Master's Thesis of Public Administration

A Study on the Effect of Korea's Emission Trading Scheme on the Corporate Financial Performance

한국의 온실가스 배출권거래제 시행이 기업 재무성과에 미친 영향에 관한 연구

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Abstract

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Global environmental regulations are deepening, such as the 2015 Paris Agreement on Climate Change. This calls for a fundamental shift in the existing energy use paradigm from fossil fuels. The global trend is likely to have a significant impact on countries with a high proportion of manufacturing like Korea.

This study tried to verify that the financial performance of the companies subject to Korea's emission trading scheme (ETS) was negatively affected by ETS Phase 1. To this end, this study compared the financial performance of the non-ETS regulated entities with that of the ETS-regulated entities over the same period. Besides, this study also looked at whether the ETS effect exists even when controlling the size of the company or industry. Out of 524 companies designated as ETS's targets in 2014, the experimental group is 299 companies (excluded three outliers) that we were able to check corporate financial information through KIS-Line or KIS-Value. Among the KOSPI-listed companies, non-financial companies that ETS does not regulate were set as the control group. The number of companies in the control group is 380, which allows us to identify the financial information we need in this study during ETS Phase 1 (2015-17).

As a result of the Difference-in-Difference (DID) analysis, we could not see that ETS necessarily harms corporate financial performance. With the implementation of ETS, revenue decreased significantly, operating profit rather increased significantly, and ROA was not statistically significant, but the ROA

itself increased. Therefore, the impact of ETS did not appear consistently according to financial indicators. We can estimate various reasons why the negative impact of ETS was insignificant, and it had a rather positive impact on some indicators. Before the ETS, companies experienced similar greenhouse gas regulations such as the Target Management System (TMS) and were likely to have easily adapted to ETS. The fact that energy costs accounted for less than 5% of the total production cost which is not large, and that companies did not suffer a serious financial impact right away, but they actively expressed future uncertainty and potential risks may be the cause that did not give such a negative shock to financial performance.

In the future, policy authorities need to present a long-term vision in consideration of the characteristics of environmental issues and provide measures for implementation at the same time. Adjusting the strength and speed of regulation as appropriate is also essential for the successful establishment of regulation. To make the emission trading market more efficient, a safety measure such as a price ceiling is also necessary. Furthermore, countries that are implementing the economy-wide ETS, including Korea, should encourage the international community to participate in ETS for mutual linkage and expansion of the carbon market. The policy authority also needs to actively encourage domestic companies to invest in energy-efficient technologies and environmental facilities.

Finally, this study considered the direction in which environmental and industrial policies can be implemented harmoniously in response to the energy and environmental regulations. The sustainability and success of environmental policies largely depend on the compliance and active use of regulations by the regulated group. Therefore, the government needs careful consideration of the regulated groups' abilities to follow the regulatory standards. It should also prepare differentiated support measures for the regulated groups according to regulatory implementation capabilities. Also, it is necessary to inform Korea's leading environmental policies such as the economy-wide ETS through international organizations and lead the active participation of member countries to bear the environmental burden equally between countries. This is not only meant to expand the scope of the emission trading market, but also an essential role of the government to emphasize the legitimacy of domestic environmental regulations for groups subject to domestic regulations.

Keyword: Environmental regulation, Industrial competitiveness, Emission Trading Scheme (ETS), Corporate financial performance, Industrial policy, Environmental policy

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Chapter 1. Introduction

1.1. Research Background and Purpose

At the COP[1] in the United Nations Framework Convention on Climate Change (UNFCCC) in 2015, the parties have reached an agreement on the Post-2020 new climate regime (the Paris Agreement). Therefore from 2020 onwards, both developed and developing countries will be responsible for reducing greenhouse gas (GHG) emissions. The GHG reduction goal under the Paris Agreement depends on the Nationally Determined Contribution (NDC), a voluntary contribution by the member countries. It has no international legal binding power but has an ethical responsibility for future generations. Each country's political obligation still exists due to criticism of the international community (Kim, 2017).

In response to these international trends, Korea has also taken various domestic measures to reduce GHG emissions within a few years. The Korean government has established and announced several steps such as 'Basic Plan for Climate Change Response (2016, 2019),' '2030 National Greenhouse Gas Reduction Roadmap (2016; 2018),' 'Comprehensive Measures to Reduce Fine dust (2017),' 'Renewable Energy 3020 (2017),' and ‘2050 Review of Long-Term Low Carbon Development Strategy (2020)’ so far. The GHG reduction target by 2020

[1] Conference of Parties: The final decision-making body of the countries that ratified the Climate Change Agreement, and coordinates opinions among countries (Korea Environment Institute. (2013). Status of Major Discussions at the 19th Conference of the Parties to the United Nations Framework Convention on Climate Change. *KEI Focus. Vol. 4 (December 2013)*, p.2).

was reducing GHG emissions by 30% from the BAU (emission estimate). and now 37% reduction from BAU by 2030. Moreover, the government tries to reduce the proportion of nuclear power plants and coal-fired power plants from 75.7% in 2017 to 64.4% in 2030. While the portion of LNG and renewable energy will increase from 23.1% to 34.5% by the 'Eighth Basic Plan of Long-Term Electricity Supply and Demand (2017).' Also, Korea is implementing the 'GHG Emissions Trading Scheme' from 2015. It is obliged by domestic law to reduce GHG emissions, which are not obligations under international law.

Table 1. GHG Reduction Goals by Country in Paris Agreement

Item	EU	China	US	Canada	Japan	Mexico
Reduction target by country (NDC)	by 2030	by 2030	by 2025	by 2030	by 2030	by 2030
	-40% from 1990	-60 to -65% per GDP from 2005	-26 to -28% from 2005	-30% from 2005	-26% from 2013	-25% from BAU

Source: Ministry of Economy and Finance. (2017). The Second Basic Plan of the Emission Trading Scheme.

As such, the recent energy and environment paradigm has been changing rapidly, and its specific aspects are becoming more severe due to domestic and overseas environmental regulations. These trends will make a considerable impact, especially on countries with a high manufacturing share, including Korea. In particular, manufacturing companies, which are the ultimate targets of these regulations, may have a considerable impact on corporate management. Increased manufacturing costs by the rise in the price of purchasing electricity and the costs for expanding eco-friendly facilities and trying technological innovation can cause those financial impacts. Therefore, it is necessary to closely analyze and respond to the effects of recent environmental regulations on corporate competitiveness.

Examining the social side effects caused by the process of achieving environmental improvement is essential to ensure the acceptability, legitimacy, and sustainability of those regulations. It would also allow for an objective assessment of regulation. Moreover, it could be the basis for rational adjustment and regulation redesign.

This study analyzes whether the implementation of ETS among many environmental regulations affected regulated companies' financial performance. The study also examines whether any different effects exist depending on the firm size or industry. This study intends to gain meaningful implications for Phase 2 (2018-2020) and Phase 3 (2021-2025) of ETS by analyzing these research problems. Furthermore, this study tries to find the direction of the industrial policy, whether there is a plan to support the corporates not to lose its original competitiveness while meeting environmental regulations' standards.

1.2. Research Subject and Scope

This study aims to analyze the effects of Korea-ETS on corporate financial performance from profitability and growth potential. We can examine the impact of Phase 1 of Korea-ETS (2015-17) by comparing the ETS-regulated companies' financial performance and non-regulated ones. Therefore, the time scope of the analysis is three years before the ETS (2012-14) and three years (2015-17) during the ETS Phase 1. Specifically, this study examines whether Korea-ETS significantly impacted the ETS-regulated companies' financial performance in 2015-17 compared to 2012-14. This study will also compare this to the difference of the listed companies' financial performance between 2012-14 and 2015-17

(KOSPI; The Korea Composite Stock Price Index).

Regarding the ETS-regulated companies, this study will analyze 303 companies that disclosed financial information to KIS-Line (Corporate Information Portal) or KIS-Value (Corporate Information Service) among the 524 designated as the target of the emission allowance in 2014, the year right before the ETS Phase 1.

On the other hand, this study will analyze 381 companies that disclosed its financial information to KIS-Line or KIS-Value, and are not subject to ETS among the 731 non-financial listed companies on the securities market[2]. This study set them as the control group.

The reasons for the comparison between the ETS-regulated companies and the non-financial listed companies are similarities in their firm size, their position in the industry, availability and reliability of financial information. The ETS-regulated companies are large companies with an annual emission of more than 125,000t CO_2eq across the enterprise or business sites emitting more than 25,000t CO_2eq a year (Emission Trading Act, 8.1.1, Act No.11419, 2012). Among the hundreds of thousands of domestic companies, the number of ETS-regulated companies (524) is extremely small, demonstrating their production scale and positions in the industries. Listed companies must have equity capital of more than KRW 30 billion, and their ordinary revenues are more than KRW 100 billion. Hence, they are similar in size to the ETS-regulated firms. We can also check the disclosed corporate financial information in detail through the Financial Supervisory Service's electronic disclosure system (dart.fss.or.kr), and the information reliability is high. Besides, this study kept the industry homogeneity of

[2] As of 2018, only 53 of the KOSPI-listed companies are pure financial firms, including banks, insurers, securities firms, and credit card companies (KISLINE, https://www.kisline.com/mi/MI0305M02GE00.nice).

the analyzed companies as much as possible because the companies' financial performance may vary depending on each industry's economic condition. The companies' financial structure may also vary depending on the industry.

Ultimately, through the analysis above, this study will consider industrial policy's direction to cope with various environmental regulations because the regulations will continue to exist and are likely to become stronger in the future. This study would like to think of the implications for the target, sector, level, and method of support of the industrial policy at the same time.

1.3. Differentiation from Previous Research

First, environmental regulation, primarily set as the independent variable, is not often narrowed down to specific regulations in previous studies. Many prior studies also set the dependent variable at a macro level, such as industrial or national competitiveness. Therefore, there is not much literature on the effect of regulation on the direct performance of firms. For regulation to operate successfully, participating companies' acceptance or compliance is crucial (Jeong and Chung, 2018). Therefore, it would be very meaningful to look from the firm-level how the profits generated by the corporation's economic activities changed before and after the enforcement of the regulations.

Second, a number of studies have analyzed how ETS achieves its original environmental goals (Gilli et al., 2013; Yu et al., 2017; Jin et al., 2018). However, few studies have analyzed the impact of ETS by looking into corporate financial performance changes. It is natural to consider corporate environmental

performance than economic outcomes because ETS is typically a product of environmental policy. However, reviewing the ETS-regulated companies' financial performance changes is also crucial as an axis of environmental policy success factors (Sara Segura et al., 2014; Sara Segura et al., 2018). If the ETS-regulated companies improve competitiveness through technological innovation, as the Porter hypothesis suggests, it could strengthen environmental policy legitimacy and attract companies' additional participation. On the other hand, if the regulated companies' competitiveness by specific environmental policies deteriorates, policymakers should consider other support measures or reconsider their designed systems.

Third, the analysis of the impact of Korea's ETS implementation is very meaningful at this moment. While many studies have analyzed EU-ETS, there are few Korean case studies. This seems to be due to Korea-ETS's economic coverage scope and its temporal factor, which was implemented ten years later than EU-ETS. Therefore, most existing researchers had conducted their studies in a pre- or pre-emptive manner in anticipation of the effects before the implementation of ETS. In this context, this study is an intermediate evaluation to analyze Korea-ETS's financial impact on the regulated companies, since it has completed its Phase 1 (2015-17). Through this research, we can get some implications for Phase 2 and 3. Furthermore, there will be an implication in terms of national characteristics such as Korea's economic size (2019, GDP, the 12th in the world; World Bank, 2020), GHG emission level (2017, the 11th in the world; Ministry of Environment, 2019), and its faithful conducting of the nationwide ETS.

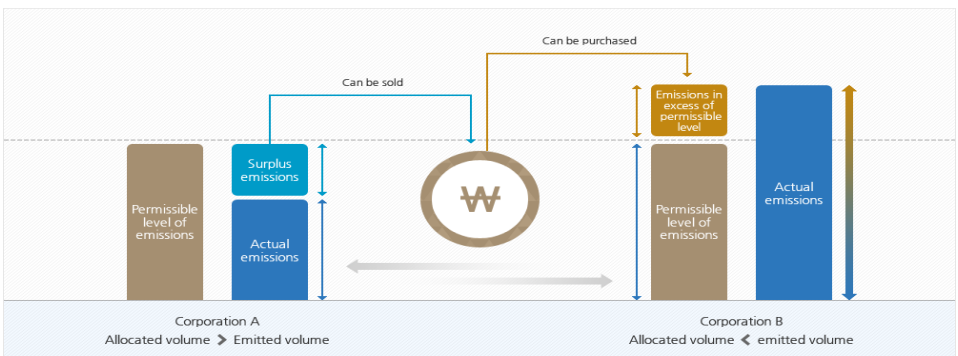
Chapter 2. Literature Review

2.1. Emission Trading Scheme (ETS)

Overview of Korea-ETS

ETS's basic concept is to allocate emission permits by companies and let the companies emit GHGs within that range but allow transactions with others for extra or deficit. Therefore, each company can voluntarily carry out direct reduction activities according to its own GHG emission reduction cost or purchase emission permits from the market (Emissions Trading Scheme Basic Plan, 2014).

Figure 2. Basic Concept of ETS



Source: Korea Exchange. (2019)

Korea-ETS is based on the "Act on the Allocation and Trading of Greenhouse-gas Emission Permits (Emission Trading Act, Act No. 11419, 2012)" and the "Enforcement Decree of the same law (Presidential Decree No. 24180, 2012." ETS's first and second Phases are three years each, and from the third Phase, it will be a 5-year basis.

※ Propulsion of Korea-ETS [3]

- Declaration on the introduction of market-based incentive system by the Korean government at G8 summit (July 2008)
- Determination of national greenhouse gas reduction target (30% reduction from BAU by 2020, November 2009)
- Establishing a legal basis for the introduction of emission trading scheme through the establishment of 「Framework Act on Low Carbon & Green Growth」 (Green Growth Act, Act No.9931, January 2010)
- Implementation of Greenhouse Gas & Energy Target Management System (TMS) as preparation of ETS (January 2012-)
- Establishment of 「Act on the Allocation and Trading of Greenhouse-gas Emission Permits」(Emission Trading Act, Act No. 11419, May 2012), and 「Enforcement Decree」 of the same law (Presidential Decree No. 24180, November 2012)
- Since January 2015, the government has fully implemented ETS. It aims to establish a trading system, accumulate infrastructure, and experience during the first planning period. From the second planning period, it will expand coverage and advance the allocation method to achieve a significant GHG reduction level.
- First planning period (Phase 1, 2015-17): The government allocated 1,598 million KAU (CO_2 eq) to 524 companies. The allocation target companies included companies in petrochemicals, steel, power generation & energy, paper, motor vehicles, and food & beverages, and so on.
- Second planning period (Phase 2, 2018-20): The government allocated 1,777 million KAU (CO2 eq) to 591 companies.

[3] Jung. (2013); Ministry of Economy and Finance. (2014)

Article 3 of the “Emission Trading Act” stipulates five principles: ① Compliance with international agreements, ② Consideration of economic impacts, ③ Activation of market functions, ④ Fair and transparent trade of emission permits, and ⑤ Compliance with international standards for connectivity with the international carbon market. The target companies have annual greenhouse gas emissions of over 125,000t CO_2eq or business sites with 25,000t CO_2eq or more (Emission Trading Act, 8.1.1).

In Phase 1, the government allocated 100% of the emission credits to the target companies free of charge. In Phase 2, the share of free allocation was 97%, and in Phase 3, the share of free allocation was 90% or less (Emission Trading Act, 18.1-3). The emission allowance is allocated to each company according to the reduction target by industry. The reduction target of each industry was determined after setting the total amount of emission rights of the country shown in the 'National Greenhouse Gas Reduction Roadmap (Ministry of Environment, 2014).'

Table 6. Korea-ETS's Allocation Method from Phase 1-3

Item	Phase 1 (2015.1.1-2017.12.31)	Phase 2 (2018.1.1-2020.12.31)	Phase 3- (2021.1.1-)
Allocation Method	100% Free Allocation	97% Free Allocation	Free Allocation, no more than 90%

Source: Lee et al., (2012). A Study on the Analysis of the Effect of Regulation and the Improvement of Acceptability by Introducing the GHG Emissions Trading Scheme of Korea, p.21. *Korea Institute of Public Administration (October 2012).*

Comparison with Target Management System (TMS)

Target Management System (TMS) is a representative direct regulatory policy instrument (Command & Control). GHG emitting companies and energy-consuming companies above the reference amount have to set the reduction targets in consultation with the government. After evaluating the results, the government imposes incentives or penalties (Lee, 2012; Lee et al., 2017). The enforcement and the details of TMS are regulated on the "Framework Act on Low Carbon and Green Growth (Green Growth Act, Act No. 9931, 2010)" and the "Enforcement Decree of the same law (Presidential Decree No. 22124. 2010)."

On the other hand, the Emission Trading Scheme (ETS) aims to reduce the pollutants with the minimum cost by establishing the right to pollutant emitters. ETS permits the polluters to deal with their pollutions, and regulate pollutant emissions through market mechanisms. It tries to clarify the pollutants' environmental responsibility and emission rights and reduce pollutant emissions at the lowest cost through market principles. The regulated companies by ETS have different marginal abatement costs (MACs). Thus they can adjust their emissions to further reduce costs by purchasing emission credits from other companies. In contrast to TMS, a direct regulatory system, ETS is more flexible in reducing pollutants because policy participants can choose their own reduction method and deal with a lack of emissions or residual emissions. There are incentives to sell additional reductions as well. Therefore, ETS has the advantage of inducing investment in pollution emission reduction.

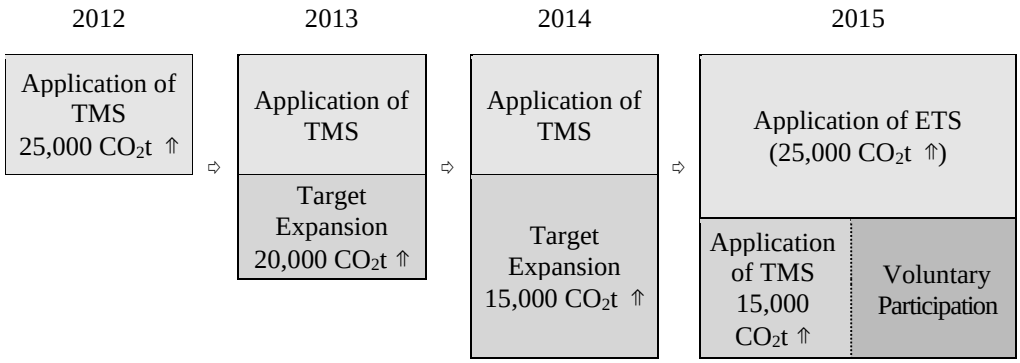
Table 7. Comparison between TMS and ETS

Item	TMS	ETS
Reduction Target / Path	Establishing goals (allocation of emission rights) by maintaining consistency with national goals, sector-specific and industry-specific reduction goals	
MRV	Common use of MRV* built under TMS * MRV: Measuring, Reporting, Verifying of the emission	
Operating method	Direct regulation (Command and control)	Market mechanism or price-function
Implementation boundary	One-year/limited to one's business site	Multi-year (5-year) / recognition of external reduction (offset)
Means of achieving a goal	Cutback (only means)	Reduce, Buy, Borrow, Offset
In the case of over-reduction	No incentives (end with goal attainment)	Can be sold or carried forward
Penalties	Penalty of up to 10 million won (fixed-rate)	Imposing fines in proportion to excess emissions

Source: Presidential Committee on Green Growth. (2012)

ETS's regulatory coverage scope is the same as the criterion of the first year of TMS implementation. The government gradually expanded the TMS scope from 25,000t CO_2eq in 2012, 20,000t CO_2eq in 2013, and 15,000t CO_2eq in 2014. ETS is limited to more than 25,000t CO_2eq of emissions from the beginning of implementation to the present. However, the door to voluntary participation in the transaction system remains open. As of 2011, the number of companies subject to TMS, which emits more than 25,000t CO_2eq of greenhouse gases, was 470 with 1,570 business sites (Lee et al., 2012).

Table 8. Comparison of targets subject to TMS & ETS



Source: Lee et al., (2012). A Study on the Analysis of the Effect of Regulation and the Improvement of Acceptability by Introducing the GHG Emissions Trading Scheme of Korea, p.67. *Korea Institute of Public Administration (October 2012).*

Overseas Cases

The only countries or economies implementing economy-wide ETS, such as Korea, are the EU (32 countries: 27 members, four non-member countries[4], and Switzerland[5]), New Zealand, and Kazakhstan. China has conducted pilot projects in eight regions since 2013. The United States is implementing the Regional Greenhouse Gas Initiative (RGGI) in the northeastern part of the country and the Western Climate Initiative (WCI) in the west. Japan is also implementing ETS only in Tokyo and Saitama. Mexico, Chile, Brazil, Vietnam, Russia, Turkey, and Taiwan are preparing for ETS (Shim, 2016; ICAP, 2018; ets.energy.or.kr). Therefore, carrying out the economy-wide ETS like Korea is very advanced.

EU-ETS is the first ETS globally and has the most significant impact in terms of emissions covered by the market and the number of countries involved. EU-ETS targets facilities with a capacity to burn more than 20MWth of fuel. It

[4] Norway, Liechtenstein, Iceland, the UK

[5] The EU and Switzerland have been operating separate ETSs, but they have linked their systems since September 2020.

started with the first pilot project in 2005 and was promoted since 2008 with 27 EU members and three non-member countries. It currently covers about 14,000 business sites in 32 states as of Phase 3 (2013-20). Phase 1 and 2, included the industrial and energy sectors. In 2012, EU-ETS included the aviation industry. From Phase 3, it has expanded to petrochemicals, ammonia, and aluminum. It plans to continuously increase the share of paid allocation from 20% in 2013 to 70% in 2020 and 100% in 2027 (Lim et al., 2014). Since the EU-ETS introduction, the EU has achieved decoupling of economic growth and GHG emissions, accelerated low-carbon technology development, and revitalized the renewable energy sector. However, uncertainties have increased in companies according to fluctuations in emission price, and concerns remain about carbon leakage (Shim, 2016).

Table 9. EU-ETS Emission Permits Allocation Method by Planning Period

	Phase 1	Phase 2	Phase 3
Year	2005-2007	2008-2012	2013-2020
Allocation Method	GF (Grandfathering)[6] * Benchmarking method was applied for early action		BM (Benchmarking)[7]
Free Allocation (%)	95% (Actual paid allocation ratio was 0.12%, so virtually 100% free allocation)	90% (Actual paid allocation ratio was 3.07%)	· Energy: 100% paid allocation · Manufacturing: 2013 (80%)-2020 (30%) * Exclude industries with large carbon leakage risks from paid allocation

Source: Lee et al., (2012). A Study on the Analysis of the Effect of Regulation and the Improvement of Acceptability by Introducing the GHG Emissions Trading Scheme of Korea, p.21. *Korea Institute of Public Administration (October 2012).*

[6] Grandfathering: Allocation based on emissions in the past. The method of allocating emission rights based on the average of two to three years of average annual or maximum emissions, such as emissions, heat input, and making products (kWh) etc. during the base year.

[7] The method of allocating emission rights by considering facility efficiency through BM coefficient based on the activity data of each company, such as production volume.

2.2. Corporate Financial Performance

We can analyze corporate financial performance indicators regarding profitability, growth potential, stability, and productivity. After reviewing previous studies, this study has found ROA (return on assets) and the operating profit as the main indicators of profitability. In terms of stability, people often use the debt-to-equity ratio or current ratio. Net sales growth rate or total asset growth rate in terms of growth potential, and per capita net sales growth rate in terms of productivity are frequently used (Lee, 2014).

The ETS-regulated companies are likely to receive financial compensation for their energy savings through the revenues from emission permits. Therefore, an increase in liabilities or assets is likely to occur during the purchase of energy-efficient facilities or waste purification facilities. Meanwhile, indicators of profitability like operating profit[8] or net income[9] may also be affected by the additional sales management costs, such as labor costs and marketing. Those are the financial burdens in response to and adapting to the new environmental regulation. Thus, ROA[10] containing both assets and profitability indicators can help examine financial changes in the ETS-regulated companies.

Sales are also an essential indicator that represents a company's overall production capacity, external size, and position in the market. According to a prior study, companies with low sales growth also had low profitability overall. That said, high sales growth was not necessarily profitable, but the top-middle-tier companies'

[8] Operating profit = Sales – Cost of Goods Sales – Selling & General Administrative
[9] Net Income = Operating profit – Non-operating income/loss + Financial income/loss – Corporate tax
[10] ROA = Net income / Total Asset *100 = Net income / (Equity capital + Debt) *100

profitability in revenue growth was the best among all the companies analyzed (Lee, 2003). This suggests that while sales are not the only and absolute indicator of a company's management status, they are still an essential indicator of close correlation with other indicators. Therefore, it is also necessary for ETS-regulated companies to look at their sales.

The total assets, comprising the sum of equity capital and debt, and debt ratios, may also be considered further to examine entities' responses to ETS regulations.

2.3. Environmental Regulation and Innovation

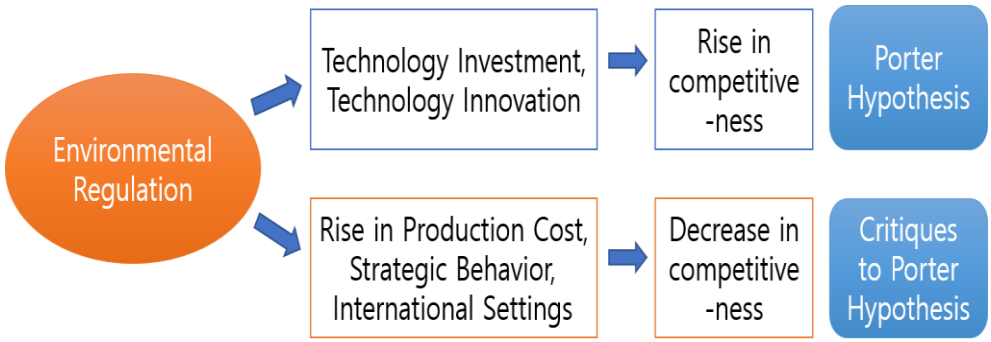
Many studies have tried to examine how environmental regulations affect industrial productivity, but discussions have not reached an agreement and are still in dispute (Jaffe and Palmer, 1997; Lee, 2016). There are two primary streams in the controversial theories.

The first stream sees that environmental regulation does not hinder industrial competitiveness. Rather it helps to expand technology development (R&D) that complies with regulatory standards and makes industrial competitiveness even stronger. The Porter hypothesis (Porter, 1991; Porter and Van der Linde, 1995, 98) is a pioneering work in this area. The Porter hypothesis argues that 'properly designed environmental standards' will trigger innovation that can offset the costs of compliance with such regulations. It also argues this will not only reduce the net cost of compliance with environmental regulations but enhance the competitiveness of domestic companies (Porter and Van der Linde, 1995, 110-114).

Specifically, innovation has the effect of improving the inefficient use of resources, promoting technological improvements, and collecting information related to its inefficiencies. Furthermore, the innovation reduces investment uncertainty by diminishing the company's unexpected environmental risks. This can offset regulatory compliance costs. Even after the Porter hypothesis, follow-up studies show that environmental regulations have no or less negative impacts on industrial competitiveness. Their basic mechanisms coincide with the Porter hypothesis.

The second stream refutes the Porter hypothesis arguing that environmental regulation is not a free lunch but accompanied by social costs. Palmer, Oates, and Portney (1995) say that the relationship between environmental regulation and business competitiveness can change by various strategic behaviors that may arise between regulatory authorities and regulated entities. They do not deny that the Porter hypothesis can occur under certain conditions. Still, in many cases, they argue that it is necessary to mitigate environmental regulations to enhance the international competitiveness of domestic firms. They show various empirical analyses to support their argument (Barrett, 1994; Simpson and Bradford, 1996; as cited in Palmer et al., 1995). Palmer, Oates, and Portney (1995) consider international competitiveness a significant factor in firm competitiveness. They also cite the U.S. government data (EPA, 1990; BEA, 1992; as cited in Rutledge and Vogan, 1994), showing that the U.S.'s actual cost of environmental mitigation was $102-135 billion in 1992, while the benefits of innovation were only $1.7 billion.

Figure 1. Theories of the relationship between environmental regulation and productivity



Source: Based on prior research, written by the author of this study.

In sum, the Porter hypothesis's existence depends on whether environmental regulation induces corporate positive responses and voluntary efforts. Therefore, in order to find out whether the Porter hypothesis exists, it is meaningful to evaluate the regulatory strength of a specific country in light of the level of regulation of its competitors. It is also important to find out how the regulated groups are actually experiencing the regulation. This is in the same vein as examining whether the condition of 'properly designed environmental regulation to trigger innovation' in the Porter hypothesis is met.

By the way, Korea-ETS is even more stringent than EU-ETS in terms of the regulated sectors, materials (gas), emission coverage, and strength (Han, 2015; ICAP, 2020). Moreover, only four economies implement economy-wide ETS globally, including the EU (including four non-member countries and Switzerland), New Zealand, Kazakhstan, and South Korea. Except for European countries, no nation has introduced economy-wide ETS within the top-10 global GHG emitters. China, which is the largest emitting country, declared its nationwide ETS was starting in 2015 after eight pilot projects since 2013. However, it has not launched

its nationwide ETS yet. In the United States, the second-largest emitting country, ETS is partially implemented only in the northeastern (RGGI) and the western area (WCI). Japan, the seventh, is also conducting ETS only in some areas such as Tokyo. Kazakhstan, the first UNFCCC non-Annex I country to implement nationwide ETS, resumed its system in 2018 after a two-year suspension. These international trends suggest that nationwide ETS in Korea is very advanced. Korea has the highest proportion of manufacturing (Korea 31.1%; China 29.9%, Japan 18.8%, EU 15.2%, US 12.1%; Han, 2015). This implies that ETS regulations may have a much higher intensity for Korean companies than in other countries.

Table 2. Comparison of Korea-ETS (Phase 1) and EU-ETS (Phase 3)

Items	Sector	Gas	Enterprises (no.)	Emission Coverage	Regulation on Indirect Emission[11]
Korea		CO_2, N_2O, PFCs, CH_4, HFCs, SF_6	524	66%	○
EU		CO_2, N_2O, PFCs	11,500+	45%	×

Source: ICAP. (2020). ETS Detailed Information (EU, Korea). As cited in Han, Hyungbin. (2015). "Environmental Policy Directions Considering Industrial Competitiveness". p.12.

We can also find a phenomenon contrary to the Porter hypothesis through the 'Report on the first and second-year operation results of ETS in Korea' (Ministry of Environment, 2018). In a survey on the impact of ETS on corporate management activities, 82% of responding companies answered that the negative effect was more significant. Specifically, they pointed out the increased workload

[11] GHG emissions generated by the use of electricity or heat supplied from outside by the company to be allocated (Guidelines for reporting and certification of emissions of greenhouse gas ETS, Article 2, Subpara 33).

(28%), the cost of preparing the statement and the cost of consulting (33%), and the purchase of emission credits (13%). As a result, the ETS effect's dissatisfaction rate was 51%, while the satisfaction rate was only 7%. These results show that the ETS may have negatively affected the regulated companies or companies feel the burden in some way, at least. Therefore, it is reasonable for Korea-ETS to infer that adverse effects are more likely to be caused by firms' strategic behavior, international competition, and so forth than positive outcomes. This is in line with the critiques about the Porter hypothesis suggest.

Table 3. Corporate Recognition of the ETS

	Potential Risk	New Opportunity	Others
Proportion (%)	81%	13%	6%
Number of responses	132	22	9

Source: Ministry of Environment (Greenhouse Gas Inventory and Research Center). (2018). Report on the first and second-year operation results of ETS in Korea. Results of the Survey on the Allocation Target Companies.

Table 4. The Effect of the ETS on Corporate Management

	Additional cost incurred [12]	Revenue from the sale of surplus credits	Reduced costs through energy conservation	Emission reduction	Increased workload	Insignificant
Proportion (%)	54%	3%	6%	6%	28%	4%
Number of responses	195	11	20	20	101	14

Source: Ministry of Environment (Greenhouse Gas Inventory and Research Center). (2018). Report on the first and second-year operation results of ETS in Korea. Results of the Survey on the Allocation Target Companies.

[12] Details of additional costs: purchase of emission rights (13%), investment in technology, workforce expansion, management system change (8%), preparation of the statement, consulting costs (33%)

Table 5. Corporate Satisfaction with the effects of the ETS

	Very satisfied	Somewhat satisfied	Neither satisfied nor dissatisfied	Somewhat dissatisfied	Very dissatisfied
Proportion (%)	1%	6%	42%	28%	23%
Number of responses	1	10	66	44	37

Source: Ministry of Environment (Greenhouse Gas Inventory and Research Center). (2018). Report on the first and second-year operation results of ETS in Korea. Results of the Survey on the Allocation Target Companies.

2.4. Relationship between Environmental Regulation and National / Industrial / Corporate Competitiveness

Most studies on the economic ripple effect of environmental regulations are the macro-level studies, such as industry- or country-level. They set independent variables to 'environmental regulation.' Dependent variables are 'industrial competitiveness' or 'national competitiveness.' This means the studies put variables in the upper category rather than the primary target of regulation. Therefore, it is not limited to specific regulations implemented at a particular time, but the level of regulation is identified by setting indicators representing the whole environmental regulations.

Many studies, such as Jaffe and Planner (1997), Lee (2003), Kang and Lee (2006), Lee and Ji (2011), Rubashkina et al. (2015) have identified pollution abatement and control expense (PACE), i.e., pollution prevention costs (capital cost, investment, expenditure, etc.) as the measurement variables. Eom (2012) has divided the environmental regulation into direct regulations (environmental emission allowance, licensing, acquisition, and transfer of waste) and indirect ones

(levy on the environmental emission, contribution to environmental improvement, loan for environment improvement). Eom (2012) has surveyed 376 sample companies in his research, and the level of regulation was measured using a 5-point scale.

'Industrial competitiveness' is often set as a dependent variable. In particular, the R&D expenditure and the number of patents acquired (Jaffe and Planner, 1997), environmental patents (Lee, 2003), value added (Lee and Ji, 2011), and trade volume (Arouri et al., 2012). Also, some studies used experts' opinion surveys as measurement variables (Zhao et al., 2014).

There are many studies that limited environmental regulation to specific regulations, such as ETS. In this case, however, the dependent variable is not corporate performance or corporate competitiveness. Instead, they used industrial or national competitiveness as the dependent variables. Vespermann and Wald (2011) analyzed the EU-ETS's economic impact on the aviation industry. It estimated that annual costs of EUR 3 billion, about 1.25% of the aviation sector's cost by 2020, would be a yearly financial burden. However, the study estimated that, except for the period immediately after the regulations' enforcement, the economic burden would be moderate. In Feng Dong et al. (2018), ETS does not help improve GDP in the short term. However, they confirmed a positive correlation between the economy and environment in the long run, as the Porter hypothesis implies.

On the other hand, Lee and Lee (2013) analyzed the impact of EU-ETS on the import and export of European steelmakers. The effect was negligible in Phase 1 of EU-ETS (2005-07). However, European steel exports declined, and imports increased in Phase 2 (2008-12). Researchers interpreted that as declining competitiveness due to the change in emission price in Phase 2.

Park (2015) and Song (2014) analyzed Korea-ETS's ripple effects on the national economy using the CGE model. In both studies, the major macroeconomic indicators such as GDP, exports, imports, consumption, and social welfare deteriorated with ETS. This is because ETS is a kind of quasi-tax, which hinders economic efficiency.

Some studies analyze the effect of enforcing ETS or other environmental policies at the firm-level such as Yu (2015), Segura et al. (2014), Mo et al. (2012), Commins et al. (2011), Brouwers et al. (2018), Lee (2016), and Kim (2014).

Yu (2015) says that since EU-ETS had launched in 2005, the researcher could not confirm the significant negative impacts on the stock market performance of the target companies during Phase 1 of EU-ETS (2005-2007). However, Yu (2015) could identify a significantly negative ex-ante impact before the EU-ETS (2001-2004), and interpret that as shareholders internalizing costs in advance. Brouwers et al. (2018) and Kim (2015) also analyzed the firms' financial performance that faithfully fulfilled these regulations was relatively higher because stronger pollution is associated with financial risks caused by abatement, litigation, remediation, reputational costs, and all of which combined. However, the negative impact of relative carbon emission performance on economic performance was mitigated for firms that can pass on the costs to end-users.

Commins et al. (2011) examined the effects of energy taxes and EU-ETS on companies in Europe from 1996 to 2007. Those effects include total factor productivity (TFP), employment, investment, and return on capital employed. As a result of the analysis, TFP and investment increased, but employment declined. While energy taxes created jobs, more jobs were disappeared. The researchers explained that the decline in employment was because the companies substituted labor for capital due to environmental regulations.

Chapter 3. Research Design

3.1. Hypothesis

Korea-ETS has started after a five-year preparation based on the “Green Growth Act” in 2010. Nonetheless, it would not have been easy for companies to reduce their GHG emissions through technological innovation or find effective alternative sources within that period. Also, there would be trials and errors because few countries are implementing economy-wide ETS in the world. It would have harmed corporate financial performance due to the decline of companies' competitiveness based in Korea. The ETS regulations require the additional purchase of environmental facilities and the application of higher energy-efficient process technologies. These requirements would create financial burdens for entities. Assuming that companies produce the same quality products, a company that involves more manufacturing costs in the production process is bound to suffer more from competitiveness. Therefore, I guess that entities subject to ETS regulations would have worsened their financial performance because of the implementation of ETS.

Meanwhile, this study assumed the firm size and type of industry to be significant factors that could affect companies' ability to respond to environmental regulations. This is because there are many differences in dedicated personnel or organizations that can quickly detect and effectively respond to environmental regulations depending on the size of the company (Kim and Ji, 2012).

Table 10. The proportion of Master's and Doctoral Researcher by Firm Size

(2010, %)

Small	Medium	Large
25.3	33.4	44.9

Source: Kim and Ji. (2012). Performance and Challenges of R&D Personnel Policy for Small Enterprises. Korea Institute for Industrial Economics & Trade. *Issue Paper 2012-285.*

That is to say, large corporations are relatively easy to cope with new regulations or develop new technologies through environment-dedicated departments or personnel and their own research institutes. However, small-sized enterprises mostly have to concentrate on their intrinsic economic activities for survival in the market (Lee, 2012). Therefore, this study will examine whether financial performance differs when the firm size of the ETS-regulated firms are controlled. There are also differences in capital power to purchase new facilities or technologies. Even by industry, the capital-rich device industry, which depends on economies of scale such as semi-conductors, petrochemicals, and oil refining, and small businesses such as paper and textiles will inevitably differ in their ability to respond to regulations. There may also be differences in GHG emissions, and regulatory response capabilities depending on the type of industry, which may also affect the company's financial performance. For these reasons, this study takes into account the type of industry as a control variable to verify the hypothesis. Additional consideration of the firm size and type of industry may result in different ETS effects on the regulated companies' financial performance. In summary, the hypothesis of this study can be summarized as follows.

Hypothesis: The ETS-regulated companies' financial performance will be worse than that of the non-regulated companies due to ETS regulations.

3.2. Methods

3.2.1. Variable Setting

Independent Variables

First of all, the implementation of the ETS is an independent variable. This is natural because this study is to verify the effectiveness of the ETS policy. Another independent variable is the 'time variable. ' I will consider 'before and after ETS' as a kind of time-variable and put it as the second independent variable. Also, I will put these independent variables as ‘policy dummy’ and ‘time dummy,’ respectively, based on the methodology of this study. For example, it sets ‘time dummy,’ which means the time before and after the implementation of ETS. Also, the ETS policy's implementation is set as the ‘policy dummy.’ This study gives a value of 1 to the ETS target companies and a value of 0 to the non-regulated companies. And the interaction item of time dummy and policy dummy is also treated as one of the independent variables. This is also associated with the Difference-in-Difference (DID) method that this study intends to utilize.

Dependent Variables

In Hypotheses 1, 2, and 3, dependent variables are corporate financial performance. As we saw earlier, this study will focus on the companies' ROA (Return on Asset), operating profit, and sales. These are the typical financial indicators to examine the change in companies' assets, profitability, and growth from environmental regulation implementation. This study will also compare the change in

the financial performance of 2015-17 from that of 2011-14 of the ETS-regulated companies. These changes of the regulated firms will be compared to the non-regulated companies' financial performance change during the same period.

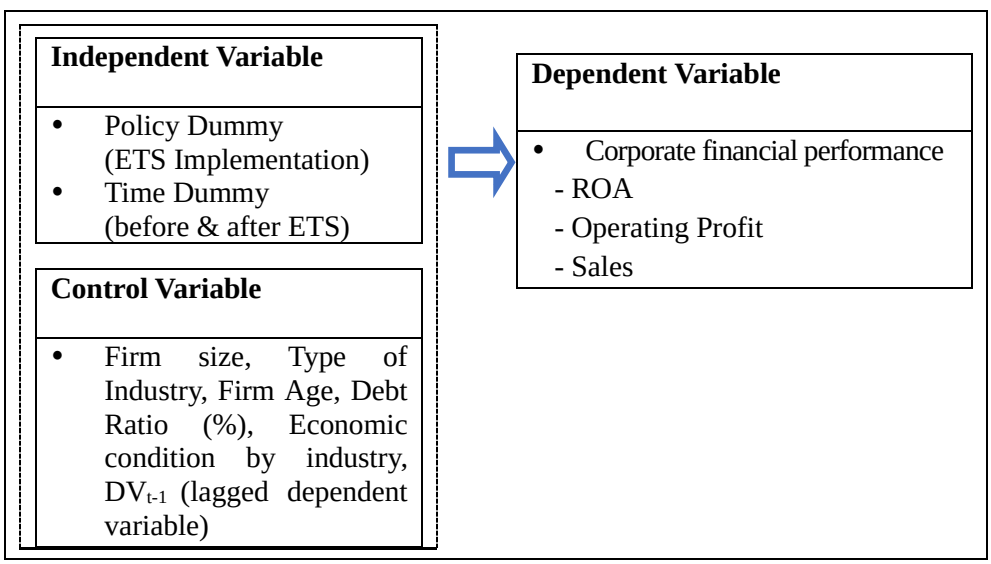
Control Variables

The control variables are mainly firm size and type of industry. We can identify the firm size (large, medium, small) through standards considering industry and sales following relevant laws regarding the firm size. KIS-Line (Corporate Information Portal) also provides the official firm size. Some studies set the number of employees to measure the firm size (Heo, 2015; Cho et al., 2008). However, the Korean major domestic industries, such as semi-conductors, displays, and petrochemicals, are the process industry. Thus, production scales are often not proportional to the number of employees. Instead, the firm size is proportionate to the capacity of production and sales. Therefore, this study considered sales as a more accurate and appropriate measure.

On the other hand, the industry includes 31 types of industry regulated by Korea-ETS. Most of them are traditional manufacturing (KSIC 10th Amendment, Section C, 2017). They also include power generation & energy, aviation, transportation, construction, waste, water, and telecommunications industries that emit large amounts of GHGs. Holding companies with large manufacturers as subsidiaries were classified as 'Financial and Insurance Activities (KSIC 10th Amendment, Section K, 2017)' in the Korean Standard Industrial Classification. Still, their consolidated financial statements include all of the subsidiary's financial information. Thus, this study included holding companies as the subject of analysis. This study added firm age, debt ratio, and economic condition by the industry as control variables. Also, the study calculated firm age by subtracting its establishment

year from 2015 when Korea-ETS has first started. Younger companies are relatively more active in riskier investments and are likely to make more innovative efforts (Hansen, 1992; Coad et al., 2016), so this study included firm age as the control variable. The study also included the debt-to-equity ratio, as it can affect investment in environmental facilities and technology development to cope with ETS. Since the economic condition by industry also greatly influences a company's financial performance, this study included the real economic growth rate by industry (Bank of Korea, 2020) as a control variable. In this study, lagged dependent variables were also added as control variables. The effects of economic actions or decisions do not appear immediately but are distributed over a considerable period of time in the future. Since the dependent variable in 'Year of t' can affect not only 'Year of t,' but also 'Year of t+1' and 'Year of t+2,' lagged dependent variables are commonly used as control variables in economic growth models. However, in this case, a thorough review of the multicollinearity issue should be supported.

Figure 3. Variable Setting



Source: Developed by the author according to the purpose and design of this study.

Table 11. Distribution of the industry of the analyzed companies in this study

No	Sector	Industry	Industry Code (KSIC)
1	Energy	Power Generation & Energy	35
2	Manufacturing	Mining & Quarrying	05-08
3		Food & Beverages	10-12
4		Textile	13, 15, 205
5		Apparel	14
6		Wood	16
7		Paper	17-18
8		Petroleum	19 (Except 191)
9		Petrochemical	20-22 (Except 205)
10		Glass·Ceramics	231-232
11		Cement	233
12		Steel	241, 2431
13		Non-ferrous Metals	242, 2432
14		Machinery	25, 29
15		Semi-conductor	261
16		Display	2621
17		Electrical & Electronics	26-28 (Except 261, 2621)
18		Motor Vehicles	30
19		Shipbuilding	311
20		Furniture	32
21		Medicaments	212
22		Medical Instruments and Supplies	271
23	Public·Waste	Water Supply	36
24		Waste	37-39
25	Building	Buildings (Except Communications)	45-47, 55-99 (Except 61-63)
26		Communications	61-63
27		Construction	41-42
28	Transportation	Air Transport	50-52
29		Land Transport	49
30	Holdings	Financial & Insurance	64
31		Headquarters	7151
Total	6	31	

Source: Based on the National Emissions Allocation Plan (Ministry of Environment, 2014), the author restructured it in consideration of the companies analyzed in this study.

3.2.2. Analysis Method: Difference-in-Difference

This study aims to compare the financial performance between the regulated and the non-regulated companies according to the ETS implementation. Therefore, this study is going to apply the DID (Difference-in-Difference) method. It is one method for measuring the policy effect between the control group and the treatment group to which the policy is applied. Ashenfelter (1985) first used the DID method. Card (1990) used this method to analyze influences by the increase in immigrants' wages and domestic workers' unemployment rate. Card and Kruger (1994) examined the minimum wage system's effect on unemployment using this method (Sohn and Lee, 2018). Park et al. (2011), Kim et al. (2012) used the DID method to analyze the effects of policy funds, and there is a study using the DID to examine the results of the pilot project of China's emissions trading scheme (Kim et al., 2018).

Even if the ETS-regulated firms show negative financial performance compared with the non-regulated ones, the performance may not be caused by the ETS but by the firm’s attributes. Therefore, a simple comparison between the treatment group (ETS-regulated firms) and the control group (non-regulated firms) may not be reliable. Therefore, it is necessary to estimate the effect difference of the ETS-regulated companies when they do not have the ETS regulation.

The DID identifies the control and the treatment group at a specific point in time and subtracts the difference between the measured values after a certain point in time. It tries to obtain the difference between the company's actual financial performance and the financial performance under the assumption that the ETS did

not regulate it. This is to see the difference between the treatment group and the control group's outcome variables purely by policy implementation, except for the characteristics that change over time. To this end, the selection of the control group, similar to the treatment group, is crucial. Researchers can confirm similarities between the two groups through the "Parallel Trend Test[13]." The parallel trend assumption means that if the government had not implemented ETS, the treatment group and the control group's financial performance should have shown a similar trend around 2015 at the beginning of the ETS. Suppose a regression analysis on the financial performance of approximately four years (2011-14) before introducing the ETS for the two groups and the coefficient estimates were not statistically significant. In that case, we could tell the parallel trend assumption was satisfied (Sohn and Lee, 2018, 16-24).

We can see the typical regression equation used by the DID below. This equation can express the net policy effect.

$$Y_{i,t} = \alpha + \beta_1 D_e + \beta_2 D_t + \beta_3 (D_e \times D_t) + \beta_4 R_{i,t} + \varepsilon_{i,t}$$

In the equation above, $Y_{i,t}$ is the financial performance of the company i in the year t, α is the constant term, D_e is the dummy of the ETS regulation (policy dummy), D_t is the time dummy before and after the ETS. ε is the error term. In particular, β_3 represents the intersection of ETS regulation and time, which implies the ETS's policy effect. If the value of β_3 is statistically significant, we can regard it

[13] Regression equation for verification of parallel trend:
$Y_{it} = \beta_0 + \beta_1 D_e + \beta_2 D_t + \beta_3 \left(D_t \times Year_{2011}\right) + \beta_4 \left(D_t \times Year_{2012}\right) + \beta_5 \left(D_t \times Year_{2013}\right) + \beta_6 \left(D_t \times Year_{2014}\right) + \beta_7 \left(D_t \times Year_{2015}\right) + \beta_8 \left(D_t \times Year_{2016}\right) + \beta_9 \left(D_t \times Year_{2017}\right) + \beta_{10} R_{it} + \varepsilon_{it}$

as the 'net effect' of the ETS. $R_{i,t}$ represents all the control variables in short. $R_{i,t}$ includes the firm size, type of industry, lagged dependent variables, and other corporate attributes as the control variables. The effect of ETS derived by the DID estimation is as follows:

$$\text{DID Estimate} = ((\alpha + \beta_1 + \beta_2 + \beta_3) – (\alpha + \beta_1)) – ((\alpha + \beta_2) - (\alpha)) = \beta_3$$

α is the average value of the resulting variable before the ETS implementation of the listed companies, which are not regulated by ETS. β_2 represents the difference in the mean value of the resulting variable before and after the ETS implementation of the listed companies. β_1 represents the difference in the resulting variable's mean value between the ETS-regulated companies and the listed companies before the ETS implementation. Therefore, the difference of the mean values between the control and the treatment group according to the ETS implementation we are looking for is β_3.

Table 12. Effect of ETS Implementation

	Control (Listed, D_e=0)	Treatment (ETS, D_e=1)	Treatment - Control
Before ETS (D_t=0)	α	$\alpha + \beta_1$	β_1
After ETS (D_t=1)	$\alpha + \beta_2$	$\alpha + \beta_1 + \beta_2 + \beta_3$	$\beta_1 + \beta_3$
After - Before	β_2	$\beta_2 + \beta_3$	DID = β_3

Source: Written by the author to describe DID estimate.

For data collection, this study obtained the list of companies subject to ETS from Ministry of Environment (The Notice of Ministry of Environment, No. 2014-162, 2014). Although ETS participating companies are newly added and designated annually[14], this study only analyzed the companies which the government designated in 2014 for the analysis consistency.

Basic corporate information and corporate financial information were available through KIS-Line (Corporate Information Portal), KIS-Value (Corporate Information Portal), and Financial Supervisory Service Electronic Disclosure System (dart.fsss.or.kr). There have been some difficulties in verifying information for some companies through the sources above. This study inevitably excluded those companies from the analysis.

Besides, the data were verified by the National Statistics Portal (kosis.kr) (KOSIS) and the Korea Energy Agency (ets.energy.or.kr) to confirm the accuracy of the data.

[14] Year 2015 (564) → Year 2016 (+44) → Year 2017 (+34)

Chapter 4. Results

4.1. Descriptive Statistics

Firm Size

Of the 299 companies subject to the ETS regulation, 98 are large companies (32.8%), 150 are mid-sized companies (50.2%), and 51 are small-sized companies (17.1%). Medium-sized companies account for the most considerable portion, and large companies account for about twice the share of small-sized enterprises.

On the other hand, out of 380 listed companies, 57 companies were large and accounted for 15.0% of the total. 268 mid-sized companies accounted for 70.5%, and 55 small-sized companies accounted for 14.5%. Mid-size companies also account for the overwhelming portion of listed companies. The proportions of large and small companies are similar.

The numbers of mid-sized companies are the largest in both groups. The proportion of large companies of the ETS-regulated companies is twice as large as that of the listed companies.

Table 13. Frequency and Size of the Analysis Samples

(KRW in millions, %)

Item	ETS Companies (Treatment Group)		Listed Companies (Control Group)		Total	
# of firms	299		380		679	
Firm Size	299	(proportion, %)	380	(proportion, %)	679	(proportion, %)
Big	98	(32.8)	57	(15.0)	155	(22.8)
Medium	150	(50.2)	268	(70.5)	418	(61.6)
Small	51	(17.1)	55	(14.5)	106	(15.6)

Source: Written by the author based on the collected data.

Type of Industry

The industry distribution of the analyzed enterprises is as shown in Table 14. It consists of six sectors and 31 industries, eight more than the 23 industries proposed in the 'First National Emissions Allocation Plan (Ministry of Environment, 2014)[15].'

Among the ETS regulated companies, Petrochemicals accounted for 19.4%, Paper 11.4%, Steel 9.0%, Power Generation & Energy 8.4%, and Motor Vehicle 6.0%. We can characterize these industries by high greenhouse gas emissions in the production process.

Among the listed companies, Petrochemicals (13.2%), Financial & Insurance (11.3%), Motor Vehicle (8.7%), Medicaments (8.2%), and Electrical & Electronics (6.6%). Medicaments account for a significant portion of 8.2%, and holding companies that function as manufacturing headquarters account for 11.6%.

In both groups, Petrochemicals accounted for the most considerable portion. Motor Vehicle is also at the top of the list. On the other hand, the share of Power Generation & Energy, a typical energy-consuming industry, was 8.4% among the ETS companies, almost 10%, while it was only 1.3% of the listed companies.

[15] In this study, manufacturers of furniture, medicaments, medical instruments & supplies, land transport, construction, and financial & insurance industry and the headquarters that function as the holding companies of manufacturers were added.

Table 14. Industry Distribution of the analysis samples

No	Sector	Industry	ETS (#)	(%)	Listed (#)	(%)
1	Energy	Power Generation & Energy	25	(8.4)	5	(1.3)
2	Manufacturing	Mining & Quarrying	3	(1.0)	0	(-)
3		Food & Beverages	16	(5.4)	22	(5.8)
4		Textile	3	(1.0)	4	(1.1)
5		Apparel	0	(-)	19	(5.0)
6		Wood	5	(1.7)	1	(0.3)
7		Paper	34	(11.4)	2	(0.5)
8		Petroleum	6	(2.0)	2	(0.5)
9		Petrochemical	58	(19.4)	50	(13.2)
10		Glass·Ceramics	15	(5.0)	6	(1.6)
11		Cement	4	(1.3)	4	(1.1)
12		Steel	27	(9.0)	23	(6.1)
13		Non-ferrous Metals	13	(4.3)	7	(1.8)
14		Machinery	4	(1.3)	21	(5.5)
15		Semi-conductor	8	(2.7)	5	(1.3)
16		Display	6	(2.0)	2	(0.5)
17		Electrical & Electronics	12	(4.0)	25	(6.6)
18		Motor Vehicles	18	(6.0)	33	(8.7)
19		Shipbuilding	5	(1.7)	0	(-)
20		Furniture	0	(-)	6	(1.6)
21		Medicaments	2	(0.7)	31	(8.2)
22		Medical Instruments and Supplies	1	(0.3)	4	(1.1)
23	Public Service & Waste	Water Supply	2	(0.7)	0	(-)
24		Waste	9	(3.0)	0	(-)
25	Building	Buildings (Except Communications)	9	(3.0)	7	(1.8)
26		Communications	6	(2.0)	16	(4.2)
27		Construction	2	(0.7)	23	(6.1)
28	Transportation	Air Transport	4	(1.3)	2	(0.5)
29		Land Transport	0	(-)	16	(4.2)
30	Holdings	Financial & Insurance	0	(-)	43	(11.3)
31		Headquarters	2	(0.7)	1	(0.3)
Total	6	31	299	(100.0)	380	(100.0)

Source: Based on collected data, written and reorganized by the author.

Financial Performance

The financial indicators of the ETS-regulated companies before and after the implementation of ETS Phase 1 showed a decrease in the revenue, ROA, and an increase in operating profit, total asset, and debt ratio. In contrast, for the listed companies, all five indicators have increased.

The operating profit increased by 13.5% for the ETS-regulated entities despite a decrease in revenue following ETS implementation. Besides, total assets increased by only 13.9%, while the debt ratio surged by 34.9%. ROA decreased by 6.1%. Listed companies saw a 28.7% increase in revenue and a 54.9% increase in operating profit. It is also notable that the total assets increased by 44.4%, but the debt ratio increased by only 1.5%. ROA has risen by 8.7% after ETS.

Table 15. Financial performance before and after ETS of the analysis samples

(KRW in millions, %)

Item	ETS Companies (Treatment Group)		Listed Companies (Control Group)	
Revenue	Mean	(% change)	Mean	(% change)
Before ETS	4,039,415	-	1,054,751	-
After ETS	3,668,651	-9.2%	1,357,233	28.7%
Operating Profit	Mean	(% change)	Mean	(% change)
Before ETS	190,786	-	57,740	-
After ETS	216,479	13.5%	87,878	54.9%
ROA	Mean	(% change)	Mean	(% change)
Before ETS	3.78	-	2.61	-
After ETS	3.55	-6.1%	2.84	8.7%
Total Asset	Mean	(% change)	Mean	(% change)
Before ETS	5,009,852	-	1,137,439	-
After ETS	5,704,774	13.9%	1,642,509	44.4%
Debt Ratio	Mean	(% change)	Mean	(% change)
Before ETS	184.7	-	144.4	-
After ETS	249.2	34.9%	146.6	1.5%

Source: Based on collected data, written and reorganized by the author.

4.2. Results of Difference-in-Difference

As a result of testing the parallel trend of the treatment group and the control group, this study could confirm the parallel trends for all three models. In other words, the dependent variables of all models would be valid because it satisfies the essential assumption. For DID analysis, a comparison group with fairly similar characteristics must exist, which requires screening of a comparative group consisting of companies with high greenhouse gas emissions, high energy consumption, and similarities in the type of industries (Sohn and Lee 2018). Fortunately, the ETS-regulated entities were comparable to the listed companies in this regard. Based on this test result, subsequent analyses were carried out.

The hypothesis wanted to confirm that ETS's implementation had a negative impact on the financial performance (revenue, operating profit, ROA) of the ETS-regulated companies. This study set the listed companies as the control group through the DID method and performed multiple regression analysis.

As shown in Table 16, model 1 with revenue as a dependent variable showed negative effects (coefficients estimate of $D_e \times D_t$: -.024**) of ETS with statistical significance as expected in the hypothesis. However, operating profit (.032*) and ROA (.031) increased rather than before the ETS. Among the three financial indicators used as dependent variables, revenue and operating profit had statistical significance, and ROA had no statistical significance. Therefore, considering only the financial indicators analyzed in this study, it is difficult to say that ETS consistently adversely affected the financial performance of regulated companies. Rather, more variables have had a positive impact.

Table 16. Effects of ETS (N=679)

	Model 1: Revenue	Model 2: Operating Profit	Model 3: ROA
ETS Implementation (D_e)	.019**	-.013	.008
Time Dummy (D_t)	.015*	.028**	.005
$D_e \times D_t$	-.024**	.032*	.031
Firm Size Dummy_1	.022***	.053***	.002
Firm Size Dummy_2	-.002	-.006	-.040**
Industry_Dummy_1	.000	.001	-.004
Industry_Dummy_2	.003	-.006	.014
Y_{t-1}	.948***	.856***	.512***
Firm Age	.006	.000	-.012
Debt Ratio	-.001	.001	-.013
Real GDP growth rate by Industry	.001	.003	.018
Adj R^2	.921	.770	.268
F-value	4300.306***	1239.364***	136.728***

* Note: Standardized coefficient, +p<.10, *p<.05, **p<.01, ***p<.001
* Written by author based on the analysis results

4.3. Interpretation of Results

As a result of the hypothesis verification above, we confirmed that the effect of ETS on corporate financial performance is inconsistent and that it has a rather positive effect on two of the three financial indicators. Although we take into account that the impact of ETS Phase 1 on ROA lacks statistical significance, the above results suggest that ETS Phase 1 did not necessarily negatively affect corporate financial performance. In other words, we can interpret the above analysis result as partially establishing the Porter hypothesis in ETS regulation. An increase in R&D expenditure (Oh et al., 2018) is one of the strong evidences. According to Hyungna Oh et al. (2018), with the implementation of ETS Phase 1, the R&D expenditures of regulated companies increased statistically significantly.

The increase in R&D expenses was estimated to be about 14 billion won. Since the average R&D cost before ETS was 87 billion won, they analyzed that there was an effect of about 15% increase in R&D cost after the introduction of ETS. In addition to R&D expenses, it was not included in this study, but it suggests that the cost of sales was also significantly reduced.

However, this is somewhat different from the results of a survey[16] of companies subject to ETS included in the aforementioned 'Report on the first and second-year operation results of ETS in Korea (Ministry of Environment, 2018).' The survey found that 54% of companies incurred additional costs due to ETS, and 28% complained of the burden of implementing regulations.

We can make some assumptions about this difference. First, we can assume that the TMS regulation, which took effect in 2012 before the ETS, has made companies significantly adjust to GHG regulations. In fact, the criteria for selecting regulated companies in 2012 (Companies with annual average greenhouse gas emissions of 125,000 tons CO_2eq or business sites with emissions of 25,000 tons CO_2eq or higher over the past three years[17]), the first year of implementation of TMS, are the same as those for selecting ETS-regulated companies. This resulted in almost all the TMS-applied entities (470, as of 2011; Lee et al., 2012) being subject to ETS regulation in 2015. This means many of the ETS companies have already experienced TMS. They may have prepared to reduce GHG emissions in any form before ETS launched. But at the same time, we can interpret that the ETS-regulated companies do not have much room for further reduction as TMS has already regulated them for three years (Sohn et al., 2019, 40-41). Furthermore,

[16] The Impact of ETS on Management Activities
[17] Presidential Decree of Green Growth Act, Article 29, Para 1, Sub-para 1, Attached Table 2.

Korea's major manufacturing industries are already implementing world-class energy efficiency as written in Table 17. This indicates there is not much room for further reductions (Yeom, 2012). Therefore, we can not say that TMS worked only positively on the corporate financial performance of the ETS-regulated companies. A more objective evaluation of the impact of ETS will be possible only when consideration of additional factors other than TMS is supported.

Table 17. Comparison of Energy Efficiency Index[18] of the Steel Industry in Major Countries

(Korea = 100)

Korea	Japan	Australia	US	Canada	India
100	104	106	118	124	143

Source: Yeom. (2012). International Comparison of Energy Efficiency in Major Korean Industries. *Press Release. The Korean Federation of Industries (June 2012).*

Second, we can also estimate that the regulatory strength of ETS Phase 1 was not strong enough to affect the financial performance of the regulated entities. Phase 1 of Korea-ETS calculated the expected emissions (BAU) based on the regulated entities' past emissions in 2011-13 (GF; Grandfathering). The government allocated 100% of the emission rights calculated by applying the reduction rate to the BAU to the companies free of charge. This allocation method has reduced the companies' financial burden. We can also estimate that sufficient emission allocation has eased the burden on the companies. In Phase 1, the regulated companies emitted 1,669.4 million tCO_2eq, which was 16.2 million tCO_2eq (0.96%) less than the final quota (Korea Energy Agency, 2018, p.1). In

[18] The energy efficiency index refers to foreign countries' energy use when Korea is set at 100 for the production of certain quantities of each industry, and the lower the figure, the higher the energy efficiency.

ETS Phase 1, industry and experts raised the issue of uneven allocation by industry (Lee, 2016). Actually, many companies in petrochemicals and non-ferrous metal industries even filed an administrative lawsuit against the government. It raised the issue of equity by industry after being notified of their quotas at the end of 2014 (Yonhap News, 2015). However, the government has since tried to alleviate the burden by allocating additional emission permits to these industries. Therefore, it is reasonable to say that the regulatory strength of Korea-ETS Phase 1 was relatively tolerable. It seems that the policy authorities did not set the level of regulation to an excessively high level, taking into account that the policy was in the early stages of implementation and taking into account the industry's acceptance of regulations.

Third, we can interpret that energy costs do not account for a large proportion of the total costs even in manufacturing companies. A number of domestic and international studies exist on the share of energy costs for manufacturers. According to Hyungna Oh (2011, p.26), as of 2008, energy costs in manufacturing accounted for an average of 3.06% of total production costs. SMEs also have a very low share of energy costs in total production costs. Korea's electricity use in the manufacturing sector was 46.7% (2013), which is significantly higher than that of other countries[19] (IEA, 2015). According to a survey, small-sized Korean manufacturers spent 4.5% on electricity to total sales (KBIZ and KNU, 2018). In Germany, a leading manufacturing hub, 70% of all small-sized enterprises spent less than 5% of their total costs on energy (Schwartz, 2018). In other words, the fact that energy costs generally account for less than five percent of the total production costs for manufacturers is one of the reasons why ETS has

[19] Percentage of electricity consumption in the manufacturing sector: 1st (Korea, 46.7%), 2nd (UK, 36.6%), 3rd (Germany, 34.9%)

not had a significant impact on financial performance.

Fourth, we may interpret that the negative effects of ETS answered by companies in the survey were not an immediate reference to the financial impact that occurred, but an expression of their concern about the future uncertainties and potential risks to overall management activities. For example, in Phase 1, there was a structural imbalance between the supply and demand of emission permits (continuous excess demand) in the emission trading market. Therefore experts have blamed for the fact that companies continued to hold emission permits without selling them even if they could afford them in the future. Companies even moved them on to the next year (Ministry of Economy and Finance, 2017). In fact, a total of 454 companies have carried forward emission permits allocated to Phase 1, with a total of 37.01 million tons (2.2% of the total quota for Phase 1). The share of companies that never participated in ETS Phase 1 in the emission trading market also reached an average of 62% per year (Oh et al., 2018, pp.109-111).

4.4. Policy Implications

Overall, the impact of ETS on corporate financial performance was not distinct and was not significant as feared before implementing the policy, either. Rather, we confirmed that ETS had a positive effect on operating profit. At least, we can evaluate that the government did not overdesign Korea-ETS Phase 1 in terms of regulatory strength or regulatory scope. However, it is essential to note that ETS regulation's effects can change over time. Although the three-year financial performance of ETS Phase 1 was not negative, that is why researchers

and policy authorities should constantly monitor and study to see if this trend continues after Phase 2. In particular, from Phase 2, as the free allocation ratio gradually decreases, and additional regulations such as restrictions on carry-over of emissions are introduced, there is a possibility that we will additionally observe the effects of ETS, which people could not confirm in Phase 1. Therefore, the government's policy management must follow in order to maintain the soft landing stance of Phase 1 well.

Presenting a Long-term Vision, Combination of Sticks & Carrots.

To prevent regulated groups from ETS's negative impact and ensure its efficient operation, policymakers must present a long-term vision to regulated businesses and consistently pursue policy directions. To this end, the government should introduce a detailed roadmap on how the current ETS has a close link to its long-term goal of a 37% reduction from the 2030 BAU. Suspending, regressing, or delaying ETS, which we have launched based on the international agreements, and already in place for six years under domestic law, may further increase uncertainty and confusion among companies. Moreover, the reverse may undermine the credibility of other GHG policies in the future. We should not disadvantage the companies that trust and faithfully prepare government policies and implement related investments. Thus, while fine-tuning a policy's details may be possible, changing the plan's foundation may be more to lose than to gain.

The long-term vision serves to give a signal to businesses. This constitutes a kind of guide role that enables companies to plan and prepare for regulatory implementation in advance in their circumstances. Therefore, they should never be punitive or coercive, nor should they overburden those subject to the regulation

through a drastic push. In other words, the government should provide regulatory constraints and sufficient means of implementation at the same time. Simply strictly operating regulations is not the only way to successfully perform the system. The key to success in ETS is enabling the regulated companies to simultaneously pursue the conditions, opportunities, and incentives to achieve the ETS objectives.

Adjusting the Strength and Speed of the Regulations

First of all, it is necessary to reconsider whether existing environmental regulations, including ETS, have been closely reviewed by the regulated groups for possible regulatory implementation. Prior studies of the successful implementation of regulations commonly emphasize compliance of regulated groups. Regarding government regulations, "regulatory compliance generally means that groups subject to policy act as required by regulation for policy objectives they intend to achieve (Kim, 2003; Anderson, 1979; Young, 1979; Duncan, 1981; as cited in Choi et al., 2018, p.6)." In other words, it is hard to say that even the strictest regulations function correctly if the regulated group does not or cannot implement the results initially targeted. Therefore, the reasons for common regulatory non-compliance in prior research are the 'cost of regulation' and the 'feasibility (Coombs, 1981; Kim, 2002).'

Under the 2030 GHG reduction goal, securing regulatory compliance is even more critical for ETS. Because it is being pursued over the long term. Therefore, it is necessary to develop institutionalized frames that can analyze the effects of regulation from the perspective of the regulated group of entities. From the standpoint of regulators, Phase 1 of Korea-ETS results has not resulted in severe regulatory costs in corporate financial performance. However, the ETS and all

domestic and international regulations can have an overall impact from the perspective of individual entities that are regulatory groups. In this case, even the weakest regulation can place a significant burden on the subject if they implement simultaneously or at a similar time to other regulations (Jang and Lee, 2019).

According to Jang and Lee (2019), the Korean government introduced a total of 509 new environmental regulations during 2008-18, including ETS. That means the government has created an average of 46 environmental regulations each year. There are also 30-80 cases of tightened regulations every year. Besides, most respondents in the survey said it was challenging to identify the regulations due to new or strengthened environmental regulations, complained of a cost burden, or lacked internal expertise[20].

In this context, we could suggest a system is necessary to assess the impact of regulations objectively by placing a tentatively named "Industrial Impact Assessment." With many evaluation systems already in place before implementing new policies such as 'environmental impact assessment' and 'employment impact assessment,' the emergence of another evaluation system may be another red tape. Hence, it is worth considering implementing them flexibly at a specific point in time or in a particular sector or industry.

Streamlining the Transaction Market's Efficiency: Need for Safety Valves

It is crucial to induce the current emission trading market to work efficiently to ease the ETS-regulated companies' burden. The average price of Korea-ETS emission in 2019 was $25.6, the world's highest price (ICAP, 2020). This is far

[20] 68 out of 100 companies (Duplicate response) that responded to the survey said it was difficult to grasp the details of the regulations. 65 out of 100 companies complained of the cost burden, and 56 said they lacked internal expertise.

higher than $24.8 of EU-ETS, $16.8 of California (U.S.), $6.0 of RGGI (U.S.), and $16.3 of New Zealand. Changes in allocation methods and reduced allowances since Phase 2 have caused anxiety and made the market continue to see high demand for supply. These phenomena require efforts to ease the system's rigidity.

One of the significant ways to streamline the emission trading market is the "price ceiling." The main purpose of the price ceiling is to control fluctuations in emissions prices so that price changes do not expand to such an extent that they undermine market stability. This is the same concept as "safety valve" in many emission trading schemes and literature, and intends to prevent exceeding the upper limit of predetermined prices (Oh et al., 2012).” According to Oh et al. (2012), The downside of the price ceiling is that if the emission price exceeds the upper limit price, the emission rights can be purchased at the market price and paid the upper limit price to the government instead of complying with the reduction obligation. This can increase the total allowable emissions (cap). However, we might think of that as a complement to the ETS's institutional deficiencies. Because price ceilings allow the regulated companies to meet their obligations at a limited level, even at the highest price, instead of submitting emission permits to comply with their assigned reduction obligations. In fact, Korea-ETS had a significant lack of supply compared to the demand for emission permits in both Phase 1 and 2, which raised concerns among companies about high market prices and raised doubts about the market's efficient operation. From Phase 2, the government made efforts to increase liquidity by limiting the carryover of emission permits, but the excess demand continued nonetheless. Thus, in the current Korean emission trading market, we can expect that the price ceiling is going to work closer to safeguards that ease market participants' anxiety and promote transactions, rather than at least playing a

role in undermining market efficiency.

Other measures, such as actively utilizing government holdings to boost liquidity, should also be considered. Besides, until market transactions become active, the government needs to apply the allocation method with flexibility for the time being to prevent market participants from hesitating or suspending transactions for fear of a lack of supply of emissions permits.

Encouraging International ETS Participation, Utilizing Opportunities

Only a few countries' efforts can never solve issues like reducing GHG emissions. ETS also needs to expand the market size and interlink each country's ETS to make transaction costs be lowered and transactions more active. Accomplishing those conditions, ETS's original efficiency mechanism can work even more efficiently. Also, regulated groups are likely to complain if only their own country is subject to overly strong regulations. That might lead to a drop in regulatory compliance. In fact, Korea's total GHG emissions account for only 1.5 percent of the world in 2016 (WRI, 2020) [21]. Moreover, Korea, as one of the UNFCCC's non-Annex I countries before the 2015 Paris Agreement, has a relatively lower historical responsibility for GHG emissions than Annex I Counties, including the EU. That is because the Annex I Counties have started industrialization way before the 20th century.

Therefore, the government should encourage other countries' ETS participation in international regimes such as the UNFCCC. Strategic and forward-looking efforts are necessary for international multilateral negotiations and in

[21] China (25.8%), US (12.8%), India (6.7%), Russia (5.3%), Japan (2.7%), Brazil (2.3%), Indonesia (1.9%), Germany (1.9%, EU=7.8%), Iran (1.7%), South Korea (1.5%)

comprehensive bilateral talks. For example, Korea could propose the interconnection of its ETS to its bilateral negotiating partners. In order to persuade the regulated companies, the government must also closely monitor and communicate the trends of its competitors in detail. Also, it is necessary to have sufficient communication with the regulated groups.

Meanwhile, domestic companies may be the leaders in the markets such as energy diagnosis, consulting, and development of energy efficiency technologies generated through ETS. To this end, the policy authorities should make various efforts, such as preemptively overhauling relevant laws, strengthening cooperation between industry and academia, and disseminating successful cases.

Chapter 5. Conclusion

To join the international community's efforts to reduce GHG emissions, including the signing of the 2015 Paris Agreement, and to reduce its dependence on fossil fuels, Korea enacted the Emissions Trading Act in 2012. It implemented Phase 1 of the ETS nationwide for 2015-17. It is the fourth economy in the world to launch the economy-wide ETS following the EU+5 (including Switzerland), New Zealand, and Kazakhstan, which is a very advanced attempt. Contrary to concerns at the beginning of ETS implementation, this study could not conclude that the effect of ETS on corporate financial performance was negative. While ETS had a negative impact on revenues, the impact of ETS on financial performance was not consistently derived for all financial indicators. Rather, in some financial indicators such as operating profit, the ETS environmental regulation had a positive effect, as the Porter hypothesis implies. In order to continue and expand the positive performance of ETS in Phases 2 and 3, environmental authorities must closely analyze the successful aspects of Phase 1. Also, environmental authorities need to be cautious about the regulations tightened after Phase 2.

M. Porter and Van der Linde (1995, p.110), who suggested the Porter hypothesis for the first time, mentioned three requirements for environmental regulation to drive innovation: ① They must create the maximum opportunity for innovation, ② Regulations should foster continuous improvement, rather than locking in any particular technology, ③ The regulatory process should leave as little room as possible for uncertainty at every state. For environmental regulation

to create opportunities for innovation and to attract continuous improvement, incentives and means of implementation should be given to the regulated group to implement the regulation faithfully. The regulated group should understand the fundamental legitimacy of regulation. It has a lot to do with regulatory compliance. Failure to secure regulatory compliance will make it even more challenging to secure new companies to participate within the regulation fence, even if many want to follow the regulations. In the process of implementing regulations, constant monitoring and improvement are necessary to ensure that the market is not functioning efficiently due to anxiety among economic players. According to Porter, if environmental regulations do not meet the conditions above, we can not guarantee the link in which environmental regulation leads to innovation.

This also provides many policy implications for this study. We should consider that although ETS Phase 1 did not have a significant impact on the entity's financial performance, we need to continuously monitor ETS effects we have not identified in Phase 1. These efforts are for the next planning periods when regulatory levels are more tightened. To this end, the government should first present a clear long-term vision. In issues like climate change, long-term perspectives, and long-term problem resolution are critical. It also requires consistent policy implementation. There may be slight adjustments in policy implementation, but the sudden suspension, delay, or alteration of the fundamental framework will only bring greater confusion and uncertainty to the regulated group.

Also, before regulation, it is necessary to closely examine the subject's ability to regulatory compliance and design regulations based on the examination. The government should phase the intensity and speed of regulation rather than full-scale, and provide differentiated support depending on the type of regulated group

identified. In the meantime, we should also strive to improve the efficiency of ETS's core mechanism, the emission trading market. The efficiency of the emission trading market is, in fact, a fundamental premise of the legitimacy of ETS. However, looking at the results of the transactions during ETS Phase 1 and 2, one cannot help but wonder whether emission permits are having a significant impact on companies' GHG reduction activities since companies have confronted excessive supply shortages in the market and price surges. Through proper market intervention, such as price ceilings, safeguards are necessary so that trading entities can buy and sell emission permits with confidence.

Furthermore, the government should try to expand the scope of countries participating in the nationwide ETS. In addition to multilateral negotiations, countries should discuss environmental issues like ETS in the bilateral talks, and share their experiences and achievements. These efforts will ultimately serve as an opportunity to further enhance GHG reduction by extending the external presence of the emission trading market. With the ETS, more public-private cooperations and funds need to support investments in developing energy diagnosis, consulting services, and related technologies.

This study was conducted with a focus on Phase 1 of Korea-ETS. This will give significant implications for the direction of Phase 2 and 3. However, the 100% free allocation of ETS Phase 1 and the fact that it was in the early stages of implementing the policy played a role as a constraint to properly assess the objective and accurate impact of ETS. Moreover, as the number of financial indicators subject to analysis is limited to three, it is necessary to add indicators such as manufacturing costs in the future. Also, we can get more accurate ETS effects if other types of supplementary studies such as surveys or visits to business

sites are conducted on facility investment by companies. In the DID analysis, the study set the KOSPI-listed companies as the control group for comparison with the ETS-regulated companies. However, the exact comparison has been limited due to the differences in corporate attributes. As ETS is a policy that continues to exist, we need more follow-up studies for Phase 2 and 3. Then, we can expect further implications by closely examining trends compared to the results of Phase 1.

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Abstract in Korean (국문 초록)

한국의 온실가스 배출권거래제 시행이 기업 재무성과에 미친 영향에 관한 연구

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2015년에 체결된 '기후변화에 관한 파리협정'을 필두로 글로벌 환경규제가 심화되고 있다. 이는 화석연료 중심의 기존 에너지 사용 패러다임의 근본적인 전환을 요구하고 있다. 이러한 국제 추세는 한국을 비롯한 제조업 중심 국가들에 적지 않은 영향을 미칠 것으로 전망된다.

이에 본 연구에서는 한국의 온실가스 배출권 거래제(ETS) 1차 계획기간(2015-17) 시행결과 배출권 할당대상업체의 재무성과에 부정적 영향이 있었는지 검증하였다. 이를 위해 ETS 규제를 받지 않은 기업의 같은 기간 재무성과와 비교 분석하였다. 기업 규모나 업종 등을 통제하였을 때도 ETS 영향이 존재하는지 살펴보았다. 실험집단은 2014년 ETS 대상업체로 지정된 524개 업체 중, KIS-Line(기업정보포털)과 KIS-Value(기업정보서비스)를 통해 기업 재무정보 확인이 가능한 299개사(이상치 3개사 제외)이다. 통제집단인 ETS 규제를 받지 않은 기업은 코스피(KOSPI) 상장기업 중 비금융사로 설정하였으며, 업체수는 ETS 1차 계획기간 동안 본 연구에서 필요로 하는 기업 재무정보 확인이 가능한 380개사이다.

이중차분(DID) 분석 결과 ETS가 기업 재무성과에 반드시 부정적인 영향을 미친다고 볼 수 없었다. ETS 시행으로 매출은 유의하게 감소, 영업이익은 오히려 유의하게 증가하였으며, 자산수익률(ROA)은 통계적 유의성은 없지만 ROA 수치는 증가하는 등

ETS의 영향이 재무지표에 따라 일관되게 나타나지 않았다. ETS의 부정적 영향이 미미하고, 영업이익, 자산수익률 등에는 오히려 긍정적 영향을 미친 이유는 여러 가지로 추정해 볼 수 있다. 목표관리제(TMS) 등 ETS 시행 전 기업들이 이미 유사한 온실가스 규제를 경험하여 ETS에 쉽게 적응했을 가능성, ETS 1차 계획기간에 배출권을 100% 무상할당 하는 등 규제 강도가 낮았던 점, 기업들의 전체 생산비에서 에너지 비용이 차지하는 비중이 대체로 5% 미만으로 크지 않은 점, 기업들이 당장 심각한 재무적 타격을 겪지 않았으나 미래의 불확실성과 잠재적 리스크를 적극적으로 표명한 점 등이 당초 우려했던 만큼 재무성과에 큰 충격이 발생되지 않은 원인일 수 있다.

앞으로 정책 당국은 환경이슈의 특성을 고려해 장기 비전을 제시하고, 규제와 동시에 이행수단을 함께 제공할 필요가 있다. 적정한 규제의 강도와 규제의 속도 조절도 규제의 성공적 안착을 위해 필수적이다. 배출권 거래시장의 효율화를 위해 가격 상한제도 필요하다. 나아가 ETS의 상호 연계 및 외연 확대를 위해 국제사회의 ETS 참여를 독려하고, 에너지 효율 기술 및 환경설비 분야에 대한 국내기업의 진출도 적극 장려해야 한다.

끝으로, 본 연구는 ETS를 포함하여 미래에 지속적으로 심화될 에너지 및 환경규제에 대응하여 환경 정책과 산업 정책이 조화롭게 추진될 수 있는 방향성을 고민해 보았다. 환경정책의 지속 가능성과 성공 가능성도 결국 피규제집단인 기업들의 규제 순응과 규제의 적극적 활용에 달려있기 때문이다. 그러므로 엄격한 규제의 이행에 앞서 피규제집단의 규제 이행 능력에 대한 면밀한 검토가 선행되어야 한다. 규제이행 역량에 따라 차별화된 지원 대책도 마련되어야 한다. 또한 국가간에 환경 이슈를 형평성 있게 부담하려면 국제기구 등을 통해 ETS와 같이 한국이 앞서 있는 환경 정책을 알리고 회원국들의 적극적인 동참을 이끌어야 한다. 이는 비단 배출권 거래시장의 외연을 넓히는 의미로서만이 아니라, 국내 규제대상 집단에 대해 국내 환경규제의 당위성을 강조하기 위해서도 필수적인 정부의 역할이다.

주요어: 환경 규제, 산업 경쟁력, 온실가스 배출권 거래제, 기업 재무성과, 산업 정책, 환경 정책

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