경영학박사학위논문

Essays on Intangible Investment

무형자산 투자에 관한 연구

2023 년 8 월

서울대학교 대학원

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Abstract

Essays on Intangible Investment

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This dissertation consists of two essays on intangible investment. The first essay, entitled "*Chaebol Group Affiliation, Patenting Activity, and Product Market Concentration*", examines the relation between chaebol group affiliation and patenting activity, as well as the economic implication of chaebols' patenting activity in product markets. Using the patent data on Korean public firms from 2001 to 2016, I find that chaebol affiliated firms obtain higher number of patents than non-chaebol firms. To explain this finding, I examine two mechanisms: R&D investment efficiency and knowledge spillover. Moreover, I find some evidence that patents are positively associated with future profitability and that this relation is stronger for chaebol firms. Given these findings, this paper explores the economic implications of patenting activity of chaebols and shows that patenting activity of chaebols is positively (negatively) associated with the market share of chaebols (non-chaebol). Lastly, I find some evidence that patenting activity of chaebols is related to market concentration, but it is not significantly associated with overall sales growth of an industry.

The second essay, entitled "*Pension Fund Ownership and ESG Performance: Evidence from Korean National Pension Service*", examines whether and how the Korean National Pension Service (NPS) follows its commitment to ESG. We explore two different channels for incorporating ESG factors in investment practices: encouraging investees to improve ESG performance (i.e., engagement), and changing holdings based on ESG. We first find that the level of NPS ownership is positively associated with future ESG score. We employ Granger causality tests to assess the causal relation and find that an increase in NPS ownership can predict future growth in ESG score, supporting the engagement channel. Furthermore, we investigate the exercise of voting rights as a form of engagement and find that ESG activities improve after the NPS votes against the agendas in shareholder meetings. However, we do not find the evidence that the changes in ESG score are associated with future changes in NPS ownership or that the NPS adjusts its holdings in response to negative ESG incidents. The findings suggest that the NPS implements its ESG commitment by engaging with companies, rather than by changing its holdings based on ESG performance of firms. Lastly, we examine the value implications of NPS holding and ESG performance. Using portfolio and firm-level regressions, we find some weak evidence that NPS's investees with higher ESG scores exhibit higher future abnormal returns.

Keyword: diversified business groups; chaebols; innovation; patents; product market concentration; pension fund ownership; National Pension Service (NPS), ESG performance; engagement

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Essay 1

Chaebol Group Affiliation, Patenting Activity, and Product Market Concentration

1. Introduction

Diversified business groups are prevalent in emerging economies. Business group is generally defined as a group consist of legally independent firms that operate under common administrative and financial control (Chang and Hong 2000). Chaebols, large business groups in Korea, have been playing a major role in driving the economic growth of Korea under government-driven economic development plans. However, chaebols have faced criticism due to their pyramidal ownership structures and cross-shareholding, which can give rise to various agency problems. Specifically, Morck et al. (2005) point out that a few wealthy families control the substantial portion of entire economy in several countries, and such phenomenon can lead to inefficiencies both at the firm and economy-wide level. They argue that such control concentration can result in biased capital allocation, increased barrier to entry, and reduced innovation, of all which have adverse consequences for economic growth.

Several prior studies examine the effect of business group dominance on the capital allocation outside the business groups (e.g., Kim 2020; Liu et al. 2021). However, limited research examines the Morck et al. (2005)'s argument on the innovation except Belenzon and Berkovitz (2010). Using European data, Belenzon and Berkovitz (2010) find that business group firms have higher number of patents and that this positive relation can be attributed to the firms' access to internal capital markets. However, they do not explore the economic implications of patenting activity. Because of the exclusive nature, patents can play a significant role in shaping a firm's market position and competitiveness. Thus, this paper aims to extend Belenzon and Berkovitz (2010) by examining the relation between a chaebol group affiliation and patenting activity, as well as the economic implications of patenting activity in product markets.

Morck et al. (2005) argue that pyramidal group firms with a higher level of control concentration may exhibit a lower level of innovation because well-established group firms can have lower incentives to invest in innovation activities. However, when considering the relation between an affiliation to business groups and patenting activity, two opposing expectations arise. On the one hand, diversified business groups are likely to achieve a higher number of patents because they have abundant resources that can support innovation activities. In particular, diversified business groups have a financing advantage since they can access internal capital markets (e.g., Almeida et al. 2015). Furthermore, they can leverage other valuable resources such as human capital and technological knowledge shared within the same business groups (e.g., Chang and Hong 2000).

On the other hand, diversified business groups may exhibit poor patenting activity due to potential inefficiencies arising from tunneling activities and bureaucratic organizational structure. These practices can divert resources from innovation-focused initiatives and hinder the overall innovation capabilities within the group. Belenzon and Berkovitz (2010) analyze the data on European firms and find that diversified business groups obtain higher number of patents, which is consistent with the former expectation. They further demonstrate that this association is more pronounced for the firms that are more likely to benefit from internal capital markets.

This paper extends the findings of Belenzon and Berkovitz (2010) by conducting more comprehensive investigation of the impact of patents on product market consequences. Patent system is designed to facilitate the innovation in an economy by granting inventors exclusive rights over their novel products or processes. This exclusivity allows investors to potentially earn monopoly profits for a specified period, which can contribute to better firm performance (e.g., Farre-Mensa et al. 2020). In addition, patents can play a crucial role in product market competition by excluding competitors from utilizing the patented technology (e.g., Cockburn and MacGarvie 2011; Veihl 2022). However, to my best knowledge, there has been limited research examining the disparities in patenting activity between chaebol and non-chaebol firms, as well as the economic consequences of patents within the specific context of the Korean economy. This study attempts to fill this gap by investigating the differences in patenting activity between chaebol and non-chaebol firms and the economic implications of patenting activity of chaebols in product markets.

Using patent data on Korean public firms from 2001 to 2016, I first find that chaebol firms obtain more patents than non-chaebol firms, consistent with Belenzon and Berkovitz (2010)'s finding. Furthermore, I link innovation input (R&D investment) and output (patents) and find that the positive relation between R&D expense and the number of patents is more pronounced for chaebol firms, indicating that chaebol firms make more productive R&D investment. I explore potential reasons for this finding. First, I find that chaebol firms make more efficient R&D investment, by showing that chaebol firms' R&D expenses are more sensitive to investment opportunities, measured as Tobin's Q. Second, I find some evidence of knowledge spillover within a chaebol group. Specifically, I find a positive relation between the number of patents obtained by a chaebol-affiliated firm and the number of patents obtained by other firms within the same business group.

Building on these findings, this study proceeds to examine the association between the number of patents and firm performance. I find some limited evidence that firms with higher number of patents have higher future profitability, and that this positive association is particularly pronounced for chaebol firms. The results are consistent with prior studies that document the economic benefits of patents (e.g., Hall et al. 2005; Hall et al. 2007; Balasubramanian and Sivadasan 2011; Kogan et al. 2017; Farre-Mensa et al. 2020). Overall, the results suggest that chaebol firms tend to acquire higher number of patents and derive greater benefits from the patents compared to non-chaebol firms.

To examine the economic implications of patenting activity by chaebols in product markets, I conduct industry-level analyses. Using Korea Standard Industrial Classification (KSIC) two-digit codes as an industry classification, I construct the share of patents and market share for both chaebol and non-chaebol groups within each industry-year.[1] The results suggest that an increase in patenting activity of chaebols, as measured by patent share, is associated with an increase in market share of chaebols and a decrease in market share of non-chaebol firms. I further find that an increase in patent share of chaebols is associated with greater market concentration. However, I fail to find the significant association between the patent share of chaebols and the aggregate sales growth of an industry. This implies that patenting activity of chaebols is associated with their market share and industry concentration, but it does not have a significant relation with overall sales growth of the entire industry.

This study is closely related to Belenzon and Berkovitz (2010), which explore the relation between business group affiliation and innovation using European patent data. However, this study differs from Belenzon and Berkovitz (2010) in several aspects. First, this study examines the role of patents in the product market concentration, as well as the dynamics between chaebol and non-chaebol firms within an industry. While Belenzon and Berkovitz (2010) primarily focus on the effect of business group affiliation on the number of patents, they do not explore the economic implications of patenting activity of business groups. Second, this study focuses on Korean setting to obtain clearer insights into the economic implications of patents within the context of Korean economy. While conglomerates were prevalent

[1] This approach is similar to that in Mahmood and Mitchell (2004), which examine the relation between the market share of business groups and innovation in an industry. Specifically, Mahmood and Mitchell (2004) measure the innovation of an industry using patent share.

in Europe and the United States for decades, many of them have struggled to survive due to poor firm performance. As a result, most of conglomerates have undergone transformation to focus on core businesses (Ramachandran et al. 2013). However, diversified business groups still continue to survive and maintain the dominant position in the emerging countries, highlighting the significant differences in institutional backgrounds. For instance, some researchers argue that business groups in emerging countries can serve as substitutes for relatively inefficient capital and labor markets compared to those in developed countries. In other words, business groups in emerging countries may address the institutional voids and thereby create value (e.g., Leff 1978; Khanna and Palepu 1997). Thus, chaebols in Korea may have unique features compared to business groups in developed countries. Given the distinction, it is worthwhile to examine the effect of business groups within the context of a particular country.

This study contributes to the literature on business groups by providing the evidence regarding the effect of chaebol affiliation on patents. Although a large body of literature supports the view on tunneling activities of business groups (e.g., Johnson et al. 2000; Bertrand et al. 2002; Baek et al. 2006; Kim and Kim 2022), another stream of literature provides the evidence related to the benefits of business group, especially an advantage in financing (e.g., Gopalan et al. 2007; Masulis et al. 2011; Byun et al. 2013; Almeida et al. 2015). This paper contributes to this line of literature by suggesting the patenting as an additional benefit arising from business group affiliation (Belenzon and Berkovitz 2010).

This paper also adds to the literature on innovation by examining the effects of patents on firm performance and overall industry. Prior studies document the positive effects of patents on firm performance (e.g., Hall et al. 2005; Hall et al. 2007; Balasubramanian and Sivadasan 2011; Kogan et al. 2017; Farre-Mensa et al. 2020). Prior literature also examines the role of patents in market competition (e.g., Cockburn and MacGarvie 2011; Veihl 2022). Combining these two streams of literature, this study provides some evidence that the positive impacts of patents are greater for chaebols, and that chaebols' patenting activity is associated with their market share and overall market structure.

Lastly, this study contributes to the literature that examines the dominance of business groups in the economy. Morck et al. (2005) argue that the situations where a few controlling owners control the company and large proportion of a country's economy can have negative impact on capital allocation, innovation, and thus macroeconomic growth. Several studies examine whether and how chaebol group dominance is related to the performance of non-chaebol firms (e.g., Kim 2020; Aghion et al. 2021; Liu et al. 2021). This study extends this line of literature by suggesting the patenting activity as a potential factor that contributes to the maintenance of chaebol's controlling position in product markets.

This paper is organized as follows. Section 2 reviews prior literature and provides research questions of this study. Section 3 describes the data and sample. Section 4 provides research design and empirical results. Section 5 summarizes and concludes the paper.

2. Literature Review and Research Questions

2.1. Literature Review

2.1.1. Prior Literature on Diversified Business Groups

The prevalence of chaebols is a distinct feature of Korean economy. The unprecedented growth of the Korean economy can be attributed to its export-oriented and government-led economic growth strategy. In early 1960s, Korean government implemented a series of economic development plans and provided various support and resources to specific industries and firms. During the period of rapid economic growth, chaebols pursued diversification strategy and exerted significant influence on the Korean economy. As a result, Korean economy is currently characterized as high concentration of chaebol firms. For instance, in 2017, the market capitalization of top 10 chaebols account for 52.8 percent of total market capitalization (Korea Exchange, KRX 2017).

However, prior studies suggest the potential costs stemming from ownership structure of diversified business groups. Due to pyramidal ownership structures and cross-shareholding, controlling shareholders can exercise the full control over all business group members despite of small portion of total ownership. The discrepancy between the ownership and control can provide incentives for controlling shareholders to engage in tunneling activities. That is, controlling shareholders can easily expropriate minority shareholders' wealth by transferring resources from a firm to other firms in the same business group. Tunneling activity may allow controlling shareholders to maximize their wealth, but it can result in poor performance of firms (e.g., Choi and Cowing 1999; Bae et al. 2002; Joh 2003; Ferris et al. 2003).

Another body of literature suggests the potential benefits of diversified business groups. Business groups can benefit from resource sharing among their affiliates (Chang and Hong 2000). Specifically, business group members can obtain capital at lower costs through the internal capital markets, which allows firms to overcome market frictions and financial constraints (e.g., Gopalan et al. 2007; Almeida et al. 2015). Moreover, cost of debt of business group affiliated firms is lower than that of standalones because of co-insurance effect (Byun et al. 2013). Using this comparative advantage in financing, business group affiliates may demonstrate higher profitability and investment (Buchuk et al. 2014), and greater innovation than standalone firms (Belenzon and Berkovitz 2010).

2.1.2. Prior Literature on Patents

In a knowledge-based economy, the importance of intangible assets has been growing over time, and innovation is a central driver of economic growth (Solow 1957; Romer 1990). To foster innovation, there exists a system of intellectual property protection, including the granting of patents. Patents grant inventors exclusive rights to utilize their original product, process, device, or technology for a specific duration of time. By allowing inventors to temporary enjoy monopoly rents from the patents, the patent system creates ex-ante incentives for innovation and facilitates overall innovation in the economy (Nordhaus 1969).

Prior studies suggest numerous economic factors that influence innovation activity including obtaining patents, such as being public (Bernstein 2015; Acharya and Xu 2017), institutional ownership (Aghion et al. 2013; Bena et al. 2017; Luong et al. 2017), board independence (Balsmeier et al. 2017), equity market development (Hsu et al. 2014), and labor unions (Bradley et al. 2017). Relying on resource-based theory, Belenzon and Berkovitz (2010) suggest that business group affiliation can facilitate firm innovation, and that greater innovation can be explained by the access to internal capital markets. This line of literature generally uses the number of patents as a proxy for innovation output and focuses on the firm-level determinants that influence innovation.

A stream of literature provides the evidence regarding the economic consequences of patents. Generally, prior studies document the positive effects of patents on firm performance, including higher firm growth and firm value (Hall et al. 2005; Hall et al. 2007; Balasubramanian and Sivadasan 2011; Kogan et al. 2017; Farre-Mensa et al. 2020). In addition, some studies suggest the positive consequences of obtaining or disclosing patents in debt and equity markets (Mann 2018; Saidi and Žaldokas 2021; Hedge and Mishra 2023).

Other studies examine the role of patents in product market competition. Because patents prevent other competitors from using invented technology, process, or products, patents can serve as a protective mechanism against copycats and deter product market competitors. For example, Cockburn and MacGarvie (2011) find a negative relation between the number of patents held by incumbents in a specific market and the rate of entry into that market, showing that the patents of incumbents can act as substantial entry barrier in the markets. Relatedly, Heger and Zaby (2018) find that the breadth of patents, which indicates the diversity of patented technologies, is associated with the threat of market entry. More recently, Veihl (2022) suggests that some firms strategically patent to prevent competitors from innovating, and that such strategic patenting protects the market position of firms and reduces the competition in markets. These studies suggest that patent system provides a strong mechanism to protect an inventor from competitors and thereby influence the overall market competition.

2.2. Research Questions

Building on the aforementioned prior studies, particularly Belenzon and Berkovitz (2010), I posit that the chaebol firms have ability to obtain higher number of patents compared to non-chaebol firms. Innovation requires the combination of capital, research facilities, talented employees, and accumulated knowledge and technology (Mahmood and Mitchell 2004). Chaebol firms have comparative advantage in these resources, which promote the patenting activity. Specifically, chaebol firms can access to the group-level resources, allowing them to share capital, technological knowledge, and human resources within the business group. Furthermore, intra-group capital allocation can improve chaebol firms' ability to invest efficiently in response to investment opportunities (Almeida et al. 2015), and more efficient investment is expected to yield greater innovation output.

The patent system, by granting exclusive rights to inventors, provides a competitive advantage to patentees and consequently influence their ability to compete in product markets (Federal Trade Commission 2011). This implies that patents can affect firm performance and overall competition within a product market (e.g., Cockburn and MacGarvie 2011; Kogan et al. 2017; Farre-Mensa et al. 2020). Thus, differential patenting activity between chaebol and non-chaebol firms may have economic implications within the product market. More specifically, I predict that the patenting activity of chaebols may be associated with their market position and the overall level of competition within the product market. Based on these predictions, this study attempts to provide the partial answers to following questions:

RQ1: Do chaebol firms obtain more patents? If so, what are the potential mechanisms?

RQ2: Are patent grants associated with firm performance?

RQ3: What are the implications of patenting activity of chaebols for non-chaebol firms and aggregate industry?

3. Data and Sample

The sample consists of non-financial Korean public firms listed on the Korea Stock Exchange (KSE) or the Korea Securities Automated

Quotation (KOSDAQ) from year 2001 to 2016.[2] I obtain the patent data on Korean firms from Korea Institute of Patent Information (KIPI).[3] Financial information data are retrieved from the DataGuide and TS2000 database. To identify an affiliation to chaebol group, I follow the classification suggested by Korea Fair Trade Commission (KFTC).[4] I obtain the list of chaebols from KFTC website. KFTC designates chaebols annually and discloses the information on the website.[5] To minimize the effects of other firm characteristics, I restrict the sample to firm-year with positive book value of equity, with December fiscal year-end, and without missing variables that are needed in the empirical analyses. All continuous variables are winsorzied at 1st and 99th percentiles to mitigate the effect of outliers. The sample size varies depending on the different model specification. I report the descriptive statistics of variables for each analysis.

4. Research Design and Empirical Results

4.1. Chaebol Group Affiliation and Patents

To test the first research question whether chaebols obtain more patents than non-chaebol firms, I estimate the following OLS regression model:

$$LN\_PATENT_{i,t+1} \text{ (or } LN\_PATENT_{i,t+2}\text{)}$$
$$= \beta_0 + \beta_1 CHAEBOL_{i,t} + \beta_2 RD\_EXP_{i,t} + \beta_3 CAPEX_{i,t} + \beta_4 MA_{i,t} + \beta_5 CASH_{i,t}$$

[2] The sample period ends in year 2016 because of patent data availability.
[3] The patent data covers the patents that are registered in Korea. It does not include the patents that are applied and registered in other countries. This is one limitation of this paper.
[4] The majority of prior studies identify chaebols following the guideline provided by KFTC (e.g., Joh 2003; Baek et al. 2004; Byun et al. 2013).
[5] Data on chaebol-affiliation can be obtained from the following KFTC's website: www.egroup.go.kr

$$+ \beta_6 LOG\_SALES_{i,t} + \beta_7 ROA_{i,t} + \beta_8 LN\_FIRM\_AGE_{i,t} + \beta_9 LEVERAGE_{i,t} + \beta_{10} TANGIBILITY_{i,t} + \beta_{11} CFO_{i,t} + \beta_{12} TOBINS\_Q_{i,t} + \beta_{13} HEFR\_INDEX_{i,t} + \beta_{14} BOD\_IND_{i,t} + \beta_{15} FOR\_OWN_{i,t} + \beta_{16} LARGE\_OWN_{i,t} + Year\ FE + Industry\ FE + \varepsilon_{i,t+1}, \quad (1)$$

where i indicates firm, and t indicates year. The dependent variable is the natural log of the number of patents that are approved in year t+1 (LN_PATENT_{t+1}) or in year t+2 (LN_PATENT_{t+2}).[6] The variable of interest is *CHAEBOL*, which is an indicator variable that takes the value of one if a firm is affiliated to chaebol group, and zero otherwise. I include control variables following prior studies that investigate the determinants of innovation (e.g., Balsmeier et al. 2017; Bena et al. 2017; Luong et al. 2017). For instance, I control R&D expense (*RD_EXP*), capital expenditure (*CAPEX*), cash outflows from merger and acquisition (*MA*), the level of cash holdings (*CASH*), firm size (*LOG_SALES*), profitability (*ROA*), firm age (*LN_FIRM_AGE*), leverage ratio (*LEVERAGE*), tangibility of assets (*TANGBILITIY*), cash flows from operations (*CFO*), growth opportunities (*TOBINS_Q*), market concentration (*HEFR_INDEX*), board independence (*BOD_IND*), foreign investor ownership (*FOR_OWN*), and large shareholders' ownership (*LARGE_OWN*). Industry and year fixed are included, and standard errors are clustered by firm. If chaebols patent more, consistent with Belenzon and Berkovitz (2010), the coefficient on *CHAEBOL* (β_1) will be positive. In addition, to examine whether the relation between

[6] In this sample, it takes approximately two years from the application date to the approval date of a patent. Thus, I use $LN\_PATENT_{i,t+2}$ as an alternative dependent variable. I find qualitatively similar results when I use the natural log of number of patents approved in year t+3 ($LN\_PATENT_{i,t+3}$).

innovation input (R&D investment) and output (patents) is different depending on chaebol group affiliation, I further include the interaction term between *RD_EXP* and *CHAEBOL* in Equation (1).

Table 1 reports the descriptive statistics of variables used in Equation (1). The sample is comprised of 19,400 firm-year observations from 2001 to 2016. In the sample, the firms obtain 7.6 number of patents annually on average. In all analyses, the number of patents is transformed into log variable (*LN_PATENT*) to reduce skewness. The corresponding mean value of LN_PATENT_{t+1} is 0.861. When I compare the number of patent grants between chaebols and non-chaebol, the mean value of *LN_PATENT* of chaebols is 1.67, whereas that of non-chaebol is 0.70. In terms of raw numbers, chaebol and non-chaebol firms, respectively, obtain 36 and 3 number of patents each year on average. The difference in mean values of the number of patents between two groups is statistically significant at 1 percent level. Figure 1 reports the yearly trend of the mean value of *LN_PATENT* for chaebols and non-chaebol group. The graph shows that there are upward trends in the number of patents for both chaebol and non-chaebol groups. However, the difference in the number of patents between chaebols and non-chaebol persists over time. The chaebol firms account for 13.6 percent of the sample.

[Insert Figure 1 about here]

[Insert Table 1 about here]

Table 2 provides the Pearson correlation matrix among the variables included in Equation (1). Table 2 suggests that an affiliation to chaebol group is positively correlated with the number of patents, while it is negatively correlated with R&D expense. The correlation implies that chaebol firms may obtain greater number of patents despite of lower spending on R&D investment. Later, I examine whether the associations hold after controlling the determinants of patenting.

[Insert Table 2 about here]

Table 3 reports the results of estimating Equation (1). The dependent variable is LN_PATENT_{t+1} in columns (1) and (3), whereas it is LN_PATENT_{t+2} in columns (2) and (4). In columns (1) and (2), I find the positive and significant coefficients on *CHAEBOL* (column (1): coefficient = 0.003, t-stat.= 4.17; column (2): coefficient = 0.003, t-stat.= 4.23), suggesting that chaebol firms obtain more patents than non-chaebol after controlling several determinants of patents.[7,8] This is consistent with Belenzon and Berkovitz (2010)'s findings that European business groups are more innovative. In columns (3) and (4), I further find that the positive relation between innovation input (R&D investment) and output (the number of patents) is more pronounced for chaebol firms, as shown by positive and significant coefficient on *CHAEBOL×RD_EXP* (column (3): coefficient = 0.183, t-stat.= 3.02; column (4): coefficient = 0.200, t-stat.= 3.05). The results imply that R&D investment of chaebols leads to higher number of patents

[7] Because the dependent variable is the natural log of the number of patents, the reported coefficient estimates are scaled by 100 to enhance the comparison across the variables.

[8] In terms of economic significance, chaebol firms obtain 0.83 more patent compared to non-chaebol firms each year, on average. The economic significance is calculated as exp(0.861 + 0.3) – exp(0.861), where 0.861 is the mean value of *LN_PATENT* and 0.3 is the coefficient on *CHAEBOL* before scaling by 100.

relative to that of non-chaebol firms. The coefficients on controls are generally consistent with prior literature (e.g., Balsmeier et al. 2017; Bena et al. 2017; Luong et al. 2017). For instance, the number of patents is positively associated with firm size (*LOG_SALES*), R&D expense (*RD_EXP*), capital expenditure (*CAPEX*), investment opportunities (*TOBINS_Q*), board independence (*BOD_IND*), and foreign investors' ownership (*FOR_OWN*), while it is negatively related to return on assets (*ROA*), firm age (*LN_FIRM_AGE*), leverage ratio (*LEVERAGE*), and large shareholders' ownership (*LARGE_OWN*).

[Insert Table 3 about here]

4.2. Mechanisms of Patenting

Given the greater patenting of chaebol firms, I further investigate the potential mechanisms for the patent gap between chaebols and non-chaebol. Specifically, I examine two different channels: (1) R&D investment efficiency, and (2) knowledge spillovers within a business group. First, if a firm makes more efficient R&D investment, one unit of R&D investment will be associated with higher number of patents. Yim et al. (2014) find that chaebol firms make more efficient investment using capital expenditure as a proxy for firm investment. To test the R&D investment efficiency channel, I estimate the below regression model:

$$
\begin{aligned}
&RD\_EXP_{i,t+1}\\
&= \beta_0 + \beta_1 CHAEBOL_{i,t} + \beta_2 TOBINS\_Q_{i,t} + \beta_3 CHAEBOL_{i,t} \times TOBINS\_Q_{i,t}\\
&+ \beta_4 SIZE_{i,t} + \beta_5 CFO\_SALES_{i,t} + \beta_6 TANGIBILITY_{i,t} + \beta_7 OPER\_CYCLE_{i,t}\\
&+ \beta_8 LOSS_{i,t} + \beta_9 STD\_CFO_{i,t} + \beta_{10} STD\_SALES_{i,t} + \beta_{11} STD\_RD\_EXP_{i,t}
\end{aligned}
$$

$$+ \beta_{12}D\_DIVIDEND_{i,t} + \beta_{13}ALTMAN\_Z_{i,t} + \beta_{14}SALES\_GROWTH_{i,t} + \beta_{15}LN\_FIRM\_AGE_{i,t} + Year\ FE + Industry\ FE + \varepsilon_{i,t+1}, \quad (2)$$

where *i* indicates firm, and *t* indicates year. Following prior studies, I proxy investment efficiency using investment-q sensitivity (e.g., McLean et al. 2012; Chen et al. 2017; Liu et al. 2021). According to Tobin's *q* theory, optimal investment is determined at a point where marginal value of investment is equal to marginal cost (Tobin 1969). In the theoretical framework of Abel and Eberly (1994), investment increases with *q* where *q* is above the upper threshold. Prior studies generally focus on the region above the upper threshold (e.g., Bushman et al. 2011), and under this assumption greater investment-*q* sensitivity represents more efficient investment.[9]

The dependent variable is the ratio of R&D expense relative to total assets in year t+1. I include control variables following Biddle et al. (2009). Specifically, I include firm size (*SIZE*), operating cash flows relative to sales (*CFO_SALES*), tangibility of assets (*TANGBILITY*), operating cycle (*OPER_CYCLE*), an indicator variable for reporting loss (*LOSS*), the standard deviation of operating cash flows scaled by total assets over the past 3 years (*STD_CFO*), the standard deviation of sales divided by total assets over the past 3 years (*STD_SALES*), the standard deviation of R&D expense divided by total assets over the past 3 years (*STD_RD_EXP*), an indicator of dividend payment (*D_DIVIDEND*), Altman's Z-score (*ALTMAN_Z*), sales growth

[9] I acknowledge that there are alternative measures of investment efficiency, including the likelihood of over- or under-investment (Biddle et al. 2009). However, I choose to use investment-*q* sensitivity to examine how firms are responsive to investment opportunities.

(*SALES_GROWTH*), and firm age (*LN_FIRM_AGE*). Industry and year fixed effects are also included, and standard errors are clustered by firm.

Panel A of Table 4 presents the descriptive statistics of variables used in Equation (2). For sample firms, R&D expense comprises about 1.1 percent of total assets. The mean value of Tobin's Q is 1.186. Panel B of Table 4 provides the results from estimating Equation (2). I find the positive and marginally significant coefficient on the interaction term between *CHAEBOL* and *TOBINS_Q* (coefficient = 0.004, t-stat.= 1.77), showing that the R&D investment of chaebol firms is more sensitive to investment opportunities. This result suggests that chaebol firms make more efficient R&D investment compared to non-chaebol firms. This is consistent with Yim et al. (2014), which document that an affiliation to chaebol is positively associated with the efficiency of investment in tangible assets. The result implies that chaebols may receive more patent grants because they make more efficient R&D investment so that one unit of R&D investment leads to greater innovation output.

[Insert Table 4 about here]

In addition, I attempt to investigate the knowledge spillovers within a business group. Belenzon and Berkovitz (2010) hypothesize that the diversified business groups can benefit from knowledge spillovers by sharing knowledge within a same business group. Based on this hypothesis, I also posit that patents of a chaebol firm will be closely related to the patents of other firms in a same chaebol group. To test this prediction, I adopt the approach in Shin and Park (1999) and Lee et al. (2009), which examine internal capital markets of business groups. Specifically, Shin and Park (1999) find that the investment of a chaebol firm is significantly associated with the cash flows of other firms in the same business group. They interpret this finding as an evidence of internal capital market within a business group. Following this approach, I construct the variables of the patents of other firms, which is defined as the sum of patents of all other firms in the same business group.[10] I then examine whether the number of patents of a chaebol firm is associated with the number of patents of others within the same chaebol group by estimating following model:

$$LN\_PATENT_{i,t+1} \text{ (or } LN\_PATENT_{i,t+2})$$
$$= \beta_0 + \beta_1 LN\_PATENT\_OTHER_{i,t} + \beta_2 LN\_PATENT_{i,t}$$
$$+ Controls_{i,t} + Year\ FE + Industry\ FE + \varepsilon_{i,t+1}, \quad (3)$$

The dependent variable is the number of a chaebol firm's patent, measured as either LN_PATENT_{t+1} or LN_PATENT_{t+2}. The variable of interest is *LN_PATENT_OTHER*, which is calculated as the sum of patents of all other members in the same chaebol group. Because the data on other firms in the same chaebol group are required, the sample is restricted to only chaebol firms in this analysis. I also include LN_PATENT_t, which is a firm's own patent in year t. Control variables are same as those included in Equation (1). I expect the coefficient on *LN_PATENT_OTHER* (β_1) to be positive if there are knowledge spillovers among the firms in the same business group.

[10] I acknowledge that using the measure of patent citation will be more appropriate to capture knowledge spillovers. However, due to the data limitation, I utilize the approach adopted in prior literature on internal capital markets (e.g., Shin and Park 1999; Lee et al. 2009), which examine the relation between a chaebol firm's investment and the sum of cash flows of other firms in the same chaebol group.

Table 5 provides the results of testing the knowledge spillover channel. Panel A of Table 5 provides the descriptive statistics of dependent variables and variable of interest. The average of LN_PATENT_{t+1} is 1.804, while that of $LN\_PATENT\_OTHER_t$ is 3.885. The mean value of *LN_PATENT* in this sample is higher than that in previous sample that includes both chaebols and non-chaebol firms. Panel B of Table 5 presents the estimation results of Equation (3). In columns (1) and (2), the dependent variable is *LN_PATENT* of year t+1 and year t+2, respectively. I find the positive relation between the number of a chaebol firm's patents and the number of other firms' patents within the same chaebol group, even after controlling a chaebol firm's own patent in year t (*LN_PATENT*) (column (1): coefficient = 0.012, t-stat.= 2.03; column (2): coefficient = 0.024, t-stat.= 2.53). The results suggest that a firm's patents are associated with other firms' patents within the same chaebol group, providing some indirect evidence of knowledge spillovers within a chaebol group.[11]

[Insert Table 5 about here]

[11] However, there is a possibility that the positive association between the number of patents of a chaebol firm and the number of patents of other firms in the same chaebol group may reflect the common time trend in obtaining patent, instead of knowledge spillover. To rule out this possibility, I conduct the falsification test. Specifically, I match the number of patents of a chaebol firm to total number of patents of other chaebol group. I assign the random number to each chaebol group, and match based on the assigned random number. If the results in Table 5 reflect the knowledge spillover within a chaebol group, there should be no significant relation between a chaebol firm's patents and other chaebol groups' patents. However, if there is time trend in obtaining the patents, there will be positive relation between the two. I find that the number of a chaebol firm's patents is not significantly associated with total number of patents of other chaebol groups, suggesting that the results in Table 5 do not capture the common time trend.

4.3. Economic Consequences of Patents

I turn to examine the economic consequences of obtaining patents. To explore the economic consequences of patents, I investigate the effects of patents on future profitability. By providing the exclusive rights to use, make, or sell the invented product or process, patents allow an inventor to earn monopoly profits. This may in turn lead to higher future profitability. Moreover, I attempt to investigate whether the economic benefits of patents vary depending on chaebol group affiliation. On the one hand, chaebols may obtain greater benefits from patents because they have abundant resources to commercialize their invented technology (Federal Trade Commission 2011). On the other hand, the benefits of patents may be greater for non-chaebol firms because small firms generally have relatively fewer assets and alternative mechanisms to defend their inventions (Federal Trade Commission 2011).

Specifically, I investigate the relation between the number of patents and the change in future profitability by estimating the following regression model:

$$\begin{aligned}
&\Delta GM_{i,t+1}\ (or\ \Delta OM_{i,t+1},\ \Delta PM_{i,t+1}) \\
&= \beta_0 + \beta_1 LN_PATENT_{i,t} + \beta_2 \Delta GM_{i,t}\ (or\ \Delta OM_{i,t},\ \Delta PM_{i,t}) + \beta_3 \Delta SIZE_{i,t} \\
&+ \beta_4 \Delta LEVERAGE_{i,t} + \beta_5 \Delta BM_{i,t} + \beta_6 \Delta D_DIVIDEND_{i,t} + \beta_7 SALES_GROWTH_{i,t} \\
&+ \beta_8 \Delta EQUITY_ISSUE_{i,t} + \beta_9 \Delta MA_{i,t} + \beta_{10} \Delta TACC_{i,t} + \beta_{11} STD_ROA_{i,t} \\
&+ \beta_{12} STD_SALES_{i,t} + Year\ FE + Industry\ FE + \varepsilon_{i,t+1}, \qquad (4)
\end{aligned}$$

where i indexes firm, and t indexes year. The dependent is the change in future profitability, measured as gross profit divided by sales (*GM*), operating income divided by sales (*OM*), or net income divided by sales (*PM*).

To examine whether the patents enhance or deteriorate firm profitability, the dependent variable is calculated as the change in profitability from year t to t+1. The variable of interest is *LN_PATENT*, which is calculated as the natural log of the number of patents plus one. If obtaining more patents improves firm profitability, the coefficient on *LN_PATENT* will be positive. To assess the difference in effects of patents on profitability between chaebols and non-chaebol firms, I further include the interaction term between *LN_PATENT* and the chaebol affiliation indicator (*CHAEBOL*).

In Equation (4), I control the factors that are associated with profitability following prior literature (e.g., Li 2008; Huang and Hilary 2018). I include firm size (*SIZE*), leverage ratio (*LEVERAGE*), book to market ratio (*BM*), an indicator variable of dividend payment (*D_DIVIDEND*), sales growth (*SALES_GROWTH*), net equity issuance (*EQUITY_ISSUE*), cash outflows from merger and acquisition (*MA*), total accruals (*TACC*), the standard deviation of return on assets over the past three years (*STD_ROA*), and the standard deviation of sales over the past three years (*STD_SALES*). The control variables are constructed as the change variable from year t-1 to t, except for *SALES_GROWTH*, *STD_ROA*, and *STD_SALES*. I further control the change in gross margin, operating margin, or profit margin in the current year (ΔGM, ΔOM, or ΔPM).[12]

Table 6 presents the results of estimating the association between the number of granted patents and the change in profitability. Panel A of Table 6

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[12] The change variables are constructed as the value of variable measured at year t minus the value of variable measured at year t-1.

report the descriptive statistics of variables used in Equation (4). The mean values of *ΔGM*, *ΔOM,* and *ΔPM* are -0.001, -0.003, and -0.008, respectively.[13] The mean values suggest that the sample firms experience a decrease in profitability on average. Panel B of Table 6 provides the results of estimating Equation (4). In panel B, the dependent variable is ΔGM_{t+1} in columns (1) and (2), ΔOM_{t+1} in columns (3) and (4), and ΔPM_{t+1} in columns (5) and (6). Columns (1), (3), and (5) provide the baseline regression results, whereas columns (2), (4), and (6) report the results with the inclusion of the interaction term between *LN_PATENT* and *CHAEBOL*.

In columns (1) and (5), I find the positive and significant coefficient on *LN_PATENT* (column (1): coefficient= 0.001, t-stat.= 1.94; column (5): coefficient= 0.002, t-stat.= 1.85). The results indicate that higher number of patents are associated with an increase in profitability, measured as gross margin or profit margin. However, in column (3), when the dependent variable is operating margin, the coefficient on *LN_PATENT* is positive, but it is marginally insignificant (coefficient=0.001, t-stat.=1.36). Although the results are somewhat weak, the overall results are consistent with prior literature that documents the positive economic consequences of patents (e.g., Hall et al. 2007; Balasubramanian and Sivadasan 2011; Kogan et al. 2017; Farre-Mensa et al. 2020).

Columns (2), (4), and (6) provide the results of testing whether the positive relation between the number of patents and profitability is different

[13] The mean values of the level of *GM*, *OM,* and *PM* are 0.234, 0.026, and -0.015, respectively.

across chaebols and non-chaebol firms. In columns (2) and (4), I find the positive and significant coefficients on the interaction term between *LN_PATENT* and *CHAEBOL* (column (2): coefficient = 0.001, t-stat.=1.74; column (4): coefficient=0.002, t-stat.=1.72). The results indicate that the positive relation between patents and gross margin or operating margin is more pronounced for chaebol firms. However, I fail to find a significant coefficient on the interaction term in column (6), showing that the association between the number of patents and profit margin is not significantly different between chaebols and non-chaebol group.

In sum, I find some evidence that patents enhance profitability, measured as either gross margin or profit margin. I also find that the effects of patents on gross margin and operating margin is greater for chaebol firms. The results provide some evidence (albeit weak) that chaebol firms derive greater benefits from patents relative to non-chaebol firms. There are two potential explanations for this finding. First, the quality of patents that chaebols obtained is superior to that of non-chaebol so that one unit of patent results in higher future profitability (Belenzon and Berkovitz 2010). Second, chaebol firms are more able to exploit the patents as they have more resources to support the utilization of patents (Federal Trade Commission 2011). More specifically, chaebols may have greater ability to use the patents to improve the products that are manufactured and commercialized, thereby generating higher profits. Prior literature suggests the several motives to use patents, including commercializing their own patents, licensing, patent blocking, and non-use (Choi and Kim 2018). Based on this literature, I conjecture that chaebols may better exploit the patents to improve the manufacturing process or commercialization of products than non-chaebol firms. In sum, the findings in Table 6 provide the evidence that chaebols derive more benefits from patents than non-chaebol firms.

[**Insert Table 6 about here]**

4.4. The Implications of Patenting Activity of Chaebols

Next, this paper aims to shed light on the economic implications of patenting activity of chaebol firms. I examine whether patenting activity of chaebols is associated with their market position and how it influences the interactions between chaebol and non-chaebol firms. Because of the exclusive nature of patents, the difference in patenting activity between chaebols and non-chaebol may have economic consequences within a product market. To provide the evidence on the effects of patenting activity of chaebols on product market consequences, I further conduct industry-year level analyses. Specifically, I attempt to explore whether and how the patenting activity of chaebols is associated with market share of non-chaebol and chaebols by estimating following regression model:

$$\Delta MS\_NON\text{-}CHAEBOL_{j,t}\ (or\ \Delta MS\_CHAEBOL_{j,t}) \\ = \beta_0 + \beta_1 \Delta PATENT\_CHAEBOL_{j,t} + \beta_2 \Delta SIZE_{j,t} + \beta_3 \Delta LEVERAGE_{j,t} \\ + \beta_4 \Delta ASSET\_TURN_{j,t} + \beta_5 \Delta LOSS_{j,t} + \beta_6 \Delta ROA_{j,t} + \beta_7 \Delta TANGIBILITY_{j,t} \\ + \beta_8 \Delta INTANGIBLE_{j,t} + \beta_9 SALES\_GROWTH_{j,t} + \beta_{10} \Delta DEBT\_ISSUE_{j,t} \\ + \beta_{11} \Delta EQUITY\_ISSUE_{j,t} + \beta_{12} STD\_SALES_{j,t} + Year\ FE + Industry\ FE + \varepsilon_{j,t} \quad (5)$$

where *j* indexes industry, and *t* indexes year. Industry classification is based on the KSIC two-digit codes.[14] The dependent variable is the change in market share of non-chaebol or chaebols, which is calculated based on sales amount. To construct the market share of non-chaebol and chaebols, I first calculate the market share of each firm within an industry-year. I then calculate the market share of chaebols and non-chaebol by aggregating the market share of all firms that belong to chaebol or non-chaebol group. I construct a proxy for patenting activity of chaebols (*PATENT_CHAEBOL*) using similar approach. Specifically, I calculate the share of patents within an industry for each firm, and then sum the patent share of firms for chaebols and non-chaebol groups. Higher patent share of chaebol (*PATENT_CHAEBOL*) indicates that the patents of chaebol firms account for greater proportion relative to total number of patents in an industry.[15.16] Thus, this variable captures the relative patenting activity of chaebols.

This approach is similar to that of Mahmood and Mitchell (2004), which investigate the relation between the market share of chaebols and the innovation of an industry. Mahmood and Mitchell (2004) measure the

[14] To classify industries, I use two-digit KSIC codes following Liu et al. (2021). Using two-digit codes allows to have sufficient number of firms in an industry. Specifically, there are 33 firms in an industry-year on average. In addition, I find qualitatively similar results when I use three-digit KSIC codes for an alternative industry classification.

[15] In this analysis, I construct the market share and patent share variable using the sample of public firms. I find consistent results when I construct these variables using the expanded sample that includes private firms that are externally audited.

[16] I use an alternative variable to capture the difference in patenting between chaebols and non-chaebol firms. Specifically, I construct *GAP_PATENT*, which is the difference in patent share of chaebols and of non-chaebol, and *GAP_MS*, which is the difference in market share between chaebols and non-chaebol. Using these alternative variables, I find that the patent gap between chaebols and non-chaebol is positively associated with the market share gap between two groups.

innovation of an industry in a country as the relative technological specialization in patenting using Technology Revealed Comparative Advantage (TRCA) index. Specifically, TRCA index for country *i* in industry *j* is calculated as the country *i*'s share of patent relative to total world patents in an industry *j* divided by the country *i*'s patent share to total world patents. The value of TRCA captures country *i*'s relative strength in patenting in industry *j*. Similar to TRCA index, *PATENT_CHAEBOL* represents relative strength in patenting of chaebols in an industry. I use the change specification to minimize the effects of other industry characteristics.

I control the factors that may affect the market share of a firm. Control variables are measured at industry level by calculating sales weighted-average variables (Mahmood and Mitchell 2004). Following Downes et al. (2018), I include firm size (*SIZE*), leverage ratio (*LEVERAGE*), asset turnover (*ASSET_TURN*), loss indicator (*LOSS*), return on assets (*ROA*), tangibility of assets (*TANGIBILITY*), the ratio of intangible assets relative to total assets (*INTANGIBILE*), the growth in sales (*SALES_GROWTH*), net debt issuance (*DEBT_ISSUE*), net equity issuance (*EQUITY_ISSUE*), and the standard deviation of sales scaled by total assets over the past three years (*STD_SALES*). Control variables are also constructed in a change form. Year and industry fixed effects are included, and standard errors are clustered by industry. Because prior studies suggest that patents can deter product market competitors (e.g., Cockburn and MacGarvie 2011), greater patenting activity of chaebols may improve chaebols' market share, whereas it decreases non-chaebol firms' market share. Based on this expectation, I predict that the coefficient on *ΔPATENT_CHAEBOL* (*β1*) will be negative (positive) when the dependent variable is *ΔMS_NON-CHAEBOL* (*ΔMS_CHAEBOL*).

Furthermore, I examine whether the patenting activity of chaebols is associated with product market concentration. Because of the protective effects of patents, patents may influence the degree of product market competition. Consistent with this view, Veihl (2022) suggests that firms strategically engage in patenting activity to defend themselves from competitors, and that such behavior results in a decrease in market competition. If chaebols are able to protect themselves from competitors using their patents, then the patenting activity of chaebols can be positively associated with overall market concentration. To test this prediction, I estimate the following regression model:

$$HERF\_INDEX_{j,t} \ (or \ HERF\_INDEX_{j,t+1}) \\ = \beta_0 + \beta_1 \Delta PATENT\_CHAEBOL_{j,t} + \beta_2 SIZE_{j,t} + \beta_3 LEVERAGE_{j,t} \\ + \beta_4 ASSET\_TURN_{j,t} + \beta_5 LOSS_{j,t} + \beta_6 ROA_{j,t} + \beta_7 TANGIBILITY_{j,t} \\ + \beta_8 INTANGIBLE_{j,t} + \beta_9 SALES\_GROWTH_{j,t} + \beta_{10} DEBT\_ISSUE_{j,t} \\ + \beta_{11} EQUITY\_ISSUE_{j,t} + \beta_{12} STD\_SALES_{j,t} + Year\ FE + Industry\ FE + \varepsilon_{j,t} \quad (6)$$

where *j* indicates industry, and *t* indicates year. The dependent variable is a measure of product market concentration, which is measured as Herfindhal-Hirschman Index (*HERF_INDEX*). Herfindhal-Hirschman Index is calculated based on KSIC two-digit industry classification.[17] The variable of interest and control variables are same as those in Equation (5).[18] If greater

[17] I find consistent results when I use three-digit KSIC codes to classify industry.
[18] Since the dependent variable is a level variable, I include the level variables of controls. I find consistent results when I use the change variables as for controls.

patenting activity of chaebols is associated with greater product market concentration, then the coefficient β_1 will be positive.

Panel A of Table 7 reports the descriptive statistics of variables used in Equations (5) and (6). I report the descriptive statistics of the level of control variables instead of change variables. The mean value of *ΔPATENT_CHAEBOL* is 0.018, implying that the patent share of chaebols increases on average. In addition, the mean values of *ΔMS_CHAEBOL* (0.009) and *ΔMS_NON-CHAEBOL* (0.000) suggest that the market share of chaebols increases on average, but the market share of non-chaebol firms does not change on average.[19]

Panel B of Table 7 reports the results of estimating Equation (5), which examines the relation between the change in patent share of chaebols and the change in market share of chaebols and non-chaebol firms. The dependent variable is *ΔMS_NON-CHAEBOL* in column (1) and *ΔMS_CHAEBOL* in column (2). In column (1), I find that the change in patent share of chaebols is negatively associated with the change in market share of non-chaebol firms (coefficient = -0.095, t-stat.= -2.90). On the other hand, the result in column (2) indicates that the change in patent share of chaebols is positively related to the change in market share of chaebols (coefficient = 0.113, t-stat.= 2.75). The results provide the evidence that patenting activity

[19] The mean values of the level of market share of chaebols and patent share of chaebols are 0.483 and 0.468, respectively. The average of market share of chaebols is comparable to that reported in Mahmood and Mitchell (2004), which is about 0.438.

of chaebol is associated with a decrease in the market share of non-chaebol firms and an increase of market share of chaebols.[20]

Panel C of Table 7 presents the results of estimating Equation (6), where the dependent variable is product market concentration measure (*HERF_INDEX*). *HERF_INDEX* is measured in year t and t+1 in columns (1) and (2), respectively. In column (1), I find a positive coefficient on *ΔPATENT_CHAEBOL,* but it is marginally insignificant (coefficient = 0.023, t-stat.= 1.54). In column (2), the coefficient on *ΔPATENT_CHAEBOL* is significantly positive (coefficient =0.031, t-stat.= 3.03), suggesting that the greater relative strength in patenting of chaebols is associated with the greater market concentration in the next year. In sum, the findings in Table 7 indicate that patenting activity of chaebol improves their market share and influences product market concentration. These results support the claim that chaebol firms may strengthen and maintain their product market power through their patenting activity.

[Insert Table 7 about here]

Lastly, I examine the implications of patenting activity of chaebols in an aggregate industry. I attempt to make some inferences whether the relative strength in patenting of chaebols is desirable for an industry. To provide a potential answer to this question, I investigate the association between the

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[20] I acknowledge the possibility of reverse causality that the market share of chaebols may affect patenting activity in an industry (Mahmood and Mitchell 2004). However, the reverse causality is less likely to exist in this analysis because it takes more than one year to obtain patents after the application. Because of long lags in the timing of granting patents, it is difficult for firms to change in the number of approved patents immediately in response to the change in the market share.

patent share of chaebols and industry sales growth. To test the relation, I estimate the following regression model:

$$IND\_SALES\_GROWTH_{j,t} \text{ (or } IND\_SALES\_GROWTH_{j,t+1})$$
$$= \beta_0 + \beta_1 \Delta PATENT\_CHAEBOL_{j,t} + \beta_2 \Delta SIZE_{j,t} + \beta_3 \Delta LEVERAGE_{j,t}$$
$$+ \beta_4 \Delta ASSET\_TURN_{j,t} + \beta_5 \Delta LOSS_{j,t} + \beta_6 \Delta ROA_{j,t} + \beta_7 \Delta TANGIBILITY_{j,t}$$
$$+ \beta_8 \Delta INTANGIBLE_{j,t} + \beta_9 \Delta DEBT\_ISSUE_{j,t} + \beta_{10} \Delta EQUITY\_ISSUE_{j,t}$$
$$+ \beta_{11} STD\_SALES_{j,t} + Year\ FE + Industry\ FE + \varepsilon_{j,t}, \quad (7)$$

In Equation (7), the dependent variable is industry sales growth, where the industry sales growth is calculated as the growth of aggregate sales in an industry. More specifically, industry sales growth (*IND_SALES_GROWTH*) is measured as the natural log of the ratio of aggregated industry sales in year t relative to sales in year t-1, or sales in year t+1 relative to sales in year t. If greater patenting activity of chaebols increases (decreases) aggregate sales of an industry, the coefficient on *ΔPATENT_CHAEBOL* will be positive (negative). I include the same set of control variables that are included in Equations (5) and (6) with the exclusion of *SALES_GROWTH*.

Panel A of Table 8 reports the descriptive statistics of the dependent variables in Equation (7). The average values of *IND_SALES_GROWTH* in year t and year t+1 is 0.086 and 0.115, respectively. The mean values indicate that the aggregated sales of an industry increase every year, on average. Panel B of Table 8 presents the results of estimating Equation (7). In both columns (1) and (2), the coefficients on *ΔPATENT_CHAEBOL* are not statistically significant, suggesting that the change in patent share of chaebols is not significantly associated with industry sales growth. The results indicate that patenting activity of chaebols is not related to the industry sales growth. Combining the results in Table 7 and Table 8, I find some evidence that an increase in the patent share of chaebols is positively associated with product market concentration, but it is not associated with the aggregate sales growth of an industry. These results suggest that greater patenting activity of chaebol firms may increase product market concentration without increasing the total size of the market.

[Insert Table 8 about here]

4.5. Additional Tests

One concern related to the findings in Table 3 is that a chaebol indicator may capture firm characteristics, such as firm size and profitability, rather than the effect of being affiliated with a chaebol group. To address this concern, I conduct several additional analyses. First, I examine cases of merger and acquisition to investigate whether non-chaebol firms acquired by chaebol firms obtain higher number of patents after the acquisition. If being affiliated with a chaebol group provides the access to various resources, the non-chaebol target firm may be able to obtain more patents in the post-acquisition period. Although the choice of merger and acquisition can be endogenously determined, it can provide a suitable setting to better assess the impact of chaebol group affiliation.

Using SDC database, I identify total 101 cases of merger and acquisitions where the acquirer is a chaebol firm and the target is a non-chaebol firm. To mitigate the potential confounding impact of different firm attributes, I restrict the sample to the target firms and include the post-acquisition indicator variable to examine whether there is an improvement in patenting activity in the post-acquisition period. Untabulated result suggests a positive and significant coefficient on the post-period dummy (coefficient = 0.002, t-stat.= 2.03), indicating that the target firms acquired by chaebol firms exhibit higher number of patents in the post-acquisition period. This result supports the argument that an affiliation to a chaebol group is beneficial for a firm because the firm can gain an access to abundant resources.

However, the inference drawn from the previous analysis may be influenced by potential time trend effects. To address this concern, I utilize the staggered differences-in-differences (DID) approach. This involves comparing the number of patents of target firms during the post-acquisition period to the number of patents of other control firms and that of target firms before the acquisition. In line with the common approach of staggered DID, I construct a post-acquisition indicator for the target firms and include firm fixed effects in the model. However, untabulated result provides that the coefficient on the post indicator is not significant (coefficient = -0.071, t-stat. = -0.86), suggesting that the number of patents of non-chaebol target firms does not significantly improve after the acquisition. Thus, I find some weak evidence that target firms exhibit higher number of patents after the acquisition by chaebol firms.

Second, to mitigate the potential impact of the difference in firm characteristics between chaebol and non-chaebol firms, I employ the propensity-score matching method. Specifically, I estimate the propensity score by using the logit regression model, where the dependent variable is an indicator variable of whether a firm is affiliated to chaebol group. As for determinants, I include the same set of control variables that are used in Equation (1). Based on the predicted value obtained from the logit regression, I match a chaebol firm to a non-chaebol firm. I match a pair with the closest predicted values within a maximum distance of 5 percent without replacement. After this caliper matching procedure, the sample size decreases to 2,992 firm-year observations. Using this matched sample, I continue to find the result that chaebol firms exhibit higher patenting activity (untabulated: coefficient= 0.001, t-stat.= 2.11).

In addition, to mitigate the potential effect of the difference in firm characteristics, I restrict the sample to the firms listed in Korea Stock Exchange (KSE), firms with positive number of patents, and find the qualitatively similar results. I also construct industry-mean adjusted number of patents to address the potential effect of industry characteristics. Lastly, I further include the interaction term between industry and year fixed effects and continue to find the consistent results. Although these analyses cannot fully address the potential endogeneity concern related to Table 3 results, the overall results are robust to the alternative model specifications.

5. Conclusion

This study aims to investigate the difference in patenting activity between chaebol and non-chaebol firms and economic consequences of patenting activity of chaebols in product markets. Using the patent data on

Korean public firms, I first find that chaebol firms generate more patents than non-chaebol after controlling several determinants. This finding is aligned with the Belenzon and Berkovitz (2010), which find the greater innovation of business groups using the data on European firms. I then examine two potential mechanisms that contribute to greater patenting activity of chaebol firms: R&D investment efficiency and knowledge spillover.

Furthermore, this paper examines the economic consequences of obtaining patents. I find some weak evidence that the number of patents is positively associated with the change in future profitability. This result is in line with prior literature that documents the positive relation between patents and firm value (e.g., Hall et al. 2005; Hall et al. 2007). In addition, I find some weak evidence that chaebols derive larger benefits from patents relative to non-chaebol firms.

To examine the economic implications of patenting activity conducted by chaebols in product markets, I perform industry-year level analyses. I find that an increase in patent share of chaebols is significantly associated with an increase in market share of chaebols, while it is associated with a decrease in market share of non-chaebol firms. Moreover, I find some evidence that greater patent share of chaebols is associated with greater product market concentration. However, I do not find a significant relation between patenting activity of chaebols and industry sales growth. The overall results suggest that patenting activity of chaebols may contribute to market shares of chaebols and concentration of industry, but it does not have significant association with industry-wide sales growth.

However, this study has several limitations that should be addressed in further research. First, it is difficult to interpret the results in a causal way. For example, a choice of business group affiliation can be endogenous, suggesting that unobserved factors may influence both the probability of being affiliated with a chaebol group and the level of patenting activity. However, the goal of this paper is not to establish the causal relation between the variables but to examine whether there is a difference in patenting ability between chaebols and non-chaebol, as well as economic consequences of patenting activity.

Second, I examine two explanations for the greater patenting ability of chaebols, including investment efficiency and knowledge spillovers. However, this paper does not provide specific insights into the mechanisms through which chaebols achieve higher investment efficiency or facilitate knowledge spillovers within a chaebol group. Future study can explore the underlying mechanisms in greater detail, including investigating the advantages in financing resources and technology transfer mechanisms.

Third, this study uses the number of patents as a proxy for patenting activity, but prior research suggests that the quality of patents also plays a crucial role (e.g., Kogan et al. 2017). While this paper focuses solely on the quantity measure of patents, future research can expand the scope of this study by examining patent quality. In addition, this paper considers only the number of patents registered in Korea, thus excluding the number of patents obtained from other countries. Given that patent grants from other countries could also affect firm profitability and product market position, this paper cannot rule out the potential effects of patent grants in other countries.

Lastly, this paper examines the cross-sectional differences between chaebols and non-chaebol. However, the effect of business group affiliation on patents and the economic consequences of patents in product market can change over time. Thus, investigating the time-series changes will be meaningful to understand the time-series dynamics. I believe that future studies will be able to address aforementioned limitations and expand the scope of this study.

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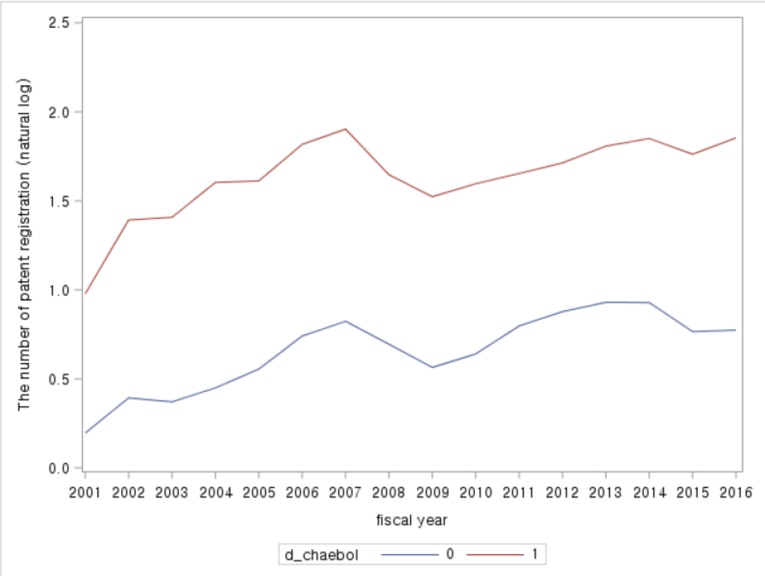
FIGURE 1
The Yearly Trend of Patents (Chaebols vs. Non-Chaebol)



This figure shows the trend of the natural log of the number of patents for chaebol and non-chaebol group from year 2001 to 2016. Graph in blue indicates mean value of the natural log of the patents of non-chaebol firms, whereas graph in red represents that of chaebol firms.

TABLE 1
Descriptive Statistics

	N	Mean	S.D.	Q1	Median	Q3
LN_PATENT_{t+1}	19,400	0.861	1.203	0.000	0.000	1.386
$CHAEBOL_t$	19,400	0.136	0.343	0.000	0.000	0.000
RD_EXP_t	19,400	0.011	0.019	0.000	0.001	0.013
$CAPEX_t$	19,400	0.042	0.058	0.008	0.025	0.061
MA_t	19,400	0.000	0.001	0.000	0.000	0.000
$CASH_t$	19,400	0.081	0.082	0.023	0.056	0.112
LOG_SALES_t	19,400	18.613	1.580	17.527	18.440	19.461
ROA_t	19,400	0.026	0.119	-0.001	0.035	0.080
$LN\_FIRM\_AGE_t$	19,400	3.107	0.698	2.708	3.219	3.638
$LEVERAGE_t$	19,400	0.426	0.201	0.264	0.426	0.578
$TANGIBILITY_t$	19,400	0.302	0.184	0.161	0.291	0.429
CFO_t	19,400	0.047	0.093	-0.002	0.049	0.100
$TOBINS\_Q_t$	19,400	1.220	0.765	0.788	0.985	1.353
$HERF\_INDEX_t$	19,400	0.160	0.105	0.072	0.130	0.238
BOD_IND_t	19,400	0.204	0.165	0.000	0.200	0.286
FOR_OWN_t	19,400	0.064	0.112	0.001	0.012	0.070
$LARGE\_OWN_t$	19,400	0.408	0.167	0.284	0.403	0.523

This table reports the descriptive statistics of variables used in Equation (1). Please refer to Appendix for the variable definitions.

TABLE 2
Pearson Correlation Matrix

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
(1)	*LN_PATENT*$_{t+1}$	1																
(2)	*CHAEBOL*$_t$	0.285***	1															
(3)	*RD_EXP*$_t$	0.232***	-0.091***	1														
(4)	*CAPEX*$_t$	0.140***	0.015**	0.036***	1													
(5)	*MA*$_t$	0.050***	0.055***	0.012*	-0.014*	1												
(6)	*CASH*$_t$	-0.020***	-0.084***	0.161***	-0.065***	0.01	1											
(7)	*LOG_SALES*$_t$	0.416***	0.542***	-0.144***	0.059***	0.087***	-0.157***	1										
(8)	*ROA*$_t$	0.083***	0.043***	-0.031***	0.160***	0.007	0.104***	0.217***	1									
(9)	*LN_FIRM_AGE*$_t$	-0.016**	0.110***	-0.210***	-0.119***	-0.011	-0.213***	0.302***	-0.046***	1								
(10)	*LEVERAGE*$_t$	0.074***	0.154***	-0.142***	0.022***	0.027***	-0.277***	0.327***	-0.282***	0.132***	1							
(11)	*TANGIBILITY*$_t$	0.087***	0.065***	-0.137***	0.369***	-0.011	-0.333***	0.205***	-0.007	0.186***	0.246***	1						
(12)	*CFO*$_t$	0.117***	0.067***	0.007	0.219***	-0.001	0.165***	0.193***	0.496***	-0.041***	-0.178***	0.104***	1					
(13)	*TOBINS_Q*$_t$	0.092***	-0.024***	0.225***	0.068***	0.023***	0.226***	-0.183***	-0.011	-0.223***	-0.093***	-0.199***	0.006	1				
(14)	*HERF_INDEX*$_t$	0.099***	0.068***	0.045***	0.087***	-0.006	0.046***	0.101***	0.005	-0.046***	0.057***	0.056***	0.076***	-0.080***	1			
(15)	*BOD_IND*$_t$	0.191***	0.270***	-0.049***	-0.014*	0.068***	0.005	0.384***	-0.019***	0.125***	0.109***	0.017**	-0.005	0.035***	0.041***	1		
(16)	*FOR_OWN*$_t$	0.308***	0.279***	-0.014*	0.067***	0.044***	0.040***	0.421***	0.177***	0.058***	-0.069***	0.003	0.181***	0.094***	0.013*	0.157***	1	
(17)	*LARGE_OWN*$_t$	-0.126***	0.085***	-0.172***	0.043***	0.01	-0.101***	0.112***	0.187***	0.114***	-0.071***	0.124***	0.105***	-0.205***	-0.025***	0.015**	-0.047***	1

This table reports Pearson correlation of matrix for the variables used in Equation (1). *, **, *** indicate statistical significance at 10%, 5%, and 1% level, respectively. Please refer to Appendix for the variable definitions.

TABLE 3
Chaebol Group Affiliation and the Number of Patents

Dep.Var.=	LN_PATENT_{t+1}	LN_PATENT_{t+2}	LN_PATENT_{t+1}	LN_PATENT_{t+2}
	(1)	(2)	(3)	(4)
$CHAEBOL_t$	**0.003*** **	**0.003*** **	**0.002** **	**0.002** **
	(4.17)	**(4.23)**	**(2.56)**	**(2.53)**
RD_EXP_t	0.121***	0.122***	0.108***	0.107***
	(12.80)	(12.26)	(11.61)	(11.03)
$CHAEBOL_t \times RD\_EXP_t$			**0.183*** **	**0.200*** **
			(3.02)	**(3.05)**
$CAPEX_t$	0.009***	0.009***	0.008***	0.009***
	(4.75)	(4.78)	(4.66)	(4.64)
MA_t	0.114	-0.004	0.108	-0.020
	(0.96)	(-0.03)	(0.91)	(-0.15)
$CASH_t$	-0.004**	-0.003**	-0.004**	-0.003**
	(-2.52)	(-2.01)	(-2.52)	(-1.98)
LOG_SALES_t	0.003***	0.003***	0.003***	0.003***
	(16.04)	(15.98)	(16.23)	(16.14)
ROA_t	-0.005***	-0.003***	-0.005***	-0.003***
	(-4.70)	(-3.25)	(-4.72)	(-3.24)
$LN\_FIRM\_AGE_t$	-0.001***	-0.001***	-0.001***	-0.001***
	(-2.79)	(-3.04)	(-3.08)	(-3.29)
$LEVERAGE_t$	-0.004***	-0.004***	-0.004***	-0.004***
	(-4.43)	(-4.25)	(-4.39)	(-4.20)
$TANGIBILITY_t$	0.002*	0.002	0.002*	0.002
	(1.94)	(1.51)	(1.88)	(1.43)
CFO_t	-0.000	0.000	-0.000	0.000
	(-0.19)	(0.45)	(-0.37)	(0.25)
$TOBINS\_Q_t$	0.001***	0.002***	0.001***	0.002***
	(6.78)	(7.46)	(6.50)	(7.18)
$HERF\_INDEX_t$	0.004*	0.000	0.003	0.000
	(1.70)	(0.22)	(1.53)	(0.05)
BOD_IND_t	0.003***	0.002**	0.003***	0.002**
	(2.86)	(2.26)	(2.61)	(1.98)
FOR_OWN_t	0.009***	0.009***	0.009***	0.009***
	(4.12)	(3.77)	(4.07)	(3.73)
$LARGE\_OWN_t$	-0.007***	-0.007***	-0.007***	-0.007***
	(-6.19)	(-5.94)	(-6.09)	(-5.82)
Constant	-0.056***	-0.057***	-0.055***	-0.056***
	(-14.79)	(-14.66)	(-14.90)	(-14.74)
Observations	19,400	17,753	19,400	17,753
Adjusted R-squared	0.408	0.414	0.413	0.420
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes

Cluster	Firm	Firm	Firm	Firm

This table reports the results of estimating Equation (1), which examines the association between chaebol group affiliation and the number of patents. Columns (1) and (2) present the baseline regression results, and columns (3) and (4) provide the results with the inclusion of the interaction term between R&D expense and the chaebol affiliation indicator. The reported coefficient estimates are scaled by 100. *T*-statistics are presented in parentheses. *, **, *** indicate statistical significance at 10%, 5%, and 1% level, respectively. Please refer to Appendix for variable definitions.

TABLE 4

Chaebol Group Affiliation and Investment-q Sensitivity

Panel A: Descriptive Statistics

	N	Mean	S.D.	Q1	Median	Q3
RD_EXP_{t+1}	17,662	0.011	0.021	0.000	0.002	0.013
$CHAEBOL_t$	17,662	0.133	0.340	0.000	0.000	0.000
$TOBINS\_Q_t$	17,662	1.186	0.720	0.779	0.969	1.317
$SIZE_t$	17,662	18.859	1.424	17.878	18.582	19.563
CFO_SALES_t	17,662	0.037	0.177	-0.005	0.052	0.111
$TANGIBILITY_t$	17,662	0.310	0.183	0.172	0.298	0.434
$OPER\_CYCLE_t$	17,662	0.428	0.318	0.242	0.350	0.501
$LOSS_t$	17,662	0.263	0.441	0.000	0.000	1.000
STD_CFO_t	17,662	0.081	0.079	0.033	0.059	0.101
STD_SALES_t	17,662	0.247	0.300	0.075	0.148	0.294
$STD\_RD\_EXP_t$	17,662	0.004	0.008	0.000	0.001	0.004
$D\_DIVIDEND_t$	17,662	0.586	0.493	0.000	1.000	1.000
$ALTMAN\_Z_t$	17,662	3.358	3.306	1.630	2.542	3.977
$SALES\_GROWTH_t$	17,662	0.112	0.373	-0.057	0.058	0.195
$LN\_FIRM\_AGE_t$	17,662	3.190	0.619	2.773	3.258	3.664

Panel B: Regression Results

Dep. Var.=	RD_EXP_{t+1}
$CHAEBOL_t$	-0.004*
	(-1.95)
$TOBINS\_Q_t$	0.002***
	(3.41)
$CHAEBOL_t \times TOBINS\_Q_t$	**0.004***
	(1.77)
$SIZE_t$	0.000
	(0.42)
CFO_SALES_t	0.002
	(1.43)
$TANGIBILITY_t$	-0.006***
	(-3.15)
$OPER\_CYCLE_t$	0.001
	(1.25)
$LOSS_t$	0.000
	(0.53)
STD_CFO_t	-0.005*
	(-1.66)
STD_SALES_t	-0.006***
	(-6.36)

$STD\_RD\_EXP_t$	1.194***
	(16.77)
$D\_DIVIDEND_t$	0.001*
	(1.90)
$ALTMAN\_Z_t$	0.000
	(0.28)
$SALES\_GROWTH_t$	-0.001***
	(-2.82)
$LN\_FIRM\_AGE_t$	-0.001**
	(-2.33)
Constant	0.001
	(0.19)
Observations	17,662
Adjusted R-squared	0.363
Year FE	Yes
Industry FE	Yes
Cluster	Firm

This table reports the results for the relation between chaebol group affiliation and investment-q sensitivity. Panel A provides the descriptive statistics of variables used in Equation (2). Panel B presents the results from estimating Equation (2). *T*-statistics are presented in parentheses. *, **, *** indicate statistical significance at 10%, 5%, and 1% level, respectively. Please refer to Appendix for variable definitions.

TABLE 5
Knowledge Spillover within a Chaebol Group

Panel A: Descriptive Statistics

	N	Mean	S.D.	Q1	Median	Q3
LN_PATENT_{t+1}	2,636	1.804	2.101	0.000	1.099	2.996
LN_PATENT_{t+2}	2,442	1.831	2.112	0.000	1.099	3.091
$LN\_PATENT\_OTHER_{t}$	2,636	3.885	2.756	1.609	3.597	6.034

Panel B: Regression Results

Dep. Var.=	LN_PATENT_{t+1}	LN_PATENT_{t+2}
	(1)	(2)
$LN\_PATENT\_OTHER_{t}$	**0.012****	**0.024****
	(2.30)	**(2.53)**
LN_PATENT_{t}	0.855***	0.750***
	(60.28)	(29.95)
RD_EXP_{t}	2.537**	5.048**
	(2.05)	(2.49)
$CAPEX_{t}$	0.175	-0.328
	(0.57)	(-0.69)
MA_{t}	-1.081	-9.627
	(-0.31)	(-1.50)
$CASH_{t}$	0.006	0.335
	(0.03)	(1.14)
LOG_SALES_{t}	0.119***	0.191***
	(7.00)	(6.70)
ROA_{t}	-0.275	-0.387
	(-1.22)	(-1.16)
$LN\_FIRM\_AGE_{t}$	-0.030	-0.046
	(-1.62)	(-1.51)
$LEVERAGE_{t}$	-0.074	-0.155
	(-0.70)	(-0.92)
$TANGIBILITY_{t}$	0.183*	0.352**
	(1.86)	(2.21)
CFO_{t}	-0.437**	-0.493*
	(-2.19)	(-1.91)
$TOBINS\_Q_{t}$	0.062**	0.117***
	(2.53)	(3.15)
$HERF\_INDEX_{t}$	-0.260	-0.582
	(-1.05)	(-1.58)
BOD_IND_{t}	-0.109	-0.106
	(-1.40)	(-0.82)
FOR_OWN_{t}	0.205	0.361

	(1.52)	(1.58)
LARGE_OWN$_t$	-0.067	-0.086
	(-0.71)	(-0.56)
Constant	-1.843***	-3.267***
	(-5.42)	(-5.71)
Observations	2,636	2,442
Adjusted R-squared	0.916	0.869
Year FE	Yes	Yes
Industry FE	Yes	Yes
Cluster	Firm	Firm

This table reports the results for the association between the number of patents of a chaebol firm and the number of patents of all other firms in the same chaebol group. Panel A presents the descriptive statistics of the patent variables used in Equation (3). Panel B provides the results of estimating Equation (3). *T*-statistics are presented in parentheses. *, **, *** indicate statistical significance at 10%, 5%, and 1% level, respectively. Please refer to Appendix for variable definitions.

TABLE 6
The Association between Patents and Future Profitability

Panel A: Descriptive Statistics

	N	Mean	S.D.	Q1	Median	Q3
ΔGM_{t+1}	18,125	-0.001	0.073	-0.026	-0.001	0.021
ΔOM_{t+1}	18,125	-0.003	0.124	-0.030	-0.002	0.023
ΔPM_{t+1}	18,125	-0.008	0.270	-0.038	-0.003	0.027
LN_PATENT_t	18,125	0.839	1.195	0.000	0.000	1.386
$CHAEBOL_t$	18,125	0.139	0.346	0.000	0.000	0.000
$\Delta SIZE_t$	18,125	0.080	0.220	-0.021	0.058	0.160
$\Delta LEVERAGE_t$	18,125	0.003	0.091	-0.037	-0.001	0.040
ΔBM_t	18,125	-0.052	0.718	-0.302	0.000	0.260
$\Delta D\_DIVIDEND_t$	18,125	0.114	0.318	0.000	0.000	0.000
$SALES\_GROWTH_t$	18,125	0.126	0.424	-0.055	0.059	0.197
$\Delta EQUITY\_ISSUE_t$	18,125	-0.007	0.091	-0.001	0.000	0.000
ΔMA_t	18,125	0.000	0.013	0.000	0.000	0.000
$\Delta TACC_t$	18,125	-0.004	0.152	-0.067	-0.002	0.060
STD_ROA_t	18,125	0.069	0.097	0.018	0.038	0.079
STD_SALES_t	18,125	0.149	0.146	0.054	0.104	0.190

Panel B: Regression Results

Dep. Var.=	ΔGM_{t+1}		ΔOM_{t+1}		ΔPM_{t+1}	
	(1)	(2)	(3)	(4)	(5)	(6)
LN_PATENT_t	**0.001***	**0.000**	**0.001**	**-0.000**	**0.002***	**0.002**
	(1.94)	**(0.41)**	**(1.36)**	**(-0.24)**	**(1.85)**	**(1.14)**
$CHAEBOL_t$		-0.002		0.000		0.005
		(-0.95)		(0.02)		(1.07)
LN_PATENT_t		**0.001***		**0.002***		**-0.001**
$\times CHAEBOL_t$		**(1.74)**		**(1.72)**		**(-0.38)**
ΔGM_t	-0.161***	-0.161***				
	(-11.31)	(-11.31)				
ΔOM_t			-0.222***	-0.222***		
			(-11.14)	(-11.15)		
ΔPM_t					-0.287***	-0.287***
					(-12.87)	(-12.87)
$\Delta SIZE_t$	-0.044***	-0.044***	-0.070***	-0.070***	-0.136***	-0.136***
	(-9.16)	(-9.15)	(-7.40)	(-7.39)	(-6.69)	(-6.70)
$\Delta LEVERAGE_t$	0.048***	0.048***	0.125***	0.125***	0.231***	0.231***
	(4.98)	(5.00)	(6.06)	(6.07)	(5.48)	(5.48)
ΔBM_t	-0.001	-0.001	-0.002	-0.002	-0.014***	-0.014***
	(-0.62)	(-0.62)	(-1.08)	(-1.08)	(-4.48)	(-4.48)
$\Delta D\_DIVIDEND_t$	-0.001	-0.001	-0.004	-0.004	-0.012**	-0.012**

	(-0.87)	(-0.89)	(-1.59)	(-1.61)	(-2.26)	(-2.25)
$SALES\_GROWTH_t$	0.000	0.000	0.007	0.007*	0.023**	0.023**
	(0.17)	(0.16)	(1.65)	(1.65)	(2.49)	(2.50)
$\Delta EQUITY\_ISSUE_t$	0.046***	0.046***	0.068***	0.068***	0.113***	0.113***
	(4.77)	(4.77)	(3.52)	(3.51)	(3.03)	(3.03)
ΔMA_t	0.053*	0.053*	0.049	0.049	0.203	0.203
	(1.67)	(1.68)	(0.82)	(0.82)	(1.08)	(1.07)
$\Delta TACC_t$	-0.013***	-0.013***	0.009	0.009	-0.063***	-0.063***
	(-2.64)	(-2.64)	(0.91)	(0.90)	(-2.78)	(-2.78)
STD_ROA_t	0.010	0.010	0.047***	0.047***	0.002	0.003
	(1.09)	(1.08)	(3.19)	(3.20)	(0.05)	(0.07)
STD_SALES_t	0.016***	0.016***	-0.001	-0.001	-0.003	-0.003
	(3.39)	(3.43)	(-0.13)	(-0.09)	(-0.17)	(-0.17)
Constant	0.002	0.002	0.002	0.002	-0.015	-0.015
	(0.59)	(0.64)	(0.38)	(0.38)	(-1.36)	(-1.40)
Observations	18,125	18,125	18,125	18,125	18,125	18,125
Adjusted R-squared	0.059	0.059	0.075	0.075	0.118	0.118
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm	Firm	Firm

This table presents the results of the association between the number of patents and the change in future profitability. Panel A presents the descriptive statistics of variables used in Equation (4). Panel B provides the results of estimating Equation (4). The dependent variable is the change in gross margin in columns (1) and (2), the change in operating margin in columns (3) and (4), and the change in profit margin in columns (5) and (6). *T*-statistics are presented in parentheses. *, **, *** indicate statistical significance at 10%, 5%, and 1% level, respectively. Please refer to Appendix for variable definitions.

TABLE 7
The Association between Patenting Activity of Chaebols and Market Share and Market Concentration
(Industry-year level analyses)

Panel A: Descriptive Statistics

	N	Mean	S.D.	Q1	Median	Q3
ΔPATENT_CHAEBOL$_t$	457	0.018	0.159	-0.033	0.000	0.052
ΔMS_CHAEBOL$_t$	457	0.009	0.082	-0.016	0.000	0.021
ΔMS_NON-CHAEBOL$_t$	457	0.000	0.069	-0.024	0.000	0.018
HERF_INDEX$_t$	457	0.193	0.118	0.094	0.178	0.254
SIZE$_t$	457	17.944	3.494	16.354	18.917	20.439
LEVERAGE$_t$	457	0.422	0.123	0.340	0.415	0.503
ASSET_TURN$_t$	457	0.896	0.309	0.701	0.845	1.032
LOSS$_t$	457	0.132	0.143	0.031	0.080	0.180
ROA$_t$	457	0.039	0.037	0.018	0.039	0.063
TANGIBILITY$_t$	457	0.280	0.121	0.195	0.265	0.375
INTANGIBLE$_t$	457	0.037	0.041	0.009	0.022	0.047
SALES_GROWTH$_t$	457	0.122	0.158	0.031	0.081	0.159
DEBT_ISSUE$_t$	457	0.028	0.039	0.003	0.020	0.043
EQUITY_ISSUE$_t$	457	0.007	0.015	0.000	0.003	0.009
STD_SALES$_t$	457	0.110	0.062	0.077	0.098	0.129

Panel B: Regression Results of Market Share

Dep. Var.=	*ΔMS_NON-CHAEBOL$_t$*	*ΔMS_CHAEBOL$_t$*
	(1)	(2)
ΔPATENT_CHAEBOL$_t$	**-0.095*****	**0.113*****
	(-2.90)	**(2.75)**
ΔSIZE$_t$	0.024**	0.021**
	(2.67)	(2.24)
ΔLEVERAGE$_t$	-0.233	0.209
	(-1.15)	(1.06)
ΔASSET_TURN$_t$	0.040	-0.017
	(0.79)	(-0.34)
ΔLOSS$_t$	-0.001	0.010
	(-0.03)	(0.32)
ΔROA$_t$	0.051	-0.068
	(0.38)	(-0.53)
ΔTANGIBILITY$_t$	-0.169	0.209
	(-0.93)	(1.17)
ΔINTANGIBLE$_t$	-0.493	0.516
	(-1.31)	(1.47)
SALES_GROWTH$_t$	-0.034	0.016

	(-0.98)	(0.53)
ΔDEBT_ISSUE$_t$	0.046	-0.067
	(0.47)	(-0.65)
ΔEQUITY_ISSUE$_t$	-0.191	0.286
	(-0.82)	(1.24)
STD_SALES$_t$	0.096	-0.128*
	(1.30)	(-1.82)
Constant	0.079	-0.058
	(1.54)	(-1.16)
Observations	457	457
Adjusted R-squared	0.179	0.366
Year FE	Yes	Yes
Industry FE	Yes	Yes
Cluster	Industry	Industry

Panel C: Regression Results of Market Concentration

Dep. Var. =	*HERF_INDEX*$_t$	*HERF_INDEX*$_{t+1}$
	(1)	(2)
ΔPATENT_CHAEBOL$_t$	**0.023**	**0.031*** **
	(1.54)	**(3.03)**
SIZE$_t$	-0.006	-0.006
	(-1.08)	(-1.44)
LEVERAGE$_t$	-0.016	-0.044
	(-0.08)	(-0.25)
ASSET_TURN$_t$	-0.001	0.016
	(-0.02)	(0.38)
LOSS$_t$	-0.026	-0.037*
	(-1.14)	(-1.69)
ROA$_t$	0.089	0.086
	(0.78)	(0.64)
TANGIBILITY$_t$	0.039	0.082
	(0.43)	(0.89)
INTANGIBLE$_t$	-0.041	-0.005
	(-0.21)	(-0.03)
SALES_GROWTH$_t$	0.001	0.031
	(0.03)	(1.41)
DEBT_ISSUE$_t$	0.074	0.061
	(0.61)	(0.50)
EQUITY_ISSUE$_t$	0.238	0.208
	(1.03)	(1.50)
STD_SALES$_t$	0.067	-0.050
	(0.70)	(-0.42)
Constant	0.368***	0.404***

	(7.12)	(7.86)
Observations	457	457
Adjusted R-squared	0.870	0.884
Year FE	Yes	Yes
Industry FE	Yes	Yes
Cluster	Industry	Industry

This table presents the estimation results of Equations (5) and (6), which examine the association between the change in patent share of chaebols and the change in market share of chaebols and non-chaebol firms and market concentration. Panel A presents the descriptive statistics of variables used in Equations (5) and (6). Panel B provides the results of estimating Equation (5), and Panel C reports the estimation results of Equation (6). *T*-statistics are presented in parentheses. *, **, *** indicate statistical significance at 10%, 5%, and 1% level, respectively. Please refer to Appendix for variable definitions.

TABLE 8
The Association between Patenting Activity of Chaebols and Industry Growth

Panel A: Descriptive Statistics

	N	Mean	S.D.	Q1	Median	Q3
$IND\_SALES\_GROWTH_t$	457	0.086	0.126	0.021	0.072	0.143
$IND\_SALES\_GROWTH_{t+1}$	457	0.115	0.203	0.019	0.078	0.166

Panel B: Regression Results

Dep.Var.=	$IND\_SALES\_GROWTH_t$	$IND\_SALES\_GROWTH_{t+1}$
	(1)	(2)
$\Delta PATENT\_CHAEBOL_t$	**-0.001**	**-0.017**
	(-0.03)	**(-0.30)**
$\Delta SIZE_t$	-0.038***	0.008
	(-3.32)	(0.54)
$\Delta LEVERAGE_t$	0.747***	0.394
	(3.25)	(1.28)
$\Delta ASSET\_TURN_t$	0.465***	-0.030
	(5.60)	(-0.33)
$\Delta LOSS_t$	-0.017	0.144
	(-0.47)	(1.36)
ΔROA_t	0.589**	0.825*
	(2.51)	(1.76)
$\Delta TANGIBILITY_t$	-0.584**	-1.030***
	(-2.13)	(-3.08)
$\Delta INTANGIBLE_t$	0.931**	-0.754
	(2.31)	(-1.11)
$\Delta DEBT\_ISSUE_t$	0.051	-0.594**
	(0.41)	(-2.06)
$\Delta EQUITY\_ISSUE_t$	-0.171	-1.205
	(-0.51)	(-1.29)
STD_SALES_t	-0.036	0.142
	(-0.18)	(0.49)
Constant	-0.105	-0.034
	(-1.66)	(-0.31)
Observations	457	457
Adjusted R-squared	0.505	0.253
Year FE	Yes	Yes
Industry FE	Yes	Yes
Cluster	Industry	Industry

This table presents the results for the relation between the change in patent share of chaebols and industry sales growth. Panel A presents the descriptive statistics of the dependent variables in Equation (7). Panel B provides the results from estimating Equation (7). *T*-statistics are presented in parentheses. *, **, *** indicate statistical significance at 10%, 5%, and 1% level, respectively. Please refer to Appendix for variable definitions.

Appendix. Variable Definitions

Variable	Definition
Dependent Variables	
LN_PATENT	The natural log of the number of patent grants plus one;
RD_EXP	R&D expense reported in income statement scaled by total assets;
GM	Gross profit divided by sales;
OM	Operating income divided by sales;
PM	Net income divided by sales;
MS_NON-CHAEBOL	The sum of market share of all non-chaebol firms in an industry-year. Market share is calculated as a firm's sales divided by total sales in an industry, where industry classification is based on KSIC two-digit code;
MS_CHAEBOL	The sum of market share of all chaebol firms in an industry-year;
HERF_INDEX	Market concentration, measured as Herfindahl-Hirschman index. Industry is classified based on KSIC two-digit code;
IND_SALES_GROWTH	Industry sales growth, where industry sales is calculated by aggregating the sales of all firms in an industry classified based on KSIC two-digit code;
Test Variables	
CHAEBOL	An indicator variable that equals to one if a firm belongs to chaebol group, and zero otherwise;
LN_PATENT_OTHER	The natural log of the sum of the patents of all other affiliates in the same chaebol group;
PATENT_CHAEBOL	The sum of patent share of all chaebol firms in an industry-year, where patent share is calculated as a firm's number of patents divided by total number of patents in an industry-year;
Control Variables	
CAPEX	Capital expenditure divided by total assets;
MA	Cash outflows from merger and acquisition activities divided by total assets;
CASH	Cash and cash equivalents divided by total assets;
LOG_SALES	The natural logarithm of sales;
ROA	Return on assets, calculated as net income scaled by total assets;
LN_FIRM_AGE	The natural logarithm of firm age, measured as the difference between fiscal year and foundation year;

LEVERAGE	Leverage ratio, measured as total liabilities divided by total assets;
TANGIBILITY	Property, plant, and equipment divided by total assets;
CFO	Operating cash flows divided by total assets;
TOBINS_Q	Tobin's q, measured as the sum of book value of total liabilities and market value of equity divided by book value of total assets at the end of fiscal-year;
BOD_IND	Board independence, measured as the number of independent directors divided by total number of directors;
FOR_OWN	The ownership of foreign investors, measured at the end of fiscal-year;
LARGE_OWN	The ownership of large shareholders (common shares), measured at the end of fiscal-year;
SIZE	Firm size, measured as the natural logarithm of total assets;
CFO_SALES	Operating cash flows divided by sales;
OPER_CYCLE	Operating cycle, calculated as (average accounts receivable/sales + average inventory/cost of goods sold);
LOSS	An indicator variable that equals to one if a firm reports loss, and zero otherwise;
STD_CFO	The standard deviation of operation cash flows divided by total assets over the last three years;
STD_SALES	The standard deviation of sales relative to total assets over the last three years;
STD_RD_EXP	The standard deviation of R&D expense relative to total assets over the past three years;
D_DIVIDEND	An indicator variable that takes the value of one if a firm pays dividend, and zero otherwise;
ALTMAN_Z	Altman's Z score, calculated as (current assets - current liabilities)/total assets*1.2 + retained earnings/total assets*1.4 + operating income/total assets*3.3 + market value of equity/total liabilities*0.6 + sales/total assets*1;
SALES_GROWTH	Sales growth, measured as (sales(t)/sales(t-1))-1;
BM	Book-to-market ratio, where market capitalization is measured at the end of fiscal-year;
EQUITY_ISSUE	Net equity issuance divided by total assets, where net equity issuance is calculated as (seasoned equity offerings – reduction in capital + disposal of treasury shares – acquisition of treasury shares);
TACC	Total accruals divided by total assets;

STD_ROA	The standard deviation of return on assets over the past three years;
ASSET_TURN	Asset turnover, measured as sales divided by total assets;
INTANGIBLE	Intangible assets scaled by total assets;
DEBT_ISSUE	Net debt issuance divided by total assets, where net debt issuance is measured as the increase in debt minus the repayment of debt.

Essay 2

Pension Fund Ownership and ESG Performance: Evidence form Korean National Pension Service

1. Introduction

Sustainable investing or Environmental, Social, and Governance (ESG) investing has experienced significant growth in recent years. The movements such as the UN's first Principles of Responsible Investment (PRI) in 2006, Business Roundtable (BRT) in 2019, and the announcement of BlackRock in 2020 triggered ESG considerations in investment practices. In 2021, UN PRI had more than 3,000 signatories with a total asset under management (AUM) of around $121 trillion (UN PRI 2021a). Another evidence suggests that the amount of ESG investing comprises approximately one-third of the total professionally managed assets in U.S. in 2020 (US SIF 2020).

Pension funds and other institutional investors have been playing an important role in the process of incorporating ESG issues into investment practices. Pension funds explicitly outlined that their investment policies consider ESG as one of factors. For instance, three large pension funds (California State Teachers' Retirement System: CalSTRS, Japanese Government Pension Investment Fund: GPIF, and Universities Superannuation Scheme: USS) made a public pledge that "companies that seek to maximize corporate revenue without considering their impacts on other stakeholders put their long-term growth at risk and are not attractive investment targets for us." (GPIF 2020). Similarly, the Korean National Pension Service (NPS) has taken initiatives to integrate ESG factors into its investment policies, including signing the PRI in 2009 and introducing a stewardship code in 2018. Thus, it is an empirical question whether pension funds actually follow through their commitments to ESG.

Prior studies examine whether funds with ESG objectives "walk the talk" and report the mixed evidence (e.g., Dikolli et al. 2022; Raghunandan and Rajgopal 2022; Kim and Yoon 2023). Specifically, Dikolli et al. (2022) find that ESG mutual funds are more likely to vote for ESG shareholder proposals, suggesting the evidence of walk the talk. In contrast, Raghunandan and Rajgopal (2022) suggest that firms held by ESG mutual funds violate environmental and labor laws more often relative to firms held by non-ESG funds. They further show that stocks invested by ESG funds exhibit higher carbon emissions despite their greater voluntary disclosure and higher ESG scores. Relatedly, Kim and Yoon (2023) find that funds that signed on PRI do not improve fund-level average ESG performance and fund returns. These studies investigate whether funds with ESG commitment follow their claims on ESG by investigating the behavior of funds and ESG performance of firms held by the funds.

However, there is relatively little evidence on whether and how pension funds actually incorporate ESG factors into their considerations. Pension funds are distinct from other types of funds in terms of their size, diversification, and long-term investment horizon. In particular, the total value of assets that are managed by pension funds of 22 countries are equivalent to 76 percent of the GDP on average in 2022 (Thinking Ahead Institute 2022). Because of their large size and diversified portfolios, pension funds are often described as universal owners (Hawley and Williams 2000).

The universal owners hold investments in every national markets and asset class worldwide, and thus they collectively own a slice of whole economy. As a result, universal owners can have interests in improving long-term growth and sustainability of the whole economy and financial markets (Urwin 2011). In addition, because of their significant impact on capital markets, pension funds are expected to leverage their power to address sustainability issues through active engagement (e.g., Kiernan 2007). In line with this view, pension funds are in a strong position to integrate ESG issues into their investment decisions (e.g., GPIF 2020; PSP 2020).

This paper examines whether the Korean National Pension Service (NPS)'s commitment to ESG is actually borne out by the evidence. We note that the NPS can implement its ESG commitment through two channels: (1) encouraging companies to improve ESG activities (i.e., engaging with investees to influence firm behavior) and (2) changing holdings based on ESG performance (i.e., considering ESG when building a portfolio) (UN PRI 2021b). Through the engagement channel, the NPS can influence the behavior of its investees using several strategies, including the exercise of voting rights and public or private dialogue with investees.[21] Through the change in holding channel, the NPS can adjust its portfolio towards firms with good ESG performance. To explore these two channels, we investigate the

[21] In this paper, the term "engagement" refers to the expressive mechanism to influence the behavior of investees. The methods for engagement include the exercise of voting rights at shareholder meetings, filing shareholder proposals, and the dialogue and interactions between an investor and an investee (e.g., Gorman 2017).

association between the NPS ownership and ESG performance of firms.[22] We use ESG score provided by Korea Corporate Governance Service (KCGS) as a proxy for ESG performance. Using the sample of Korean public firms from 2015 to 2020, we first find that the level of NPS ownership is positively associated with future ESG score. To provide the evidence on the causal relation, we conduct Granger causality tests (Granger 1969) following Lev et al. (2010). Applying granger causality tests, we find that the prior changes in NPS ownership are positively associated with future changes in ESG performance, supporting the engagement channel.

We further explore potential mechanism behind the findings. Specifically, we examine the exercise of voting rights as one form of engagement. Using the data on NPS voting decisions on shareholder meetings agendas, we find that the NPS's "vote no" decision is associated with an improvement in future ESG performance. This result suggests that the NPS's investees improve ESG activities after experiencing "vote no" decision of the NPS. To delve deeper into the voting decisions, we classify the agendas in shareholder meetings into three categories: (1) election of directors or auditors, (2) remuneration, and (3) firm operation. We then examine whether the effect of "vote no" decision on ESG score varies depending on the item of agenda. The findings show that firms improve ESG performance when the NPS votes against the agenda related to the election of directors or internal

[22] We examine the NPS ownership because the level of ownership of an investor is generally used as a proxy for an investor's influence on management (Woidtke 2002).

auditors. However, such effect is not observed when the NPS votes against remuneration agendas or operation agendas.

Next, we examine whether the NPS changes its shareholdings based on ESG performance of firms. Using Granger causality methodology, we do not find the evidence that the prior changes in ESG score are associated with future changes in NPS ownership. This result suggests that the NPS does not make significant adjustments to its shareholdings based on ESG performance. We further investigate whether the NPS changes its holdings in response to negative ESG incidents using the RepRisk dataset.[23] RepRisk identifies daily news on negative ESG incidents using a wide range of information sources and provides the negative news counts of a specific company. However, we fail to find the evidence that the NPS reduces its level of ownership in response to negative ESG incidents. Overall, the results suggest that the NPS implements ESG practices through engagement rather than changing holdings.

Lastly, we investigate the value implications of the combined effect of NPS ownership and ESG performance. Pension funds have fiduciary duty to achieve higher future returns for their beneficiaries. As part of the investment strategies, pension funds are well-placed to incorporate ESG factors. Thus, it is worthwhile to examine whether the ESG investing practices are associated with superior future returns. To test value implications, we estimate portfolio return regressions and firm-level return

[23] RepRisk is a consultancy on ESG issues and provides the data on negative ESG events since 2007.

regressions. In portfolio analysis, we construct the portfolios of firms based on NPS holding and ESG scores, and estimate regressions using one-year-ahead monthly returns and risk factors. This test allows us to examine abnormal return performance of each portfolio. We find that the portfolio of firms held by the NPS with higher ESG scores has significant alpha when we use value-weighted portfolio. However, we fail to find a significant alpha when we use equal-weighted portfolio. In the firm-level return analysis, we find similar results to the portfolio analysis. Specifically, stocks with positive NPS ownership and higher ESG score exhibit higher future returns. Overall, the findings suggest that the NPS can play a role in enhancing ESG performance, and that the combination of NPS holding and strong ESG performance may have value implications.

This paper makes several contributions to the literature. First, this paper adds to the literature that examines whether ESG committed funds actually integrate ESG issues into their investment strategies (e.g., Dikolli et al. 2022; Raghunandan and Rajgopal 2022; Kim and Yoon 2023). These studies focus on ESG mutual funds or funds with PRI signatories to examine the research question. However, we focus on pension funds as a universal owner who committed to incorporate ESG issues into their investment policies. Second, this paper contributes to the literature that examines the determinants of ESG performance of firms by suggesting the ownership of pension fund as a potential factor that facilitates ESG activities (e.g., Dhaliwal et al. 2011; Lys et al. 2015).

Third, this paper contributes to the literature on pension funds and shareholder activism. Prior literature on pension funds examines their effects on firm value by investigating ownership and activism (e.g., Wahal 1996; Woidtke 2002). In addition, prior studies document that voting decisions of pension fund can affect internal corporate governance (Kim et al. 2014) and have capital market consequences (e.g., Kim and Yon 2014; Lee et al. 2018; Ko and Kim 2020). This paper contributes to this line of literature by providing the evidence that "vote no" decision of the NPS can have an impact on ESG performance of firms. Lastly, this paper contributes to the literature that investigates the value implications of ESG activities (e.g., Khan et al. 2016). We find some weak evidence that the NPS's investees with better ESG performance may outperform the others, providing some value implications for investors.

This paper is organized as follows. Section 2 provides the background and suggests research questions. Section 3 describes the sample and data used for the analyses. Section 4 presents research design, and Section 5 provides empirical results. Section 6 summarizes and concludes the paper.

2. Background and Research Questions

2.1. Background of the NPS

The NPS of Korea, the largest public pension in Korea, was established in 1988. The size of assets under management (AUM) of the NPS has grown rapidly, and it reaches approximately 890 trillion Korean Won (about 680 USD billion) in 2022. The NPS is currently the third-largest public pension fund in the world and has ownership of more than five percent of 260 companies listed on the Korean stock market in 2021. Consistent with the pension funds in other countries (e.g., GPIF 2020; PSP 2020), the NPS also has made commitment to embracing ESG factors in its investment policies. Specifically, the NPS launched externally managed domestic responsible investment (RI) funds in 2006. The NPS signed on PRI in 2009 and established its own sustainable investing team in 2013. The NPS also developed its own ESG evaluation system in 2015, and ESG information sharing platform was established in 2017. Notably, in 2018, the NPS adopted a stewardship code, emphasizing its fiduciary duties. Since the introduction of the stewardship code, the NPS has been committed to more actively exercising shareholder rights compared to the past. In 2019, the NPS formulated a plan to facilitate responsible investment and adopted RI principles. In 2020, the guideline for ESG integration strategies for domestic equity was developed, and in 2021, negative screening was adopted.[24] These initiatives over 15 years demonstrate the NPS's commitment to ESG issues.

2.2. Pension Fund Ownership, Activism, and Firm Value

Prior studies explore the association between pension funds ownership or activism and firm value. However, the evidence has been mixed.

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[24] Please refer to the annual report of NPS for more information on NPS's responsible investment.
(https://www.nps.or.kr/jsppage/fund/fundCms/list.jsp?cPage=1&cmsId=KD600&SK=&SW=)

For instance, Woidtke (2002) finds the positive (negative) association between private (public) pension fund ownership and firm value. Using Swedish data, Giannetti and Laeven (2009) report that an increase in the shareholding of public pension fund and large independent private pension fund is positively associated with firm value. Jiao and Ye (2013) suggest that the relation between public pension fund ownership and firm performance is non-linear by showing the inverted-U shape relationship. Using Korean data, Kim and Koh (2020) finds the negative relation between NPS ownership and firm value.

Another stream of literature examines the effects of pension fund activism on capital markets and provides the inconsistent results. Shareholder activism strategies with relatively low costs include shareholder proposals, being a target of California Public Employees' Retirement System (CalPERS), and opposing to agendas in shareholder meetings (Ko and Kim 2020). Prior studies find that shareholder proposals submitted by pension funds do not have significant consequences on capital market (e.g., Wahal 1996; Del Guercio and Hawkins 1999). In contrast, prior research generally reports the positive reactions in the stock market following the announcements of being a target of CalPERS (e.g., Anson et al. 2003; English II et al. 2004). However, Nelson (2006) suggests that CalPERS effects are only observed in earlier periods and not in later periods.

In the Korean setting, voting against agendas in shareholder meetings is particularly relevant because shareholder proposals are rarely observed and "vote no" activity is a more common strategy of shareholder activism in

Korea (Kim et al. 2014). Accordingly, several Korean studies examine the effects of the NPS voting decision as one form of shareholder activism. Specifically, Kim et al. (2014) find that firms improve their internal corporate governance after experiencing "vote no" decision of the NPS, which ultimately leads to higher firm value. However, they fail to find a significant stock market reaction to the announcement of "vote no". Relatedly, Lim and Lee (2019) suggest that a target firm's stock price decrease when the NPS announces to vote against to agendas. Similarly, Ko and Kim (2020) investigate the NPS's pre-disclosure to veto agenda and find the negative stock market reactions to "vote no" announcements. In sum, prior studies suggest the mixed finding on the effect of pension fund ownership or activism on firm value. Thus, it remains unclear whether pension funds ownership is associated with ESG performance of firms.

2.3. Pension Funds and ESG Consideration

Major pension funds around the world take strong positions to manage and integrate ESG factors into their investment decisions. For example, CalSTRS, GPIF, USS, and eight largest Canadian pension funds publicly announced their consideration of ESG issues in their investment strategies (GPIF 2020; PSP 2020). Accordingly, prior research explores the potential factors that drive pension funds to incorporate ESG factors into their considerations. One factor is fiduciary duty that pension funds have to their members as pension funds have responsibility to act in the best interests of their beneficiaries. Integrating ESG issues into investment decision-making may allow pension funds to identify and manage potential risks more effectively (Nikulina 2021; Sautner and Starks 2021). Specifically, under the ESG framework, various types of risks, such as climate risk and reputational risk can be identified as potential risks, which may not be considered risks under the traditional valuation framework. These types of risks can have long-term effects, and pension funds, with their long-term horizon, are particularly vulnerable to long-live effects of ESG risks (Sautner and Starks 2021). Therefore, by taking into account the expanded scope of risks, pension funds can manage potential risks more effectively and potentially earn higher financial returns.

In addition, reputational consideration and increasing regulatory pressure may encourage pension funds to manage and incorporate ESG factors into investment policies (Nikulina 2021). For instance, pension funds may suffer from legal actions if they failed to consider ESG risks in their investment (Angwin and Edwards 2021). Moreover, the number of ESG-related regulations and policies has been significantly increased in the recent period (UN PRI 2021c). In particular, 124 of new ESG policies introduced in year 2020. Increasing regulatory intervention is putting pressure on pension funds to take ESG issues into consideration. Because of those potential reasons, pension funds have been moving toward integrating ESG factors into investment decisions and managing ESG-related issues by engaging with companies, thereby pursuing long-term health of economy as a whole.

Another important feature of pension funds is their growing size. For instance, the ratio of asset size of pensions to GDP is on average 76.3 percent for 22 major countries (Thinking Ahead Institute 2022). In the case of Korea, the asset size of pension ranked eight out of 22 major countries with a ratio of asset size of pension to GDP is approximately 55.1 percent (Thinking Ahead Institute 2022). Because of their significant size, Clark and Monk (2010) suggest that diversification alone is not sufficient strategy for pension funds. Moreover, some researchers argue that pension funds should utilize their power to address sustainability issues (e.g., Kiernan 2007; Quigley 2019). Consistent with this perspective, several pension funds engage with companies to manage ESG issues (e.g., Rohr 2022).

2.4. Assessing whether Firms or Funds with ESG commitments "Walk the Talk"

A growing body of literature examines whether firms or funds with ESG commitments "walk the talk". Some prior studies document that the ESG committed firms do not align their behaviors with their claims on ESG. Specifically, Raghunandan and Rajgopal (2021) document that the firms signed on Business Roundtable (BRT) are more likely to violate environmental and labor-related compliance, exhibit higher carbon emissions, and are more dependent on government subsidies. Similarly, Basu et al. (2022) find that banks with higher ESG ratings do not act in the interests of poor localities, as evidenced by the issuance of fewer mortgages in these areas. These studies suggest that there is discrepancy between the firms' commitment on ESG issues and their actual behavior.

Another literature focuses on the ESG investing practices and examines whether mutual funds with ESG objectives behave consistent with their goals. Investigating voting behavior, Dikolli et al. (2022) show that ESG mutual funds are more likely than other mutual funds to vote in favor of ESG shareholder proposals, supporting the "walk the talk" hypothesis. However, other studies that examine the ESG performance of firms held by ESG funds report totally opposite results. For instance, Raghunandan and Rajgopal (2022) find that firms held by ESG mutual funds have worse track records for ESG issues, as shown by higher propensity to violate environmental and labor laws. They further suggest that firms held by ESG funds have higher carbon emissions per unit of revenue. However, these firms have higher ESG scores partly because of their greater voluntary disclosure. Similarly, Kim and Yoon (2023) find that funds that signed on UN PRI do not improve fund-level average ESG scores or fund returns. They further suggest that funds with PRI signatories did not exhibit higher ESG performance before joining to PRI compared to non-PRI funds. However, they find that funds with PRI signatories attract large fund inflows and tend to heavily advertise the joining of PRI.

2.5. Research Questions

Building on prior studies, this paper attempts to investigate whether and how the NPS follows through its commitments to ESG. To provide a potential answer to this question, this paper examines whether the NPS ownership is associated with ESG performance of firms. The NPS can implement ESG in two different ways: (1) using its influence to encourage investees to enhance ESG activities (i.e., engagement channel), and (2) changing its holdings based on ESG performance of firms, which involves buying (selling) the stocks with good (poor) ESG performance (i.e., changing holding channel). In this paper, we attempt to assess these two different channels.

While there are two possible channels, we expect that the engagement channel is more plausible because the NPS faces difficulty in selling stocks of a firm due to its large ownership and thereby huge impact on stock market. Since its establishment in 1988, the size of the NPS has grown significantly, reaching 890 trillion Korean Won in 2022. When it is difficult to dispose of holding stocks, the NPS may have greater incentives to engage with management to address ESG issues (Gillan and Starks 2000; Kim et al. 2014). To test this prediction, we examine the voting decision of the NPS as one method of engagement. Furthermore, to test the changing holdings channel, we examine whether the NPS adjusts its ownership level in response to negative ESG incidents using RepRisk dataset.

Lastly, we examine the value implications of NPS holding and ESG performance. Pension funds may consider ESG issues into their investment policies as they have fiduciary duty and responsibility to beneficiaries (Nikulina 2021). Because the primary objective of pension funds is to generate higher returns for their beneficiaries, ESG implementation can be supported when it provides higher financial returns. However, prior research suggests that pension funds may pursue investment strategies that are aligned with their own objectives but not with those of members (e.g., Woidtke 2002; Barber 2007). This raises concerns that the implementation of ESG issues by the NPS may lead to lower financial returns, which would be detrimental to the interests of its members. Thus, it is an empirical question whether the combination of the NPS ownership and superior ESG performance is associated with the financial value.

In sum, this study attempts to provide the partial answers to following questions:

RQ1: Does the NPS follow through its commitment to ESG? If so, what is the mechanism?

RQ2: What is the value implication of NPS holding in combination with ESG performance?

3. Data and Sample

The main sample consists of Korean public firms listed on the Korea Stock Exchange (KSE) or the Korea Securities Automated Quotation (KOSDAQ) from year 2015 to 2020.[25] The NPS ownership data on Korean public firms and voting decisions of the NPS are collected from the NPS website.[26] ESG scores on Korean public firms are obtained from Korea

[25] The sample period starts in 2015 because the data on NPS voting is available since 2014. The NPS ownership data is available since 2012, and the data on ESG scores is available since 2011. The NPS ownership data is available since 2016 on NPS website, and hence we requested the information disclosure for the years from 2012 to 2015.

[26] Data on NPS ownership and voting decisions are publicly disclosed in the following NPS website: https://fund.nps.or.kr/jsppage/fund/mcs/mcs_04_01_01.jsp#

Corporate Governance Service (KCGS). The data on negative ESG incidents are retrieved from RepRisk dataset. RepRisk screens daily news using more than 100,000 information sources and identifies negative ESG news of a firm.[27,28] Financial information data are retrieved from the DataGuide. All continuous variables are winsorized at 1st and 99th percentiles to mitigate the effect of outliers. The sample size varies depending on the analyses. Panel A of Table 1 reports the sample selection procedure used to estimate Equation (1). The sample size starts from 13,814 firm-year observations from 2015 to 2020. For the analyses, we restrict the sample to firm-year with ESG scores and non-missing variables that are needed in the analyses. This restriction eliminates 8,907 firm-year observations.[29] The final sample consists of 4,907 firm-year observations.

4. Research Design

4.1. NPS Ownership and ESG Performance

We first examine whether the NPS ownership is associated with ESG performance of firms by estimating the following OLS regression model:

$$LOG\_ESG_{i,t} = \beta_0 + \beta_1 NPS_{i,t-1} + \beta_2 VOTE\_NO_{i,t-1} + \beta_3 LOG\_MV_{i,t-1} + \beta_4 ROA_{i,t-1} + \beta_5 HHI_{i,t-1} + \beta_6 TOBINQ_{i,t-1} + \beta_7 LIQUIDITY_{i,t-1} + \beta_8 EQUITY\_FIN_{i,t-1} + \beta_9 DEBT\_FIN_{i,t-1} + \beta_{10} ABS\_DA_{i,t-1} + \beta_{11} FOR\_OWN_{i,t-1} + \beta_{12} LARGE\_OWN_{i,t-1}$$

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27 Specifically, RepRisk screens the information from public sources, stakeholder, and third-party sources, including print and online media, social media, blogs, regulators, governmental bodies, think tanks, and newsletters, etc.

28 Prior studies widely use the RepRisk dataset to identify negative ESG news (e.g., Li and Wu 2020; Gantchev et al. 2022).

29 The decrease in sample size is primarily attributable to the limited coverage of ESG scores. KCGS provides ESG scores for approximately 900 firms, including companies listed in KSE and some large companies listed in KOSDAQ.

$+Year\ FE\ +Industry\ FE\ +Firm\ FE+\varepsilon_{i,t},$ (1)

where *i* indicates firm, *t* indicates year. The dependent variable is a proxy for ESG performance, which is ESG score provided by KCGS. Raw ESG scores range from 0 to 7. We convert this raw number into the natural log of ESG scores (*LOG_ESG*). The variable of interest is *NPS*, defined as the level of NPS ownership at the end of year (December). To address the potential skewed distribution of NPS ownership, we also use the rank variables of NPS ownership, which are *R3_NPS* and *R5_NPS*. We assign zero number to firms with zero NPS ownership, and firms with positive NPS holdings are divided into three groups (*R3_NPS*) or five groups each year (*R5_NPS*). The number from 1 to 3 (5) are assigned based on the ranks, where high numbers represent higher NPS ownership.

For control variables, we include the voting decision of the NPS on agendas in shareholder meetings. *VOTE_NO* is coded as one if the NPS votes against at least one agenda during a year, and zero otherwise. We also include the control variables following Dhaliwal et al. (2011), which examine the determinants of voluntary CSR disclosure. Specifically, we control firm size (*LOG_MV*) because large firms have greater resources to manage ESG issues, and therefore they are under greater pressure to engage in ESG activities. We include a measure of firm profitability (*ROA*) as firms with higher profitability are able to finance ESG activities. The industry competition measure (*HHI*), which is calculated as Herfindahl-Hirschman Index, is also controlled because overall industry competition can affect a firm's commitment to ESG activities. We also control for growth opportunities, measured as Tobin's Q (*TOBINQ)* because firms with greater opportunities are likely to be financially constrained, thereby having fewer resources to support ESG activities. On the other hand, firms with greater opportunities may engage more actively in ESG activities to enhance their reputation and to attract potential investors. Relatedly, managers may attempt to improve ESG activities if they have incentives to increase liquidity. This is because ESG risks can be negatively associated with downside risk (e.g., Kim et al. 2014) and potentially affect liquidity. Thus, we control for liquidity (*LIQUIDITY*), which is measured as the number of shares traded divided by the total number of shares outstanding. We further control for financing activities of firms, including equity financing (*EQUITY_FIN*) and debt financing (*DEBT_FIN*). We also include the absolute value of discretionary accruals (*ABS_DA*) to control financial transparency of firms. Lastly, we control for potential effects of other investors' ownership: foreign investors' ownership (*FOR_OWN*), and large shareholder's ownership (*LARGE_OWN*). Detailed definitions of variables are provided in Appendix. To mitigate potential correlated omitted variable problem, we include firm fixed effects as well as year and industry fixed effects in the regression model.

4.2. Granger Causality Tests

By estimating Equation (1), we can assess the association between the NPS ownership and ESG performance. However, it is difficult to establish a strong causal relation from estimating Equation (1). To assess the causal relation between the NPS ownership and ESG performance, we apply

Granger causality tests (Granger 1969) following Lev et al. (2010). Granger causality tests involves two estimations: investigating (1) the current change in ESG score as a function of prior change in NPS ownership, and (2) the current change in NPS ownership as a function of prior change in ESG score. By estimating two sets of regressions, Granger Causality tests investigate whether a variable has predictive value, thereby assessing causality (Lev et al. 2010). Specifically, we estimate the following two equations to apply Granger causality tests:

$$log(ESG_{i,t}/ESG_{i,t-1}) = \alpha_0 + \alpha_1 \Delta NPS_{i,t-1} + \alpha_2 log(ESG_{i,t-1}/ESG_{i,t-2}) + \alpha_3 \Delta VOTE\_NO_{i,t-1} + \alpha_4 \Delta LOG\_MV_{i,t-1} + \alpha_5 \Delta ROA_{i,t-1} + \alpha_6 \Delta HHI_{i,t-1} + \alpha_7 \Delta TOBINQ_{i,t-1} + \alpha_8 \Delta LIQUIDITY_{i,t-1} + \alpha_9 \Delta EQUITY\_FIN_{i,t-1} + \alpha_{10} \Delta DEBT\_FIN_{i,t-1} + \alpha_{11} \Delta ABS\_DA_{i,t-1} + \alpha_{12} \Delta FOR\_OWN_{i,t-1} + \alpha_{13} \Delta LARGE\_OWN_{i,t-1} + Year\ FE + Industry\ FE + \varepsilon_{i,t}, \quad (2)$$

$$\Delta NPS_{i,t} = \beta_0 + \beta_1 \Delta NPS_{i,t-1} + \beta_2 log(ESG_{i,t-1}/ESG_{i,t-2}) + \beta_3 \Delta VOTE\_NO_{i,t-1} + \beta_4 \Delta LOG\_MV_{i,t-1} + \beta_5 \Delta ROA_{i,t-1} + \beta_6 \Delta HHI_{i,t-1} + \beta_7 \Delta TOBINQ_{i,t-1} + \beta_8 \Delta LIQUIDITY_{i,t-1} + \beta_9 \Delta EQUITY\_FIN_{i,t-1} + \beta_{10} \Delta DEBT\_FIN_{i,t-1} + \beta_{11} \Delta ABS\_DA_{i,t-1} + \beta_{12} \Delta FOR\_OWN_{i,t-1} + \beta_{13} \Delta LARGE\_OWN_{i,t-1} + Year\ FE + Industry\ FE + \varepsilon_{i,t}, \quad (3)$$

The intuition underlying these regressions is that if the NPS induces the improvement of ESG performance of firms, then an increase in NPS ownership in the past can predict the future improvement in ESG performance. However, it is unlikely that past ESG improvement could predict a future increase in NPS ownership. Equation (2) tests the engagement channel by investigating whether the change in ESG performance can be explained by prior change in NPS ownership. On the other hand, Equation (3) tests whether the NPS adjusts its holdings based on the ESG scores by examining whether the change in NPS ownership can be explained by prior change in ESG performance of firms. In sum, Granger causality tests identify whether the change in independent variable is useful in predicting the change in dependent variable, thereby assessing the causal relation.

In general, Granger causality tests include lagged variable of the dependent variable in model and examine whether prior change in test variable has predictive power over the prior value of the dependent variable (Lev et al. 2010). Following the prior literature, we also include lagged variables of the dependent variables: prior change in NPS ownership ($\Delta NPS_{i,t-1}$) and prior growth in ESG performance ($log(ESG_{i,t}/ESG_{i,t-1})$). Moreover, all control variables are constructed in a change form.[30] Because Granger causality tests do not guarantee the definite causality, we use term 'Granger cause' following prior literature (Lev et al. 2010). If the NPS ownership 'Granger cause' ESG performance of firms, then we expect the coefficient on $\Delta NPS_{i,t-1}$ in Equation (2) (α_1) to be positive. On the other hand, if ESG performance 'Granger cause' NPS holdings, then the coefficient on $log(ESG_{i,t}/ESG_{i,t-1})$ in Equation (3) (β_2) will be positive.

4.3. The Effect of Voting Decision

We investigate the exercise of voting rights as one form of engagement (e.g., Gorman 2017). In particular, voting against at shareholder meeting is a way to express shareholders' dissatisfaction with management. Prior literature suggests that "vote no" decision can induce the change in

[30] The change in control variable is calculated as the variable of year t-1 minus that of year t-2.

corporate governance (Kim et al. 2014), and firm performance (Del Guercio et al. 2008). If the NPS can influence the behavior of firms through the exercise of voting rights, then the firms may enhance their ESG activities when the NPS votes against the agendas in shareholder meetings. To examine the impact of "vote no" decisions of the NPS, we construct an indicator variable that is coded as one if the NPS votes against at least one agenda during a year, and zero otherwise.[31] Since the data on "vote no" decision of the NPS is only available for the firms held by the NPS, we restrict the sample to firms with positive NPS ownership. We then examine the impact of NPS's "vote no" decision on ESG performance. Specifically, we estimate the following regression model to test the effect of "vote no" decision by the NPS:

$$log(ESG_{i,t}/ESG_{i,t-1})=\alpha_0 + \alpha_1 VOTE\_NO_{i,t-1} + \alpha_2 \Delta LOG\_MV_{i,t-1} + \alpha_3 \Delta ROA_{i,t-1} + \alpha_4 \Delta HHI_{i,t-1} + \alpha_5 \Delta TOBINQ_{i,t-1} + \alpha_6 \Delta LIQUIDITY_{i,t-1} + \alpha_7 \Delta EQUITY\_FIN_{i,t-1} + \alpha_8 \Delta DEBT\_FIN_{i,t-1} + \alpha_9 \Delta ABS\_DA_{i,t-1} + \alpha_{10} \Delta FOR\_OWN_{i,t-1} + \alpha_{11} \Delta LARGE\_OWN_{i,t-1} + Year\ FE + Industry\ FE + \varepsilon_{i,t}, \quad (4)$$

If the "vote no" activity of the NPS plays a role in improving ESG activities of firms, then the coefficient on the "vote no" dummy (α_1) will be positive. Furthermore, we note that the NPS exercises its voting rights to various items of agendas in shareholder meetings, and it is possible that voting decision on a certain item can affect ESG performance of investees. To explore this possibility, we categorize the agendas in shareholder meetings into three items: (1) election, (2) remuneration, and (3) firm operation. More specifically, election agendas include the election of directors, internal

[31] The use of an indicator variable of "vote no" is consistent with prior literature's approach (e.g., Kim et al. 2014; Lee et al. 2018).

auditors, and audit committee members. Remuneration agendas are generally related to the approval of the limit on the remuneration of directors and others. Lastly, most of operation agendas consist of amendments to the articles of incorporation. We then examine the "vote no" decision on these agendas separately when estimating Equation (4).

4.4. Changing Holdings in response to Negative ESG Incidents

Next, we assess the changing holding channel by investigating whether the NPS changes its holdings in response to negative ESG incidents. Due to its large stake, the NPS may face challenges in implementing exit strategy for poor ESG performers. Specifically, the average NPS ownership is approximately 2.6 percent across 1,249 Korean companies, and the NPS holds more than 5 percent over 260 companies at the end of 2021. If the NPS sells the shares of a firm, then stock prices would drop significantly, resulting in losses. However, it is possible that the NPS adjusts its level of ownership based on ESG activities of firms instead of choosing exit strategy. To test this possibility, we examine whether the NPS decreases its holdings in response to negative ESG incidents. To identify negative ESG incidents, we use RepRisk dataset, which provides the counts of daily negative ESG news. We investigate the association between the number of negative ESG incidents and the change in NPS ownership by estimating following regression model:

$$\Delta NPS_{i,t} = \beta_0 + \beta_1 LOG\_Incidents_{i,t-1} + \beta_2 LOG\_MV_{i,t-1} + \beta_3 ROA_{i,t-1} + \beta_4 HHI_{i,t-1} + \beta_5 TOBINQ_{i,t-1} + \beta_6 LIQUIDITY_{i,t-1} + \beta_7 EQUITY\_FIN_{i,t-1} + \beta_8 DEBT\_FIN_{i,t-1} + \beta_9 ABS\_DA_{i,t-1} + \beta_{10} FOR\_OWN_{i,t-1} + \beta_{11} LARGE\_OWN_{i,t-1} + \beta_{12} PAST\_RET_{i,t}$$

$$+ \beta_{13} IVOL_{i,t-1} + \beta_{14} NANALYST_{i,t-1} + \beta_{15} LEVERAGE_{i,t-1}$$
$$+ Year\ FE + Industry\ FE + \varepsilon_{i,t}, \quad (5)$$

The dependent variable (*ΔNPS*) is the change in NPS ownership in a firm from year t-1 to year t. The variable of interest is *LOG_Incidents*, which is calculated as the natural log of the number of negative ESG incidents occurred during a year. RepRisk dataset provides the daily negative incidents on E, S, G issues separately.[32] Thus, we count total ESG incidents based on each E, S, G incidents. An incident can include the negative news on all three E, S, G issues, or it can include the negative incidents on only one of factors (e.g., only on E issue). We include controls that are included in Equation (1) and further control variables that are known to be associated with institutional investor ownership based on prior literature (e.g., Chung and Zhang 2011; Bushee and Miller 2012). For instance, we additionally control last year stock returns (*PAST_RET*), idiosyncratic volatility (*IVOL*), the number of analyst following (*NANALYST*), and leverage ratio (*LEVERAGE*). If the NPS decreases its holdings in response to negative ESG incidents, then the coefficient on *LOG_Incidents* (β_1) will be negative.

4.5. Value Implications of NPS Holding and ESG Performance

Finally, we examine the value implications of NPS holding and ESG performance. If ESG implementation by the NPS results in higher financial

[32] RepRisk identifies ESG news for 28 categories of environmental, social, and governance issues.

returns, the NPS's ESG commitment can be supported. To test the value implication, we investigate the abnormal stock return performance following Khan et al. (2016). More specifically, we examine whether the NPS investees with better ESG performance outperform the other firms in terms of future abnormal stock returns. We acknowledge that abnormal future returns can be interpreted in two different ways. On the one hand, higher abnormal future returns can capture omitted risk factors. On the other hand, abnormal future stock returns can reflect the information that was not immediately incorporated into stock prices. That is, the information on the NPS ownership and ESG performance may not be fully reflected into stock prices immediately, but it is incorporated into stock prices over the longer term. We adopt the second approach to interpret future returns following Khan et al. (2016). We assume that investors may struggle to understand the implications of NPS ownership and ESG activities, resulting in delayed market reaction. Alternatively, it is possible that better financial performance resulting from NPS ownership and ESG activities could lead to higher returns. Furthermore, investigating future return performance is relevant in this context because the NPS can have objectives to find out the undervalued stocks to obtain higher future returns.

To test the abnormal stock return performance, we perform two different tests: (1) portfolio analysis and (2) firm-level return analysis. To conduct the portfolio analysis, we construct portfolios based on the NPS ownership and ESG scores. First, we form the portfolios of firms based on whether the firms are held by the NPS. Second, we construct the portfolios based on ESG scores of firms. Specifically, we partition the firms into three groups: firms with low, middle, and high ESG scores, and examine the difference between the firms in top tercile and the firms in bottom tercile. Third, we combine the information on NPS holding and ESG scores. We restrict the sample to firms with positive NPS ownership, and then divide the firms into three groups based on ESG scores. We attempt to examine the difference between the firms belong to top tercile and the firms in bottom tercile. The portfolios are constructed at the end of each year based on the NPS ownership and ESG scores. We then regress one-year ahead monthly returns (from January to December) on Fama and French (1993) three factors as well as Carhart (1997) momentum factor: market excess return (*MKT*), size factor (*SMB*), market to book factor (*HML*), and momentum factor (*MOM*). We obtain the data on four factors from DataGuide. The estimated intercept from the monthly regression, which is not explained by risk factors, represent alpha.

In addition, we also utilize firm-level annual return regression and estimate the below regression model:

$$RET12_{i,t+1} \text{ or } (ABRET12_{i,t+1}) = \beta_0 + \beta_1 D\_NPS_{i,t} + \beta_2 R3\_ESG_{i,t} + \beta_3 D\_NPS_{i,t} \times R3\_ESG_{i,t} + \beta_4 PAST\_RET_{i,t} + \beta_5 RD_{i,t} + \beta_6 ADV_{i,t} + \beta_7 SGA_{i,t} + \beta_8 CAPEX_{i,t} + \beta_9 LOG\_MV_{i,} + \beta_{10} ROE_{i,t} + \beta_{11} TOBINQ_{i,t} + \beta_{12} LIQUIDITY_{i,t} + \beta_{13} LEVERAGE_{i,t} + \beta_{14} ABS\_DA_{i,t} + \beta_{15} NANALYST_{i,t} + \beta_{16} BETA_{i,t} + \beta_{17} IVOL_{i,t} + Year\ FE + Industry\ FE + \varepsilon_{i,t+1}, \quad (6)$$

where *i* indexes firm, *t* indexes year. The dependent variable is one-year ahead future returns, measured as either one year buy-and-hold returns from January to December in year t+1 (*RET12*), or one year buy-and-hold abnormal returns (*ABRET12*) from January to December in year t+1, where abnormal return is calculated as a firm's monthly return minus monthly market return. To assess whether the firms with NPS holding and higher ESG performance exhibit different future returns, we include the interaction term between an indicator variable of whether the firm is held by NPS (*D_NPS*) and the rank variable for ESG performance (*R3_ESG*). Specifically, *D_NPS* is equal to one if the stocks are held by NPS, and zero otherwise. As for ESG rank variable, the firms are ranked into three groups based on ESG scores. *R3_ESG* indicates the rank of ESG scores, measured in two ways: (1) an indicator variable that takes the value of one if a firm's ESG score belongs to top tercile group and zero otherwise, or (2) a rank variable that ranges from 1 to 3, where 1 (3) number is assigned to bottom (top) tercile group. Consistent with portfolio analysis, we rank the firms based on ESG scores within NPS holding firms and non-NPS holding firms separately.

We include control variables following prior literature (e.g., Khan et al. 2016). For instance, we control for prior year's return (*PAST_RET*), R&D expense (*RD*), advertising expense (*ADV*), SG&A expense (*SGA*), capital expenditure (*CAPEX*), firm size (*LOG_MV*), profitability (*ROE*), growth opportunities (*TOBINQ*), liquidity (*LIQUIDITY*), leverage (*LEVERAGE*), the absolute value of discretionary accruals (*ABS_DA*), the number of analysts following (*NANALYST*), CAPM beta (*BETA*), idiosyncratic volatility (*IVOL*). If the firms held by NPS with higher ESG performance exhibit higher future returns, then the coefficient on the interaction term *D_NPS* ×*R3_ESG* will be positive (β_3). In both portfolio and firm-level analysis, we restrict the sample to the firms listed in Korea Stock Exchange because the coverage of ESG scores on KOSDAQ firms is largely limited.

5. Empirical Results

5.1. Descriptive Statistics

Panel B of Table 1 reports the sample distribution by year. Sample distribution shows that the sample is evenly distributed across years from 2015 to 2020. Panel C of Table 1 shows the descriptive statistics of variables used in Equation (1). ESG scores provided by KCGS range from 0 to 7. The mean values of log of ESG score is 0.917. In terms of raw ESG score, the mean value is 2.7. The average value of NPS ownership is 0.029. In the sample, about 49 percent of firms are held by NPS in year t-1. Table 2 provides the correlation matrix among the variables used in Equation (1). The variables of interest, the NPS ownership and ESG score is positively correlated, suggesting the potential positive relation between these two variables. For other control variables, firm size, profitability, industry concentration, foreign investors' ownership are positively correlated with ESG scores, whereas growth opportunities, liquidity, equity and debt financing activities, and the absolute value of discretionary accruals are negatively correlated with ESG scores. We further attempt to examine the association between the variables using multivariate analyses.

[Insert Table 1 about here]

[Insert Table 2 about here]

5.2. Results for Engagement

We first examine whether the NPS ownership influences the ESG performance of investee companies. Panel A of Table 3 reports the results of estimating Equation (1), which examines the association between the level of NPS ownership and ESG scores. The dependent variable is the natural log of ESG scores (*LOG_ESG*). Columns (1), (2), (3) provide the results when the NPS ownership variable is measured as *NPS, R3_NPS*, and *R5_NPS*, respectively. In all columns (1)-(3), we find the positive and significant coefficients on the NPS ownership variable, suggesting that the NPS ownership is positively associated with ESG scores. In terms of economic significance, 1 percent point increase in the NPS ownership is associated with 0.006 increase in ESG score. Alternatively, an increase in one standard deviation of the NPS ownership is related to 0.025 increase in ESG score.[33] For the control variables, we find that an indicator variable of whether the NPS votes against agendas in shareholder meeting (*VOTE_NO*) is positively associated with ESG score, indicating that voting behavior of the NPS is associated with ESG performance. In addition, we find that liquidity is negatively associated with ESG score.

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[33] The standard deviation of *NPS* is about 0.041, so we can calculate the effect of an increase in one standard deviation of *NPS* on the natural log of ESG score as 0.0251 (=0.612*0.041). As the dependent variable is the natural log of ESG scores, we estimate the economic significance by calculating $e^{z}-1$, where z is the coefficient on the independent variable (Craswell et al. 1995). Thus, the economic significance of an increase in one standard deviation of *NPS* is calculated as: $e^{(0.0251)}-1 = 0.025$. Similarly, the economic significance of 1 percent increase in the NPS ownership is calculated as: $e^{(0.612*0.01)}-1 = 0.006$.

We further attempt to assess the engagement channel by utilizing Granger causality methodology. Panel B of Table 3 presents the result of estimating Equation (2), which is designed to implement Granger causality test. In Equation (2), the growth in ESG score is regressed on the prior change in the NPS ownership and other control variables. This approach allows us to examine the engagement channel by investigating whether the prior change in NPS ownership can predict future changes in ESG score. In Panel B of Table 3, we find the positive and statistically significant coefficient on *ΔNPS(t-1)* (coefficient= 0.612, t-stat.= 2.73), suggesting that the NPS ownership 'Granger cause' the ESG performance of firms. This result indicates that an increase in the NPS ownership leads to superior ESG activities, supporting the engagement channel.

[Insert Table 3 about here]

5.3. The Effect of Voting Decision

The results in Table 3 suggest that the NPS ownership drives the ESG performance of firms. The results support the argument that the NPS engages with companies to improve ESG performance. We further attempt to examine underlying mechanism for the findings. We investigate the exercise of voting rights as a mechanism of engagement. If the NPS utilizes its voting rights to encourage ESG activities, we predict that there will be an improvement in ESG performance when the NPS votes against the agendas in shareholder meetings. To conduct more in-depth analysis of voting decision, we classify the agendas of shareholder meetings into three categories: (1) election, (2) remuneration, and (3) operation.

Panel A of Table 4 provides the descriptive statistics on *VOTE_NO* variables. The mean values suggest that about 32.5 percent of the NPS's investees experience the "vote no" decision of the NPS on average. When we divide all types of agendas into three different items, the percentage is the highest for the election agenda (0.192), followed by remuneration (0.157), and operation agenda (0.055).

Panel B of Table 4 presents the estimation results of Equation (4). The dependent variable is the change in ESG scores, and the variables of interest is an indicator variable whether the NPS votes against the agendas in shareholder meetings. Column (1) provides the result when we examine "vote no" decision on all types of agendas. Columns (2), (3), and (4) suggest the results when the agendas are related to election, remuneration, and operation, respectively. In column (1), the coefficient on the "vote no" dummy is significantly positive (coefficient= 0.029, t-stat.= 1.97), suggesting that the NPS's investees improve ESG performance after experiencing "vote no" decision of the NPS. In columns (2), (3), and (4), we further examine the specific item of agenda. When the item is election agenda in column (2), we find the statistically significant coefficient on the "vote no" variable (coefficient = 0.058, t-stat. = 3.10), indicating that the NPS's decision to vote against the election of directors or auditors is significantly associated with the future improvement in ESG activities. However, in columns (3) and (4), we do not find the significant results for remuneration or operation agendas.

Overall, the results show that the NPS may encourage firms to improve ESG activities using its voting decision, and that especially "vote no" decision on the election of directors or auditors agendas has significant impact.[34]

[Insert Table 4 about here]

5.4. Results for Changing Holdings

Previously, we examine the engagement as one channel to implement ESG. However, the NPS can achieve its ESG objectives by buying or selling the stocks based on ESG performance of firms. This strategy can be implemented in a relatively short period of time compared to the engagement (e.g., Kim and Yoon 2023). In this section, we investigate whether the NPS changes its ownership level based on ESG performance of firms. To test the change in holding channel, we first adopt Granger causality methodology as we did in the earlier analysis. Specifically, we estimate Equation (3), which is the regression of the change in the NPS ownership on prior ESG growth. If the NPS alters its shareholdings in response to the change in ESG performance of firms, then prior changes in ESG score can predict the future changes in NPS holdings. Table 5 presents the estimation results of Equation (3). We find the insignificant coefficient on the prior change in ESG score (coefficient = - 0.001, t-stat. = -0.65), implying that ESG performance of firms

[34] We further decompose total ESG score into individual components: E, S, G factor. We find that the impact of NPS's "vote no" activity is particularly significant in improving governance factor. This result suggests that the NPS's voting decision has an effect on improving governance of the investees, which is consistent with Kim et al (2014)'s findings.

does not ‘Granger cause’ NPS ownership. Thus, we fail to find the evidence that NPS changes its level of shareholdings based on ESG activities of firms.

[Insert Table 5 about here]

5.5. Changing Holdings in response to Negative ESG Incidents

We further examine whether the NPS changes its holdings in response to negative ESG incidents. Although we fail to find the evidence that NPS changes its ownership based on ESG scores in Table 5, it is possible that the NPS reacts more strongly to negative ESG incidents relative to good ESG news. To test this possibility, we estimate Equation (5), which examines the association between the number of negative ESG incidents in the last year and the change in NPS ownership.

Table 6 provides the estimation results. Panel A of Table 6 reports the frequency of firm observations and the negative ESG incidents each year. Because of the limited coverage of RepRisk dataset, the sample size decreases to 1,734 firm-year observations. Panel B of Table 6 provides the descriptive statistics. It shows that the mean value of the negative ESG incidents (*Incidents*) is 4.532, indicating that sample firms experience about 4.5 number of negative ESG incidents during a year.

Panel C presents the estimation results of Equation (5). The analysis reveals that the coefficient on *LOG(Incidents)* is statistically insignificant (coefficient = 0.001, t-stat.=0.94), suggesting that negative ESG incidents are not significantly associated with the change in NPS ownership. This finding implies that the NPS does not make significant changes in its shareholdings in response to negative ESG news regarding investee firms. Consequently, overall results fail to provide evidence supporting the changing holdings channel.

[Insert Table 6 about here]

5.6. Value Implications of NPS Holding and ESG Performance

Next, we turn to examine the value implications of NPS holding and ESG performance. Because the NPS's primary objective is to generate higher financial returns to its members, it is worthwhile to examine the value implication of NPS's ESG investment practices. If the improvement in ESG performance driven by the NPS engagement has positive value implications, then the NPS's ESG initiatives can be beneficial to its members. To assess the value implications, we examine future abnormal stock return performance. The underlying assumption of this test is that the information regarding NPS ownership and ESG performance is not fully incorporated into stock prices immediately and therefore realized as future returns over the extended period. In addition, examining future returns is particularly relevant in this setting because one of the key roles of the NPS is to identify undervalued stocks with the objective of achieving higher future returns.

We first perform portfolio analyses. Table 7 provides the estimated coefficients on four risk factors and intercept for the portfolios that are formed based on the NPS holding and ESG score. Specifically, we construct the portfolios based on the NPS ownership, ESG scores, and the ESG scores of firms held by the NPS. Columns (1)-(4) report the results when portfolios are formed based on the NPS holding, columns (5)-(8) present the results of portfolios based on ESG score, and columns (9)-(12) provide the results where portfolios are constructed based on ESG scores of the NPS investees. We provide the results using both equal-weighted and value-weighted approach.

In columns (1)-(4), we construct the portfolios based on whether the firms are held by NPS. In all columns (1)-(4), we find insignificant alphas, suggesting that NPS holding portfolio does not outperforms non-NPS holding portfolio. In addition, the differences in alphas between two portfolios are not statistically significant in both equal-weighted and value-weighted portfolios. The results in columns (1)-(4) indicate that NPS holding itself does not have value implications.

Columns (5)-(8) provide the results when the portfolios are formed based on ESG scores of firms. We classify the firms into three groups based on ESG scores, and then examine the alphas of high ESG group (top tercile) and low ESG group (bottom tercile). We find significantly negative alpha in column (6), suggesting that firms with higher ESG scores exhibit lower future stock return performance. However, we do not find significant alpha when we use value-weighted approach. Moreover, the differences in alphas between high ESG firms and low ESG firms are not statistically significant. Thus, we find mixed evidence for the value implication of ESG performance.

Lastly, columns (9)-(12) present the results of portfolio analysis, which is constructed based on both NPS holding and ESG score. Specifically, we restrict the sample to firms with positive NPS holding, and then classify the firms into three groups based on ESG scores. In column (12), using value-weighted approach, we find positive and significant alpha (alpha = 0.0024, t-stat.= 1.85), where the annualized alpha is estimated as 2.92 percent. This result indicates that among the NPS's investee firms, firms with superior ESG performance exhibit higher abnormal returns as evidenced by significant alpha. However, when we employ equal-weighted approach in column (10), we do not observe the consistent result (alpha= -0.0020, t-stat.= -1.11). Additionally, alphas of two groups (high ESG vs. low ESG) are not statistically significantly different. Overall, we find some weak evidence that the firms with NPS holding and higher ESG scores exhibit positive alpha, but this abnormal future return is observed only when we use value-weighted approach. Therefore, we fail to find strong evidence on the value implications of NPS holding and ESG performance using portfolio analysis.

[Insert Table 7 about here]

We further examine the value implications of NPS holding and ESG performance using firm-level annual return regression. Table 8 presents the results from estimating Equation (6). The dependent variables include both buy-and-hold returns (*RET12*) and abnormal buy-and-hold returns (*ABRET12*) from January to December in year t+1. Columns (1) and (2) present the results when *R3_ESG* is an indicator variable of whether firms belonging to top tercile group, while columns (3) and (4) report the results when *R3_ESG* is a tercile rank variable ranging from 1 to 3. In all columns, we find the positive and significant coefficients on the interaction term between *D_NPS* and *R3_ESG*, indicating that firms with superior ESG performance among the NPS's investee firms tend to exhibit higher future returns.

However, we find the negative and significant coefficients on *D_NPS*, suggesting that firms with NPS holding have lower future returns compared to firms without NPS ownership. This result is inconsistent with portfolio analysis. Furthermore, we observe insignificant coefficients on *R3_ESG* across all specifications, indicating the absence of a significant standalone effect of ESG performance on future returns. Overall, we find no positive value implications from either NPS ownership or ESG performance alone. However, when we combine the two, we find some weak evidence that NPS's investees with better ESG performance exhibit higher future returns. The results suggest that improvement in ESG performance via engagement of the NPS can potentially lead to positive value implications.

[Insert Table 8 about here]

6. Conclusion

This study aims to investigate whether and how the NPS implements its commitment to ESG. Pension funds take a strong position to integrate ESG factors into their investment practices, but there has been relatively little evidence on whether and how pension funds are actually following through their commitments. This paper attempts to fill this void by examining the association between the NPS ownership and ESG performance of firms. There are two distinct channels through which ESG objectives can implemented: (1) encouraging firms to enhance their ESG performance (i.e., engagement), and (2) adjusting its holdings based on the ESG performance of firms. We investigate which of these approaches the NPS employs.

This paper first finds that the level of NPS ownership is positively associated with future ESG scores provided by KCGS. When we utilize Granger causality methodology, the finding suggests that prior changes in NPS ownership can predict future improvement in ESG scores, supporting the argument that the NPS engage with investees to improves ESG performance. We further examine underlying mechanism of how the NPS affects ESG performance. We examine voting decisions on agendas in shareholder meetings as a form of engagement. We find that the NPS's investees enhance ESG activities following “vote no” decision from the NPS, particularly in the cases where the vote is against the election of directors or auditors agenda.

Next, we evaluate whether the NPS changes its holdings based on ESG performance of firms. Using Granger causality test, we find that prior changes in ESG score are not significantly associated with future changes in NPS ownership. We further find that the NPS does not make significant adjustments to its shareholdings in response to negative ESG incidents. Overall, the findings suggest that there is insufficient evidence to support the claim that the NPS changes its holdings based on ESG performance of firms.

Lastly, we examine the value implications of NPS holding and ESG performance. We find that neither the NPS holding nor ESG score has positive standalone effect on future abnormal returns. However, we find some weak evidence that the NPS's investees with higher ESG scores exhibit higher future abnormal returns relative to investees with lower EGS scores. Overall, this paper provides the evidence that the NPS plays a role in improving ESG activities of firms, and that such improvement can have some value implications.

However, we acknowledge that there are several limitations of this paper. First, ESG score can be imperfect measure to capture ESG activities of firms. For instance, Raghunandan and Rajgopal (2022) suggest that ESG scores are correlated with voluntary disclosure on ESG issues but not with firms' compliance or carbon emissions. Second, we attempt to draw causality using Granger causality tests, but neither Granger causality nor other statistical tests can definitely establish strong causal relation. Thus, we have to be cautious in establishing strong causality from the results. Lastly, we do not provide the evidence on the specific mechanism behind the relation between NPS ownership and ESG performance. We show that the firms improve ESG performance after experiencing the "vote no" decision by the NPS. However, there is a remaining question of how voting decision can affect firm behavior. Future research can extend the scope of study and further examine the specific mechanism for the effects of the NPS ownership on ESG performance.

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TABLE 1
Sample Selection, Sample Distribution, and Descriptive Statistics

Panel A: Sample Selection Procedure

Public Firms from year 2015 to 2020	13,814
Firms without ESG score	(8,711)
Firms with missing variables	(196)
Final Sample	4,907

Panel B: Sample Distribution by Year

Year	# of observations	Percent
2015	777	15.83
2016	814	16.59
2017	800	16.30
2018	831	16.93
2019	829	16.89
2020	856	17.44
Total	4,907	100

Panel C: Descriptive Statistics

	N	Mean	S.D.	p25	Median	p75
LOG_ESG(t)	4,907	0.917	0.437	0.718	0.975	1.194
NPS(t-1)	4,907	0.029	0.041	0.000	0.000	0.059
R3_NPS(t-1)	4,907	0.980	1.152	0.000	0.000	2.000
R5_NPS(t-1)	4,907	1.468	1.796	0.000	0.000	3.000
VOTE_NO(t-1)	4,907	0.168	0.374	0.000	0.000	0.000
LOG_MV(t-1)	4,907	12.700	1.492	11.597	12.499	13.578
ROA(t-1)	4,907	0.018	0.078	0.002	0.023	0.053
HHI(t-1)	4,907	0.144	0.098	0.075	0.118	0.165
TOBINQ(t-1)	4,907	1.087	1.134	0.524	0.732	1.144
LIQUIDITY(t-1)	4,907	2.373	3.472	0.550	1.147	2.556
EQUITY_FIN(t-1)	4,907	0.007	0.040	0.000	0.000	0.000
DEBT_FIN(t-1)	4,907	0.004	0.063	-0.018	0.000	0.022
ABS_DA(t-1)	4,907	0.068	0.078	0.017	0.045	0.089
FOR_OWN(t-1)	4,907	0.108	0.131	0.019	0.056	0.152
LARGE_OWN(t-1)	4,907	0.434	0.168	0.309	0.438	0.547

This table provides the sample selection procedure, the sample distribution, and the descriptive statistics of variables used in Equation (1). Please refer to Appendix for the variable definitions.

TABLE 2
Pearson Correlation Matrix

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1)	*LOG_ESG(t)*	1														
(2)	*NPS(t-1)*	0.377***	1													
(3)	*R3_NPS(t-1)*	0.342***	0.899***	1												
(4)	*R5_NPS(t-1)*	0.346***	0.919***	0.977***	1											
(5)	*VOTE_NO(t-1)*	0.150***	0.382***	0.461***	0.463***	1										
(6)	*LOG_MV(t-1)*	0.461***	0.575***	0.556***	0.557***	0.241***	1									
(7)	*ROA(t-1)*	0.130***	0.180***	0.172***	0.168***	0.097***	0.242***	1								
(8)	*HHI(t-1)*	0.052***	-0.019	-0.034**	-0.033**	-0.005	-0.073***	-0.043***	1							
(9)	*TOBINQ(t-1)*	-0.160***	-0.053***	-0.035**	-0.039***	-0.025*	0.214***	-0.013	-0.097***	1						
(10)	*LIQUIDITY(t-1)*	-0.287***	-0.231***	-0.226***	-0.223***	-0.151***	-0.223***	-0.191***	0.028**	0.229***	1					
(11)	*EQUITY_FIN(t-1)*	-0.154***	-0.097***	-0.095***	-0.094***	-0.067***	-0.068***	-0.274***	0.012	0.159***	0.195***	1				
(12)	*DEBT_FIN(t-1)*	-0.061***	0.023	0.045***	0.043***	0.024*	0.038***	-0.062***	-0.031**	0.098***	0.059***	-0.005	1			
(13)	*ABS_DA(t-1)*	-0.157***	-0.111***	-0.082***	-0.086***	-0.019	-0.064***	-0.082***	-0.031**	0.285***	0.162***	0.242***	0.111***	1		
(14)	*FOR_OWN(t-1)*	0.321***	0.414***	0.397***	0.401***	0.183***	0.573***	0.221***	0.002	0.015	-0.207***	-0.099***	0	-0.115***	1	
(15)	*LARGE_OWN(t-1)*	0.017	-0.153***	-0.113***	-0.120***	0.016	-0.113***	0.151***	-0.002	-0.221***	-0.288***	-0.135***	-0.062***	-0.114***	-0.244***	1

This table reports the Pearson correlation of matrix for the variables used in Equation (1). *, **, *** indicate statistical significance at 10%, 5%, and 1% level, respectively. Please refer to Appendix for the variable definitions.

TABLE 3
NPS Ownership and ESG Performance: Engagement

Panel A: Level Regression Results with Firm Fixed Effects

Dep.Var. =	*LOG_ESG(t)*		
NPS =	*NPS*	*R3_NPS*	*R5_NPS*
	(1)	(2)	(3)
NPS(t-1)	**0.612****	**0.028*****	**0.019*****
	(2.28)	**(3.05)**	**(3.15)**
VOTE_NO(t-1)	0.041**	0.037**	0.036**
	(2.54)	(2.30)	(2.24)
LOG_MV(t-1)	-0.015	-0.016	-0.016
	(-0.75)	(-0.77)	(-0.79)
ROA(t-1)	-0.029	-0.031	-0.028
	(-0.24)	(-0.26)	(-0.24)
HHI(t-1)	0.105	0.102	0.101
	(0.41)	(0.40)	(0.39)
TOBINQ(t-1)	-0.006	-0.005	-0.005
	(-0.39)	(-0.36)	(-0.34)
LIQUIDITY(t-1)	-0.005**	-0.005**	-0.005**
	(-2.20)	(-2.20)	(-2.20)
EQUITY_FIN(t-1)	-0.204	-0.206	-0.209
	(-1.18)	(-1.19)	(-1.21)
DEBT_FIN(t-1)	-0.044	-0.046	-0.044
	(-0.55)	(-0.57)	(-0.55)
ABS_DA(t-1)	-0.056	-0.057	-0.054
	(-0.73)	(-0.74)	(-0.70)
FOR_OWN(t-1)	0.042	0.024	0.027
	(0.30)	(0.17)	(0.19)
LARGE_OWN(t-1)	0.090	0.087	0.088
	(0.66)	(0.64)	(0.64)
Constant	1.702***	1.707***	1.707***
	(5.54)	(5.57)	(5.58)
Observations	4,907	4,907	4,907
Adjusted R-squared	0.661	0.661	0.661
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Cluster	Firm	Firm	Firm

Panel B: Granger Causality Test (Regression of ESG growth on prior NPS ownership change)

Dep.Var. =	*LOG(ESG(t)/ESG(t-1))*
ΔNPS(t-1)	**0.612*****
	(2.73)
LOG(ESG(t-1)/ESG(t-2))	-0.390***
	(-21.57)
ΔVOTE_NO(t-1)	0.042***
	(2.73)
ΔLOG_MV(t-1)	-0.004
	(-0.19)
ΔROA(t-1)	-0.010
	(-0.10)
ΔHHI(t-1)	0.245
	(1.31)
ΔTOBINQ(t-1)	0.015
	(0.87)
ΔLIQUIDITY(t-1)	-0.001
	(-0.56)
ΔEQUITY_FIN(t-1)	0.052
	(0.37)
ΔDEBT_FIN(t-1)	0.099*
	(1.82)
ΔABS_DA(t-1)	-0.090
	(-1.28)
ΔFOR_OWN(t-1)	0.002
	(1.42)
ΔLARGE_OWN(t-1)	0.086
	(0.47)
Constant	-0.010
	(-0.41)
Observations	3,603
Adjusted R-squared	0.165
Year FE	Yes
Industry FE	Yes
Cluster	Firm

This table reports the results for the relation between NPS ownership and ESG performance. Panel A reports the results of estimating Equation (1), which examines the association between the level of NPS ownership and ESG scores. Panel B presents the estimation results of Equation (2), which utilizes Granger causality test, where ESG score growth is regressed on the prior change in NPS ownership. In Panel A, the regressions are estimated from 2015 to 2020, and in Panel B, the regression is estimated from 2016 to 2020. *T*-statistics are presented in parentheses. *, **, *** indicate statistical significance at 10%, 5%, and 1% level, respectively. Please refer to Appendix for the variable definitions.

TABLE 4
The Effect of Voting Decision of NPS

Panel A: Descriptive Statistics

	N	Mean	S.D.	p25	Median	p75
VOTE_NO_Total	2,148	0.325	0.468	0.000	0.000	1.000
VOTE_NO_Election	2,148	0.192	0.394	0.000	0.000	0.000
VOTE_NO_Remuneration	2,148	0.157	0.364	0.000	0.000	0.000
VOTE_NO_Operation	2,148	0.055	0.229	0.000	0.000	0.000

Panel B: Regression Results

Dep.Var. =	*LOG(ESG(t)/ESG(t-1))*			
Agenda =	Total	Election	Remuneration	Operation
	(1)	(2)	(3)	(4)
VOTE_NO(t-1)	**0.029****	**0.058*****	**0.024**	**0.008**
	(1.97)	**(3.10)**	**(1.27)**	**(0.28)**
ΔLOG_MV(t-1)	0.007	0.008	0.007	0.007
	(0.23)	(0.25)	(0.22)	(0.21)
ΔROA(t-1)	-0.093	-0.095	-0.097	-0.090
	(-0.52)	(-0.53)	(-0.54)	(-0.50)
ΔHHI(t-1)	0.283	0.261	0.299	0.292
	(0.95)	(0.87)	(1.00)	(0.98)
ΔTOBINQ(t-1)	0.029	0.028	0.029	0.029
	(1.05)	(1.02)	(1.05)	(1.04)
ΔLIQUIDITY(t-1)	0.001	0.002	0.001	0.001
	(0.31)	(0.33)	(0.28)	(0.29)
ΔEQUITY_FIN(t-1)	-0.150	-0.161	-0.150	-0.156
	(-0.58)	(-0.64)	(-0.58)	(-0.60)
ΔDEBT_FIN(t-1)	0.049	0.046	0.050	0.048
	(0.43)	(0.41)	(0.44)	(0.42)
ΔABS_DA(t-1)	-0.308***	-0.306***	-0.308***	-0.307***
	(-2.70)	(-2.71)	(-2.69)	(-2.68)
ΔFOR_OWN(t-1)	-0.002	-0.002	-0.002	-0.002
	(-0.96)	(-0.99)	(-0.90)	(-0.91)
ΔLARGE_OWN(t-1)	-0.343	-0.340	-0.337	-0.337
	(-1.21)	(-1.20)	(-1.20)	(-1.20)
Constant	-0.063***	-0.068***	-0.055**	-0.055**
	(-2.62)	(-2.74)	(-2.33)	(-2.31)
Observations	2,148	2,148	2,148	2,148
Adjusted R-squared	0.034	0.038	0.033	0.032
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm

This table reports the results of estimating Equation (4), which examines the effects of NPS "vote no" decision on the change in ESG scores. In this analysis, the sample is restricted to the firm-year with positive NPS ownership. Panel A provides the descriptive statistics, and Panel B presents the regression results. Column (1) presents the result for all types of agendas. Columns (2), (3), and (4) provide the results for election, remuneration, and operation agendas, respectively. The regressions are estimated from 2015 to 2020. *T*-statistics are presented in parentheses. *, **, *** indicate statistical significance at 10%, 5%, and 1% level, respectively. Please refer to Appendix for the variable definitions.

TABLE 5
The Change in NPS Holdings: Granger Causality Test
(Regression of NPS ownership change on prior ESG growth)

Dep.Var. =	*ΔNPS(t)*
LOG(ESG(t-1)/ESG(t-2))	**-0.001**
	(-0.65)
ΔNPS(t-1)	-0.158***
	(-6.80)
ΔVOTE_NO(t-1)	-0.003**
	(-2.37)
ΔLOG_MV(t-1)	0.003**
	(2.04)
ΔROA(t-1)	-0.002
	(-0.63)
ΔHHI(t-1)	0.026
	(1.23)
ΔTOBINQ(t-1)	-0.002**
	(-2.11)
ΔLIQUIDITY(t-1)	-0.000
	(-1.04)
ΔEQUITY_FIN(t-1)	-0.003
	(-1.07)
ΔDEBT_FIN(t-1)	0.002
	(0.91)
ΔABS_DA(t-1)	0.001
	(0.17)
ΔFOR_OWN(t-1)	0.000
	(0.16)
ΔLARGE_OWN(t-1)	-0.026***
	(-2.83)
Constant	-0.002
	(-1.16)
Observations	3,603
Adjusted R-squared	0.084
Year FE	Yes
Industry FE	Yes
Cluster	Firm

This table reports the results of estimating Equation (3), which implements Granger causality test. The change in NPS ownership is regressed on the prior change in ESG scores. The regressions are estimated from 2016 to 2020. *T*-statistics are presented in parentheses. *, **, *** indicate statistical significance at 10%, 5%, and 1% level, respectively. Please refer to Appendix for the variable definitions.

TABLE 6
Negative ESG Incidents and the Change in NPS Holdings

Panel A: Frequency of Negative ESG Incidents

Year	# of observations	# of negative ESG incidents
2013	129	632
2014	166	1,166
2015	241	936
2016	216	889
2017	219	952
2018	245	891
2019	220	1,002
2020	298	1,233

Panel B: Descriptive Statistics

	N	Mean	S.D.	p25	Median	p75
Incidents	1,734	4.532	8.669	1.000	2.000	4.000
LOG(Incidents)	1,734	1.241	0.800	0.693	1.099	1.609

Panel C: Regression Results

Dep.Var. =	Δ*NPS(t)*
LOG(Incidents)(t-1)	**0.001**
	(0.94)
LOG_MV(t-1)	0.000
	(0.16)
ROA(t-1)	0.006
	(1.24)
HHI(t-1)	0.036
	(0.88)
TOBINQ(t-1)	-0.001
	(-0.73)
LIQUIDITY(t-1)	-0.000
	(-1.14)
EQUITY_FIN(t-1)	0.017
	(1.64)
DEBT_FIN(t-1)	0.006
	(0.70)
ABS_DA(t-1)	-0.008
	(-0.99)
FOR_OWN(t-1)	0.004
	(0.83)
LARGE_OWN(t-1)	-0.005*
	(-1.85)

RET(t-1)	0.003*
	(1.95)
IVOL(t-1)	0.005
	(0.53)
NANALYST(t-1)	0.000
	(1.02)
LEVERAGE(t-1)	-0.001
	(-0.21)
Constant	0.015
	(1.64)
Observations	1,734
Adjusted R-squared	0.077
Year FE	Yes
Industry FE	Yes
Cluster	Firm

This table presents the results of estimating Equation (5), which examines the association between the number of negative ESG incidents and the change in NPS ownership. Panel A provides the frequency table, Panel B reports the descriptive statistics, and Panel C presents the regression results. The regression is estimated from 2013 to 2020. *T*-statistics are presented in parentheses. *, **, *** indicate statistical significance at 10%, 5%, and 1% level, respectively. Please refer to Appendix for the variable definitions.

TABLE 7

NPS Holding, ESG Performance, and Future Returns: Portfolio Analysis

	1. NPS holding				2. ESG scores				3. ESG scores among the stocks held by NPS			
	Equal-weighted		Value-weighted		Equal-weighted		Value-weighted		Equal-weighted		Value-weighted	
Portfolio	No	Yes	No	Yes	Lowest Tercile	Highest Tercile	Lowest Tercile	Highest Tercile	Lowest Tercile	Highest Tercile	Lowest Tercile	Highest Tercile
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Constant	**0.0006**	**-0.0026**	**-0.0023**	**0.0010**	**0.0010**	**-0.0029****	**-0.0011**	**0.0012**	**-0.0022**	**-0.0020**	**-0.0020**	**0.0024***
	(0.34)	**(-1.36)**	**(-0.87)**	**(1.00)**	**(0.69)**	**(-2.00)**	**(-0.42)**	**(1.20)**	**(-0.85)**	**(-1.11)**	**(-0.65)**	**(1.85)**
MKT	0.8702***	0.9037***	0.8935***	0.9361***	0.8699***	0.9491***	0.8222***	0.9616***	0.8554***	0.9395***	0.8357***	0.9477***
	(21.27)	(20.24)	(14.30)	(41.69)	(23.92)	(27.22)	(13.73)	(41.88)	(13.84)	(22.30)	(11.34)	(31.27)
HML	0.0527	0.0576	-0.0077	0.0303	0.0041	0.1117**	-0.1198	0.0549*	-0.0128	0.1522***	-0.1698*	0.0824**
	(1.03)	(1.03)	(-0.10)	(1.08)	(0.09)	(2.52)	(-1.57)	(1.88)	(-0.17)	(2.90)	(-1.85)	(2.18)
SMB	0.8430***	0.4995***	0.5247***	-0.0262	0.8688***	0.4478***	0.5707***	-0.0805***	0.6539***	0.2545***	0.3931***	-0.0971**
	(16.72)	(9.08)	(6.81)	(-0.95)	(19.89)	(10.69)	(7.93)	(-2.92)	(8.58)	(4.90)	(4.33)	(-2.60)
MOM	-0.0987*	-0.0650	-0.1718**	-0.0804***	-0.1030**	-0.1886***	0.0143	-0.0878***	0.0147	-0.1697***	0.0780	-0.0991***
	(-1.96)	(-1.19)	(-2.24)	(-2.91)	(-2.36)	(-4.51)	(0.20)	(-3.19)	(0.19)	(-3.28)	(0.86)	(-2.66)
Diff. in alpha		-0.0032		0.0033		-0.0039		0.0023		0.0002		0.0044
Annualized alpha	0.72%	-3.08%	-2.73%	1.21%	1.21%	-3.43%	-1.31%	1.45%	-2.61%	-2.37%	-2.37%	2.92%
Adjusted R^2	0.889	0.840	0.726	0.944	0.902	0.896	0.694	0.940	0.736	0.852	0.595	0.907
NPS Holding	No	Yes	No	Yes					Yes	Yes	Yes	Yes
ESG score					Low	High	Low	High	Low	High	Low	High
No. of month	108	108	108	108	120	120	120	120	108	108	108	108
Period	JAN 2013- DEC 2021				JAN 2012- DEC 2021				JAN 2013- DEC 2021			

This table reports the portfolio analyses results. The coefficients on the constant represent alphas. Columns (1)-(4) report results for equal-weighted and value-weighted portfolios based on NPS holding. Columns (5)-(8) present results for equal-weighted and value-weighted portfolios of firms at the bottom and top terciles of ESG scores. Columns (9)-(12) restrict the firms with NPS holding and provide the results for equal-weighted and value-weighted portfolios of firms at the bottom and top terciles of ESG scores. The regressions are estimated from January 2013 to December 2021 in columns (1)-(4) and columns (9)-(12), while the regressions are estimated from January 2012 to December 2021 in columns (5)-(8). *T*-statistics are presented in parentheses. *, **, *** indicate statistical significance at 10%, 5%, and 1% level, respectively. Please refer to Appendix for the variable definitions.

TABLE 8

NPS Holding, ESG Performance, and Future Returns: Firm-level Analysis

Panel A: Descriptive Statistics

	N	Mean	S.D.	p25	Median	p75
RET12	5,817	0.103	0.450	-0.163	0.004	0.241
ABRET12	5,817	0.056	0.440	-0.215	-0.038	0.199
NPS	5,817	0.029	0.041	0.000	0.000	0.061
D_NPS	5,817	0.480	0.500	0.000	0.000	1.000
R3_ESG(Indicator)	5,817	0.409	0.492	0.000	0.000	1.000
R3_ESG(Rank)	5,817	2.152	0.801	1.000	2.000	3.000
PAST_RET	5,817	0.065	0.426	-0.195	-0.022	0.206
RD	5,817	0.007	0.015	0.000	0.000	0.006
ADV	5,817	0.007	0.015	0.000	0.001	0.005
SGA	5,817	0.135	0.146	0.051	0.088	0.155
CAPEX	5,817	0.035	0.043	0.007	0.022	0.050
LOG_MV	5,817	12.575	1.612	11.408	12.260	13.537
ROE	5,817	0.016	0.204	0.000	0.049	0.096
TOBINQ	5,817	0.857	0.717	0.499	0.670	0.945
LIQUIDITY	5,817	2.694	4.583	0.524	1.100	2.573
LEVERAGE	5,817	0.240	0.176	0.085	0.229	0.365
ABS_DA	5,817	0.062	0.067	0.017	0.043	0.083
NALAYST	5,817	3.206	5.956	0.000	0.000	3.000
BETA	5,817	0.923	0.688	0.500	0.922	1.333
IVOL	5,817	0.104	0.063	0.063	0.087	0.124

Panel B: Regression Results

Dep.Var. =	*RET12*	*ABRET12*	*RET12*	*ABRET12*
R3_ESG =	*High Indicator*		*Rank Variable*	
	(1)	(2)	(3)	(4)
D_NPS	-0.042***	-0.048***	-0.079***	-0.087***
	(-2.79)	(-3.32)	(-2.67)	(-3.07)
R3_ESG	-0.008	-0.010	-0.003	-0.005
	(-0.46)	(-0.65)	(-0.30)	(-0.47)
D_NPS×R3_ESG	**0.052****	**0.056*****	**0.027****	**0.028****
	(2.37)	**(2.63)**	**(1.97)**	**(2.14)**
PAST_RET	-0.049***	-0.044***	-0.049***	-0.044***
	(-3.46)	(-3.20)	(-3.43)	(-3.18)
RD	2.068***	1.942***	2.083***	1.957***
	(4.37)	(4.30)	(4.39)	(4.31)
ADV	-0.518	-0.488	-0.531	-0.502
	(-0.98)	(-0.96)	(-1.00)	(-0.99)
SGA	0.135*	0.140**	0.136*	0.141**

	(1.91)	(2.11)	(1.91)	(2.12)
CAPEX	0.310*	0.263	0.307*	0.260
	(1.81)	(1.58)	(1.79)	(1.56)
LOG_MV	-0.065***	-0.064***	-0.065***	-0.064***
	(-9.39)	(-9.61)	(-9.31)	(-9.52)
ROE	0.290***	0.281***	0.289***	0.280***
	(7.26)	(7.18)	(7.25)	(7.16)
TOBINQ	-0.056***	-0.056***	-0.057***	-0.056***
	(-4.98)	(-5.11)	(-5.02)	(-5.15)
LIQUIDITY	-0.020***	-0.020***	-0.020***	-0.020***
	(-12.75)	(-13.05)	(-12.71)	(-13.00)
LEVERAGE	-0.043	-0.044	-0.043	-0.044
	(-1.32)	(-1.41)	(-1.31)	(-1.40)
ABS_DA	-0.103	-0.109	-0.103	-0.110
	(-1.07)	(-1.17)	(-1.08)	(-1.18)
NANALYST	0.008***	0.007***	0.008***	0.008***
	(4.80)	(4.82)	(4.91)	(4.96)
BETA	-0.006	0.000	-0.006	0.000
	(-0.70)	(0.03)	(-0.71)	(0.02)
IVOL	2.263***	2.280***	2.264***	2.282***
	(12.95)	(13.50)	(12.96)	(13.50)
Constant	0.684***	0.646***	0.686***	0.650***
	(7.93)	(7.77)	(7.81)	(7.65)
Observations	5,817	5,817	5,817	5,817
Adjusted R-squared	0.172	0.198	0.172	0.198
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm

This table reports the results of estimating Equation (6), which examines the relation between NPS ownership, ESG score, and future returns. The dependent variable is future buy-and-hold returns (*RET12*) is columns (1) and (3), whereas it is abnormal buy-and-hold returns (*ABRET12*) in columns (2) and (4). *D_NPS* is an indicator variable of whether a firm is held by NPS. In columns (1) and (2), *R3_ESG* represents an indicator variable that equals to one if a firm belongs to top tercile of ESG score, and zero otherwise. In columns (3) and (4), *R3_ESG* indicates a rank variable, ranging from 1 to 3 based on tercile ranks. The regression is estimated from 2012 to 2020. *T*-statistics are presented in parentheses. *, **, *** indicate statistical significance at 10%, 5%, and 1% level, respectively. Please refer to Appendix for variable definitions.

Appendix. Variable Definitions

Variable	Definition
Dependent Variables	
LOG_ESG	The natural log of ESG score provided by Korea Corporate Governance Service (KCGS);
RET12	One year buy-and-hold returns from January December in year t+1;
ABRET12	One year buy-and-hold abnormal returns from January to December in year t+1, where abnormal return is calculated as market-adjusted returns (monthly return of a firm – monthly market return);
Test Variables	
NPS	The level of NPS ownership at the end of year (December);
VOTE_NO	An indicator variable that takes the value of one if the NPS votes against at least one agenda in shareholder meetings during a year, and zero otherwise;
R3_NPS	Tercile rank of NPS ownership, ranging from 1 to 3. Firms with zero NPS ownership is set to zero;
R5_NPS	Quintile rank of NPS ownership, ranging from 1 to 5. Firms with zero NPS ownership is set to zero;
LOG(Incidents)	The natural log of one plus the number of negative ESG incidents, provided by RepRisk database;
D_NPS	An indicator variable that takes the value of one if NPS ownership is greater than zero, and zero otherwise;
R3_ESG	Tercile rank of ESG score, ranging from 1 to 3, or an indicator variable that equals to one if ESG score belongs to the highest tercile rank group;

Control Variables	
LOG_MV	The natural log of market value of equity;
ROA	Return on assets, calculated as net income divided by total assets;
HHI	Herfindahl-Hirschman Index based on the 50 largest companies (sales-based) in a year-industry, where industry is classified using KSIC 1-digit code, and manufacturing firms are classified based on KSIC 2-digit code;
TOBINSQ	Tobin's Q, measured as the sum of book value of liabilities and market value of equity divided by total assets;
LIQUIDITY	Liquidity, measured as number of shares traded divided by total number of shares outstanding during a year;
EQUITY_FIN	The amount of net equity issuance scaled by total assets;
DEBT_FIN	The amount of net debt issuance divided by total assets;

ABS_DA	The absolute value of abnormal accruals estimated based on the modified Jones (1995) model;
FOR_OWN	The ownership of foreign shareholders at the end of fiscal-year;
LARGE_OWN	The ownership of largest shareholders at the end of fiscal-year;
PAST_RET	One year buy-and-hold returns from January to December in year t-1;
IVOL	Idiosyncratic volatility obtained from market model using the previous 36 month returns (from April to March);
NANALYST	The number of analyst following in December;
LEVERAGE	Leverage ratio, calculated as total liabilities divided by total assets;
MKT	Market excess returns;
HML	Fama and French (1993) book-to-market factors;
SMB	Fama and French (1993) size factors;
MOM	Carhart (1997) momentum factor;
RD	R&D expense divided by total assets;
ADV	Advertising expense divided by total assets;
SGA	SG&A expense divided by total assets;
CAPEX	Capital expenditure divided by total assets;
ROE	Return on equity, calculated as net income divided by total equity;
BETA	Previous 36 months rolling estimated beta obtained from firm-specific CAPM estimations (from April to March);

국문초록

무형자산 투자에 관한 연구

본 논문은 기업의 무형자산 투자와 관련한 두 개의 독립적인 논문으로 구성되어 있다. 첫 번째 논문은 특허등록 자료를 이용하여 재벌기업들이 비재벌기업들에 비해 특허를 더 많이 취득하는지 분석하고 이러한 두 그룹간 특허활동의 차이가 상품시장에서 갖는 시사점에 대해 살펴본다. 구체적으로 본 논문은 재벌 집단에 속한 기업들이 다른 기업들보다 매년 더 많은 개수의 특허를 취득함을 확인하였으며, 이러한 이유를 R&D 투자 효율성과 재벌 집단 내 지식파급효과를 통해 살펴보았다. 재벌기업들의 경우 투자기회에 더 민감하게 반응하여 R&D 투자를 수행하고 있었으며, 재벌 집단에 속한 한 기업의 특허 개수가 같은 재벌 집단에 속한 다른 기업들의 특허의 개수와 양의 상관관계를 가짐을 확인하였다. 또한 본 연구는 한 기업이 취득한 특허의 개수가 증가할수록 미래 수익률이 증가하는 현상을 일부 발견하였으며, 이러한 현상은 재벌 집단에 속한 기업들에게 더 크게 나타남을 일부 확인하였다. 이는 재벌기업들이 비재벌기업들에 비해 특허를 더 많이 취득하고, 특허 취득으로 인한 경제적 효익도 더 크게 누리고 있음을 시사한다. 마지막으로 본 연구는 재벌기업들의 특허활동이 상품시장 전체에서 갖는 시사점을 살펴보고자 산업-연도 단위의 분석을 수행하였다. 구체적으로, 한 산업에서 재벌 집단에 속한 기업들이 취득한 특허의 비중이 증가할수록 재벌기업들의 시장점유율은 증가하고 비재벌기업들의 시장점유율은 감소하는 현상을 발견하였다. 또한 재벌기업들이 취득한 특허 비중이 증가할수록 허핀달-허쉬만 지수로 측정한 시장집중도가 증가함을 발견하였으나, 산업전체의 성장률과는 유의한 상관관계를

발견하지 못하였다. 이는 재벌기업들의 특허활동이 활발해질수록 재벌기업들의 시장점유율이 증가하고 시장집중도가 높아지나 시장전체의 크기는 증가하지 않음을 시사한다.

두번째 논문은 국민연금이 ESG를 고려한 책임투자(responsible investment)를 이행하고 있는지, 이행하고 있다면 어떠한 방법을 사용하고 있는지 분석한다. 국민연금은 2006년부터 책임투자활동을 수행하기 위한 기반을 마련하였으며, 2018년에 스튜어드십 코드를 도입하는 등 책임투자와 수탁자 책임활동을 이행할 것을 명시적으로 공표하였다. 본 연구는 국민연금이 실제로 책임투자를 이행하는지 분석하기 위해 국민연금 지분율과 피투자기업들의 ESG 성과의 상관관계를 분석하였다. 책임투자를 이행하는 두 가지 방법으로는 주주활동(engagement)을 통해 기업들의 ESG 성과를 개선시키는 것과 기업들의 ESG 성과에 따라 투자의사결정을 하는 ESG 투자 방법을 살펴보았다. 분석결과, 국민연금 지분율이 높을수록 피투자기업들의 ESG 성과가 높음을 확인하였다. 또한 그레인저 인과관계(Granger causality) 방법론을 사용하여 국민연금 지분율이 증가하면 피투자기업들의 ESG 성과가 개선됨을 발견하였다. 이는 국민연금이 주주활동을 통해 책임투자를 이행하고 있음을 보여준다. 더 나아가 국민연금의 주주활동 방법을 자세히 살펴보고자 국민연금의 의결권 행사내역을 분석하였다. 국민연금이 주주총회에서 상정한 안건에 대해 반대 의결권을 행사하였을 때 피투자기업들의 ESG 성과가 개선됨을 발견하였으며, 특히 안건이 이사 및 감사의 선임 안건이었을 경우 그 효과가 나타남을 확인하였다. 그러나 본 연구는 피투자기업들의 ESG 성과가 변함에 따라 국민연금 지분율이 유의하게 변하지 않음을 확인하였으며, 피투자기업에 부정적인 ESG 사건들이 발생했을 때 국민연금의 지분율이 감소하는 결과를 발견하지 못하였다. 이는 국민연금이 기업들의 ESG 성과에 따라서 투자를 즉각적으로 조정하지

않음을 의미한다. 마지막으로 본 연구는 국민연금의 책임투자가 갖는 시사점을 살펴보기 위해 국민연금의 투자와 ESG 성과에 기반하여 포트폴리오 및 기업단위의 주식수익률 분석을 수행하였다. 분석결과, 국민연금이 투자한 기업들 중에서 ESG 성과가 좋은 기업들의 경우 ESG 성과가 좋지 않은 기업들에 비해 상대적으로 더 높은 미래 초과수익률을 보이고 있음을 일부 확인하였다.

주요어: 대규모 기업집단, 재벌, 특허, 시장집중도, 국민연금, 책임투자, ESG 성과, 주주활동

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