption in the contract examination. In addition, the appropriateness of punishment against an employee who commits corruption showed a statistically meaningful correlation with the reporting of two types of corruption, such as corruption in promotion examination and corruption in contract examination. When establishing a plan to promote the reporting against corruption, it is required to consider how to prevent these two types of corruption from being committed. The positiveness of encouragement to report corruption showed a statistically meaningful correlation only with embezzlement. It seems that it is relatively ineffective to induce its reporting compared to the other cases. However, it seems to be a mechanism that could induce employees to report cases that may be perceived as severe corruption, such as embezzlement. Thus, it should not be overlooked, when devising countermeasures.

Table 21_ Summary of major findings of analysis

Variable name	(1) False business trip	(2) Unapproved additional position	(3) Corruption in promotion examination	(4) Pursuit of private interest using insider information	(5) Corruption in contract examination	(6) Embezzlement
Motivation for public service	0.216	0.324**	0.145	0.128	0.050	0.356**
Belonging and satisfaction	0.288*	0.411**	0.290*	0.527***	0.642***	0.352*
Positiveness of anti-corruption training	-0.139	0.374*	0.068	0.332*	0.399**	0.247
Reliability of handling process	0.333*	0.438**	0.476**	0.238	0.760***	0.358*
Appropriateness of punishment	0.125	0.144	0.232*	-0.006	0.329**	0.262
Positiveness of encouragement in reporting of corruption	0.215	0.346	0.112	0.289	0.299	0.614**
Anti-corruption culture	-0.042	-0.073	0.042	0.135	-0.368*	-0.095
Organizational politics	-0.018	0.203	0.165	-0.021	-0.045	-0.018
Fairness of personnel affairs	0.078	-0.021	-0.348**	-0.033	-0.647***	-0.230

Note: ***($p < 0.01$), **($p < 0.05$), *($p < 0.1$)

Source: Written by Author.

Variables in the institutional culture level did not show a meaningful correlation with dependent variables, in general. An anti-corruption culture, which refers to the will to eradicate corruption held by employees of an institution, did not show a constant correlation with the type of corruption. A statistically meaningful correlation was shown only in corruption in the contract examination, which is exactly opposite to what is anticipated in the hypotheses. Nor did the degree of organizational politics did not show a statistically meaningful relation with the report of corruption. The fairness of personnel affairs also showed a meaningful correlation with the corruption in the promotion examination and corruption in the contract examination, but displayed a direction that conflicted with the hypotheses.

It is difficult to clearly explain why the findings of the regression analysis are different among the types of corruption. Thus, it seems difficult to render a general conclusion for factors that have an effect. The same regression analysis was conducted using the average of response value to the reporting of the six types of corruption, as a dependent variable, in order to determine the general tendency for correlation between the various dependent and independent variables. Since dependent variables are continuous variables, it is impossible to directly compare the findings of the analysis stated above with the coefficient values obtained from the regression analysis with OLS. However, it would be possible to examine the direction and statistical significance of a coefficient.

In Model (3), in which all independent variables are controlled, a statistically meaningful positive correlation was shown in both the motivation for public service and the sense of belonging to and satisfaction towards the institution, which are variables in an individual level. Moreover, a statistically meaningful positive correlation was shown in the reliability of handling of corruption, appropriateness of punishment, and the positiveness of encouragement to report corruption, among variables in an institutional level. Similar to the findings of the regression analysis discussed above, the variables in an institutional culture level did not show a meaningful correlation.

In light of the direction and statistical significance of the correlation between the selection of corruption and the variables in at the individual, institutional, and institutional culture level, the individual characteristics and the systematic response of public institutions could be effective in relation to the reporting of corruption.

Table 22_ Decision-Making on the Reporting of Corruption

Variable name	(1)		(2)		(3)	
	Coefficient	Standard deviation	Coefficient	Standard deviation	Coefficient	Standard deviation
Motivation for public service	0.049***	0.019	0.031*	0.019	0.034*	0.019
Belonging and satisfaction	0.099***	0.017	0.060***	0.020	0.071***	0.021
Positiveness of anti-corruption training			0.027	0.021	0.033	0.023
Reliability of handling process			0.059***	0.018	0.072***	0.023
Appropriateness of punishment			0.022	0.015	0.028*	0.017
Positiveness of encouragement in reporting of corruption			0.057**	0.028	0.053*	0.029
Anti-corruption culture					-0.007	0.024
Organizational politics					0.010	0.017
Fairness of personnel affairs					-0.027	0.021
Female	0.060*	0.033	0.050	0.033	0.045	0.033
Age (excluding 20s)						
30s	-0.028	0.060	-0.032	0.057	-0.031	0.057
40s	-0.023	0.065	-0.031	0.063	-0.032	0.063
50s	-0.037	0.070	-0.044	0.068	-0.046	0.068
60s	0.072	0.121	0.058	0.120	0.053	0.120
Highest level of education (excluding high school graduates or lower)						
Junior college graduate	0.028	0.093	0.048	0.090	0.047	0.090
College graduate	0.043	0.086	0.059	0.082	0.056	0.082
Graduate school	0.070	0.092	0.092	0.088	0.090	0.088

Table 22_ Decision-Making on the Reporting of Corruption(continued)

Variable name	(1)		(2)		(3)	
	Coefficient	Standard deviation	Coefficient	Standard deviation	Coefficient	Standard deviation
Position (excluding staff and assistant manager)						
Manager and deputy manager	-0.025	0.042	-0.038	0.042	-0.040	0.042
Senior manager	0.042	0.060	0.020	0.060	0.018	0.061
General manager	0.014	0.116	-0.003	0.117	0.015	0.120
Contract business	0.001	0.036	0.001	0.036	-0.002	0.037
Annual salary (excluding 30,000,000 won or less)						
> 30,000,000 won – < 50,000,000 won	0.080	0.053	0.080	0.052	0.075	0.052
> 50,000,000 won – < 70,000,000 won	0.043	0.063	0.055	0.061	0.047	0.062
> 70,000,000 won – < 100,000,000 won	0.025	0.073	0.038	0.072	0.030	0.072
> 100,000,000 won	0.027	0.088	0.036	0.087	0.028	0.087
Type of institution (excluding other public institution)						
Public institution	-0.041	0.041	-0.046	0.040	-0.041	0.040
Quasi-government agency	0.034	0.039	0.029	0.039	0.033	0.040
Scale of personnel (excluding < 200 employees)						
> 200 employees – < 500 employees	0.038	0.048	0.035	0.049	0.030	0.049
> 500 employees – < 1,000 employees	0.024	0.058	0.008	0.057	0.005	0.057
> 1,000 employees – < 5,000 employees	-0.055	0.051	-0.068	0.051	-0.073	0.052
> 5,000 employees	0.006	0.054	-0.012	0.054	-0.012	0.055
Type of industry (excluding energy)						
Finances	0.028	0.090	0.031	0.088	0.033	0.088
Employment welfare	-0.027	0.064	-0.042	0.062	-0.042	0.062
Education research	-0.156**	0.065	-0.151	0.064**	-0.150	0.065
Industry	-0.096	0.078	-0.089	0.079	-0.099	0.079
Public safety	-0.126*	0.071	-0.127	0.069*	-0.126	0.071
SOC	-0.070	0.056	-0.058	0.054	-0.064	0.055
Culture	-0.100	0.078	-0.099	0.079	-0.096	0.079
Other	-0.073	0.058	-0.078	0.056	-0.076	0.057
Constant	0.607***	0.123	0.610	0.119***	0.621	0.118
R2	0.090		0.199		0.202	
Sample count	506		506		506	

Note: ***($p < 0.01$), **($p < 0.05$), *($p < 0.1$)

Source: Written by Author.

V. Conclusion

One purpose of this study was to determine the degree of ethics of employees in public institutions. As discussed above, it was highly more likely for employees of public institutions to make an ethical selection compared to those in private companies, in a scenario related to the 11 types of corruptions set in this study. However, not all such differences were statistically meaningful. The employees of public institutions were not so different from those in private companies in the types of corruption regarded as a relatively severe misdeed. In addition, such differences were not deemed to be statistically meaningful.

Even if a considerable number of employees in public institutions are likely to make an ethical decision, it is still necessary to improve their ethics. In particular, the types of corruption, such as false business trips, etc., which were perceived as damaging less to an organization were recognized as being minor. This result is in accordance with a reality in which false business trips are frequently discovered from an internal or external audit of public institutions.

In particular, it was found that anti-corruption training is effective as a factor that influences ethical decision-making. Current training programs focus on bribery and treatments that could occur with the interested parties. However, the information of other types of corruption that could occur internally are restricted. Thus, it is required to consider how to improve the effectiveness of training.

Overall, 90% or more of employees in public institutions responded that they would not commit corruption in the promotion examination or corruption in the contract examination. Thus, it is substantially less likely that they would occur in reality. However, since a small number of respondents still answered that they could commit such form of corruption, it seems that effort shall be made to reduce the number. Subsequently, devising countermeasures against severe corruption remains required, which should be customized through further in-depth investigation and analysis.

In general, employees of public institutions answered that they would not commit relatively severe corruption. However, they are relatively passive as to the corruption being committed in their organizations. Public institutions are commonly subjected to various internal and external audits. However, it is expected that it would be impossible to discover all corruption being committed ordinarily. Thus, it is required to activate a system in which employees of public institutions monitor and report corruption, if any, in order to discover the small amount of deviation that is inflicting damage to the organization and all members

thereof.

Public institutions are typically considered as an example for other institutions to follow, in terms of being a model employer. It includes being equipped with ethical behavior in terms of the operation and management of the organization. This study discovered that public institutions are making, in general, more ethical decisions, compared to private companies. However, there is still room for improvement. Based on the findings of this analysis, the following are proposed: an increase in positive anti-corruption training; establishment of a reliable process to handle corruption; and ensuring the appropriateness of punishment.

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